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CHANGES IN TREE SPARROW PASSER MONTANUS
POPULATIONS FROM URBAN PARKS

ABSTRACT

Studies of local Tree Sparrow Passer montanus populations from urban parks of Polish cities reveal changes in abundance and in nest site selection which differ from data collected from farmland. These changes are not always synchronous among neighbouring cities and parks. Several urban declines are difficult to explain, chiefly when obscured by the changes in the number of artificial nesting sites. One such case was a recorded decline Tree Sparrow and a switch to nesting in buildings observed in the Szczytnicki Park of Wrocław, after colonization by pine martens Martes martes. Judging from this the absence/presence of important predators or nest predators in other urban parks of Polish cities may be an additional factor promoting Tree Sparrow declines. It is suggested that a lack of precise data on the intensity of (mosaic-like in time and space) predation pressure in agricultural and urban landscapes should be considered when explaining the reasons for population changes in other bird species.

Key words: Tree Sparrow, breeding numbers, nest sites, predators, urban areas, Poland

INTRODUCTION

In Western Europe, from the British Isles to Switzerland, a serious decline in Tree Sparrow populations has been noticed during the 1950s and 1960s (Summers-Smith 1989, Marchant et al. 1990, Glutz v. Blotzheim and Bauer 1997), and again during the 1980s-1990s (Hagemeijer and Blair 1997, Both et al. 2002). This trend was especially conspicuous in agricultural regions. In western parts of Poland similar trends appeared in a much weaker form (decline by 30%) and later – during the 1990s (Kujawa 2000), while in the Silesian Lowland around Wrocław this has even not been noticed (Orłowski and Ławniczak 2009). Later, around the year 2005, both in western Europe, as on the farmland in Poland (chiefly in NW part, in Pomerania), a stabilization or a slight recovery was reported (Baillie et al. 2012, Kuczyński and Chylarecki 2012). In urban habitats, at least across the German-Polish Lowland, comparable changes have appeared much later, as during the 1960-70s still strong increases prevailed there,
while declines emerged as late as in the 1980s and 1990s (Mizera 1988, Tomiałojć and Stawarczyk 2007). Some asynchrony and a mosaic-like patchiness may suggest the involvement of various local factors.

Several explanations have been proposed, as possible reasons for such trends, some not necessarily exclusive to each other. One group of reasons was thought to be responsible for lowering the adult survival, i.e. acting through a shortage of winter food, while the other one pointed to poorer reproduction indices, possibly owing to higher nestling mortality, and apparently acting through a shortage of animal food, chemical contamination of an environment and food, and/or by increased impact of pathogens (Wesołowski 1991, Pinowski et al. 1995, Svensson et al. 2007). However, there is no general consensus on the main reasons for Tree Sparrow declines (Glutz v. Blotzheim and Bauer 1997, Gatter 2007), chiefly when one takes into account some spectacular local changes. A hypothesis that a retreat and then return of some predators could contribute to such changes remains a barely acceptable possibility (Thomson et al. 1998), though a different opinion by C.P. Bell (2011) should be noted.

On such a background, long-term observations from west-Polish towns, chiefly from Legnica, Wrocław and Poznań, the urban parks of which were located far from any direct impact of organochlorine biocides, though some might have suffered of heavy metal contamination, can add a new dimension. Another factor considered here, is the possible impact of important predators on sparrow populations over time.

**STUDY AREA AND METHODS**

The size of local Tree Sparrow populations has been estimated with the help of a combined version of the mapping method (spot mapping), with 7-11 visits conducted per season to each sample plot. In the case of this species the focus was on intensive searching for nests (Tomiałojć 1980), which were found in c. 90% of nesting territories. During field work the personnel responsible for park care had also been asked for observations of nocturnal mammals as potential predators.

Field work was carried out by the authors during several periods between 1965 and 2012 in two parks of Legnica, a town now with a population of 110 thousand inhabitants (Tomiałojć 2007) and in a few parks of Wrocław, a city of 630 thousand inhabitants (Tomiałojć and Profus 1977, Mazurek 2003, Tomiałojć 2011). Data from other towns were accepted on the basis of identical census method and habitat similarity. Parks included in the analysis had to be over 100 years old, mainly of deciduous character, thus fairly stable structurally and similar trophically. Their location within town boundaries varied from the down-town zone, typical urban zone, and the one on the edge of dense urban development. More detailed characteristics can be found in Tomiałojć 1970, Tomiałojć and Profus 1977 and more recent papers listed above. Other common features of this sample were as follows: a) all park tree stands had abundant natural tree holes, b) there were only a few (up to 15) nest-boxes suitable
to the species. One exception occurred during the 1990s (between series of censuses) in the 17-ha part of Szczytnicki Park when 30 boxes were added, however, only a half of these were still present during bird counts in 2000-02; in Słowacki’s Park between 1983-95 there were 20 street lanterns offering the nest sites, c) Down-town parks in Legnica and Wrocław were crossed by busy streets (with c. 20 and 80 vehicles/minute accordingly), exposing these green areas to contamination with heavy metals, d) In most parks there were no predators important to Tree Sparrows, except red squirrels *Sciurus vulgaris* and small corvids, however in three of them more serious predators did occur, more recently. In Szczytnicki Park, from c. 1978 to 2001 pine martens *Martes martes* occurred, in 2005 an exceptional brood of the Sparrow Hawk *Accipiter nisus* was present, while between 2009-12 there was a threefold increase in Hooded Crows *Corvus cornix*, known to regularly kill bird fledglings and sporadically to open some nest-boxes (Tomiałojć 2011). In the peripheral Zachodni Park the presence of pine martens and two mustellids *Mustela nivalis, M. erminea* was reported, at least for the 1970s (Lontkowski 1989). Still more diverse was the predatory guild in the peripheral park of Legnica, though this area has been poorly studied.

**RESULTS**

Changes in Tree Sparrow abundance in some parks of west-Polish towns during the past half century have been summarized in the Table 1. Below are more detailed data.

**Wrocław – Botanical Gardens.** This down-town green area (7.4 ha, of which 4 ha with an older treestand) harboured 17-18 pairs in nest-boxes during 1953-55 while 5 during 1972 and 1976 (Peters 1963, Król 1977). Later only two pairs were found (Mazurek 2003). This could be attributed to a shortage of suitable nest sites, as with increased number of nest-boxes to 50 (since 2003) the Tree Sparrow population has risen to at least 16 pairs in April 2013.

**Wrocław – Słowacki’s Park.** The abundance of Tree Sparrows was monitored in this down-town park for 40 years. The habitat differed from the Botanical Gardens by almost a complete absence of a bush layer. Numbers of sparrows were around 15-20 pairs, the addition of nest boxes (15) occurred in 1975 and street lanterns (20) provided nest sites until 1995. In spite of doubling the pedestrian and street traffic (from 18-40 to 45-80 vehicles/min in rush hours), and the transformation of a neighbouring weedy ground into grass lawns, no decline in Tree Sparrows occurred (Fig. 1).

**Wrocław – Szczytnicki Park.** A 17-ha “forest like” part of the whole park, recalling old riparian stand, has been repeatedly censused for half a century (Dyrcz 1963, Tomiałojć and Profus 1977). Starting with c. 50-69 pairs during from 1959-74, nesting mostly in natural tree holes, a dramatic decline of Tree Sparrows was noticed, first 6 then 2 pairs during 1986-88 and in 2001-02, later to nil (Cisakowski 1993, Mazurek 2003, Tomiałojć 2011). The decline occurred despite no marked differences in the habitat or its neighbourhood state, with the continuous presence of numerous *Tortrix*
viridana caterpillars, and with no change in street traffic (up to 12 vehicles/min.). The decline followed the appearance in the park of a family of pine martens and has not been reversed despite erecting 40 nest-boxes (150 in the whole park) during early 1990s (Mazurek 2003).

A bird census in 2011-12 covering the whole 90 ha of mostly deciduous Park stands revealed, that though there were no still Tree Sparrows nesting in trees or nest-boxes in the „forest-like” part, within the nearest neighborhood there were two Tree Sparrow colonies (14 +3 pairs) in two buildings plus another 20-22 pairs nesting each year in the buildings surrounding the Park (Fig 2, map for 2011). The colony of 14 nests has only appeared after that building was renovated in 2000, birds appeared perhaps after 2003 (Mazurek 2003). All these birds continue to forage in the park, chiefly on geometrid caterpillars in oaks, both during the nestling and fledgling periods.

**Wrocław – Zachodni Park.** Tree Sparrows were first censused from 1975-77 in this park, which at that time was on the periphery of urban development. There were 44, 38 and 30 pairs accordingly, mostly in nest-boxes. Already before the end of the 1980s a distinct decline in numbers was noticed (Lontkowski 1989), while during 2002-03 there were 8 pairs, in spite of several nest-boxes present (Mazurek 2003). The reasons for the decline are obscure, as in the meantime a neighbouring weedy grassland has gradually been covered with an urban development and it is not known when precisely pine martens and weasels arrived in the park, though they were present during the 1970s, and subsequently disappeared.

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Fig. 2. Changes in Tree Sparrow distribution over the whole Szczytnicki Park, Wrocław (years 1973, 2003 and 2011). The symbols mean: 1 – occupied tree holes or (few) nest-boxes; 2 – areas with other nests, not censused, 3 – groups of nests in buildings, their numbers and the ranges of feeding flights; 4 – pine marten hole during 2000-01

**Legnica – Central and Peripheral Parks.** Censuses repeated in 2003-04 and 2007 have revealed the almost total disappearance of the species from both sites. In Central Park, after an increase between 1965 and 1972, the population nesting largely in natural tree holes declined from its peak number of 85 pairs to the mere three pairs in 2003-04 (Tomiałojć 2007). Casual observations in the meantime indicated there presence in this park during the 1980s, so the decline must have occurred during the 1990s. The reasons for the decline remain unclear, perhaps they should be looked for in agricultural areas some 2-3 km from the park.

**Poznań – Sołacki Park.** This down-town park (10.5 ha) in 1951 was populated by three Tree Sparrow pairs while in 1975 by 25 nesting mostly in tree holes. After erecting nest-boxes this population reached 64 pairs in 1984 (R. Graczyk, cit. after Mizera 1988). Yet, in 2006 there were only 5-6 pairs (T. Mizera, in litt.), in spite of the presence of nest-boxes.

**DISCUSSION**

The main difficulty in analysing the changes in Tree Sparrow abundance, as of other hole-nesters, comes of the uncertainty of, to a what extent and when the data were compromised by the introduction or removal (or through a decaying process) of artificial nest sites. To some extent this plagues the data in this paper. In spite of this reservation, it can be shown that after post-war increases observed in most of the Tree Sparrow urban populations in several Polish towns, strong declines took place subsequently (Tab. 1).


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<td>Peripheral P. 20 ha</td>
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<td>Sołacki P. 10.5 ha</td>
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1) In April 2013 at least 16 pairs, all in nest-boxes (L.T.).
Directions and timing of urban Tree Sparrow population changes

Until the early 20th century Tree Sparrows avoided urban areas of central-European, including Silesian, towns (Kollibay 1906). Later they colonized them, which during the 1950s and 1960s was strengthened by three opportunities: a) emerging post-war extensive weedy ruderal sites, b) abundance of nesting niches in war damaged trees and buildings, and b) an absence in towns of efficient predators, even most corvids. In Silesian towns, but also elsewhere, from Dortmund, Hamburg, Berlin up to Warsaw and Lublin, the Tree Sparrow became a common breeder, chiefly in allotments, urban parks and villa districts. Its high numbers lasted until the mid-1980s or early 1990s, e.g. in Sołacz district of Poznań, in Legnica, Wrocław and Siedlce (Mizera 1988, Lontkowski 1989, Dombrowski and Łuczak 1998, Tomiałojć 2007, Tomiałojć and Profus 1977). Later a decreasing tendency was observed, and almost contemporarily from Dortmund (Abs and Bergen 1999), Hamburg (Mulsow 2006), up to Łódź (Janiszewski et al. 2009), Lublin (Biaduń 2004) and Gliwice (Grochowski and Szlama 2011). A lesser decline occurred in parks of Cracow between 1966-67 and 1991-92 (Krokos 1994), while in a park of Kielce as late as between 1997 and 2005 (P. Wilniewczyc, pers. com.). Some declines were irreversible even after erecting nest-boxes (e.g. Szczytnicki Park of Wrocław), but other populations recovered, as e.g. in parks of Warsaw (Nowicki 1992, Luniak and Węgrzynowicz 2009). Only in the NE-cities, Olsztyn and Kaliningrad, has a Tree Sparrow decline not occurred at all (Nowakowski et al. 2006, Lykov 2007). In general, the increases and then declines were fairly contemporary, with a slight geographical difference. Remarkably, post-war urban increases were contemporaneous with contrasting heavy declines in the farmland of western Europe, suggesting different causation. The later turn into urban declines was also not necessarily contemporary even with the changes in the state and extent in the nearest non-urban populations (e.g. in Wielkopolska and in Lower Silesia – Kujawa 2000, Orłowski and Ławniczak 2009) and not always contemporaneous in several towns (Tab. 1). Additionally, there was a strong differentiation of tendencies – within two cities (Wrocław and Lublin – Biaduń 2004), where alongside decline in some plots, there were other ones without such a tendency.

Possible cause of Tree Sparrow declines in urban green areas of western Poland

Of a range of causes of Tree Sparrow declines on farmland some for obvious reasons cannot be valid under urban conditions, where this species faces milder winters and is less exposed to organochlorine biocides, though instead, may be contaminated with heavy metals. In green areas in Wrocław, some fluctuations were of minor importance, as either they were fairly small or triggered by addition/removal of artificial nest sites and, finally, as resulting from a possible replacement of some birds between closely located plots (Botanical Gardens and Słowacki’s Park). However, these data allow to
exclude a possibility of declines to be triggered by heavy metals (Kostelecka-Myrcha et al. 1997, Kamiński 1998). Though increased contamination by combustion gases undoubtedly occurred, due to twice increased numbers of passing vehicles/min. in rush hours (from 18-30 during the 1970s to c. 45-80 recently), yet there were no negative reflections in the most exposed Tree Sparrow populations: in Botanical Gardens it declined years before heavy traffic developed, while in Sławkowski's Park changes depended on availability of nest sites, with no clear decline (Fig. 1). Contrarily, the strongest declines have been found in parks less exposed to street impact (8-20 vehicles/min), such as Szczytnicki Park, Zachodni Park, Central Park of Legnica and Słacki Park of Poznań.

The dramatic population declines after severe winters, which have been documented for Tree Sparrows e.g. on the outskirts of Warsaw (Pinowski 1968), hardly find a support in Silesian data. For example, the censuses started in Legnica plots three years after the „winter of the century” 1962/63 have revealed fairly good Tree Sparrow numbers, similarly as in parks of Wrocław there were no persistent “downs” after harsh or long winters 1978/79, 1986/87 or 2009/10 (Tomiałojć 2007, 2011, Fig. 1). This could be explained by a milder winter climate of Lower Silesia. Above does not exclude, however, a possibility of a long-term impact of the changes in the farmland surrounding the town, as a wintering habitat of urban Tree Sparrows. This seems most plausible in the case of Central Park of Legnica, where after peak numbers in 1972 Tree Sparrows later have declined to mere three pairs, and in the peripheral park to nil (Tomiałojć 2007), even though neither the structure of tree stands nor the numbers of nesting holes had changed significantly there. Yet, during last 25 years in the farmland around Legnica there were marked changes apparently influencing food availability during the winter: the fields have been separated from the parks by extensive zone of new urban development, and former fields with potatoes and sugar beet, abound of weeds, have been replaced by monocultures of dense maize and rape. Together with an explosion of dense and high vegetation due to eutrophication (Reichholf 2010), replacing former patches overgrown with low plants, all this has probably deteriorated conditions for winter survival. An alternative possibility, that in Legnica Tree Sparrows collapsed due to some epizootic disease (Pinowski et al. 1995), seems less probable in view of contemporary very strong population explosions of other bird species in the same park, apart from the House Sparrow Passer domesticus (Tomiałojć 2007).

The changes in Tree Sparrows abundance and behaviour in the Szczytnicki park were of a special category. Decline of high numbers in the long-studied 17 ha part of this park occurred during the period when elsewhere in Wrocław, Poznań and probably Legnica, dense populations still occurred (Tab. 1). It should be stressed, that this park was neither subjected to the strongest (down-town) urban influences, like contamination with heavy metals, nor to (distant) agricultural treatments with organochlorine biocides. In the radius of some 3 km, no marked changes in land use or in agricultural treatment were noticed. Yet, from “forest-like” part of this park formerly populated by
numerous Tree Sparrows (Dyrcz 1963, Tomiałojć and Profus 1977) they almost completely disappeared during c.1978-85. Contemporarily with an arrival of pine martens, the family of which thrived in the park till 2001 inclusively, bringing a symptoms of threat to hole-nesters (Tomiałojć 2011). In contrast to other urban parks, here the retreat of Tree Sparrows failed to be reversed even by erecting nest boxes during early 1990. Birds of this species appear to be highly sensitive to predators, and they may monitor the potential threat already during their autumn and winter sexual activity, while building nests and roosting in holes (Pinowski et al. 2009). Being threatened they could desert risky nest sites before the breeding season. Yet, Tree Sparrows did not desert Szczytnicki Park entirely. Censuses during 2003 and 2011-12 in the whole deciduous-tree-dominated part (90 ha) have revealed the presence of some pairs breeding in a few park buildings, as well as in buildings surrounding the park (Mazurek 2003, Fig. 2). In 2011 there were 37-40 pairs there. A decline in abundance was undeniable (probably by half or by 2/3), as formerly on 17 ha alone 65-69 pairs nested, so in the whole park probably there were twice as many. Alongside the decline there was also a permanent change in their behaviour and nest site selection, in particular desertion of nesting in tree holes or nest-boxes (last such cases were in 2000 and 2003) and a switch to nesting in niches of buildings and under roofing-tiles, in places apparently not penetrated by pine martens. Remarkably, even 10 years after pine marten disappearance Tree Sparrows no longer breed in trees. Last pairs nesting in trees solitarily, instead as earlier in clumps, turned to be very shy (R. Cisakowski; own obs.), and individuals coming to the park from outside also no longer go deep under canopy, but forage on the edges and meadows. Consequently, formerly optimal Szczytnicki Park, without any change in its structure, turned into a site worse than Słowacki’s Park: proportions of breeding densities have been reversed from former 33.8 to 24.8 p/10 ha, to the present one 1.8 to 24.2 p/10 ha. However, continued foraging in this park, chiefly on numerous in some years caterpillars of *Tortrix viridana*, confirms that the change could not be triggered by a shortage of breeding season food resources.

Thus, even when accepting as a general explanation for Tree Sparrow increases and declines some changes on farmland, possibly acting through reduction in the winter food supply, this does not exclude a possibility of contemporaneous modifications caused by patchily acting predation. In Szczytnicki Park the restored predation by pine martens (Tomiałojć 2011), was followed by destruction of broods and then desertion of nesting sites by some hole-nesters (*Passer montanus, Corvus monedula*), less by Starlings *Sturnus vulgaris*. After a retreat of Tree Sparrows and Jackdaws, the pine martens continued to rob nests of other species or to block the entrances to nest-boxes with extracted nest material. This made feeding of nestlings by Pied Flycatchers *Ficedula hypoleuca* impossible: during 2000-01 six such cases were recorded, while there were none in the absence of pine martens (Tomiałojć 2011).

A radical change in the pattern of nesting in Szczytnicki Park, from scattered and solitary in natural holes or in a few nest-boxes into a group (2-14 pairs) nesting
exclusively in buildings recalls a situation found in one of Budapest parks. There Sasvari and Hegyi (1994) revealed that after brood failure Tree Sparrows were changing the way of nesting from solitary to colonial or vice versa, as an alternative reproductive strategy. No mentioning, however, what was the ultimate reason for this. Perhaps originally it was a variable response to a threat from predators (when dynamic coloniality paid off) or to a long-term absence of such a danger (when solitary nesting was possible). Yet, in that park main predators might be absent for generations.

Here it should be made clear that, contrarily to pine martens, the presence in urban green areas of stone martens Martes foina had no impact on breeding Tree Sparrows or other hole nesters (Tomiałojć 1980a, 2011, Klausnitzer 1987). At least since the 1960. These mammals have regularly been occurring in all parks of Legnica and Wroclaw. Yet, their presence failed to inhibit strong increases in bird numbers, including Tree Sparrow, at that time (Tomiałojć 1970, Tomiałojć Profus 1977).

**A danger of predation as a factor modifying distribution and local abundance of Tree Sparrows**

A difficulty with explaining field data comes from a lack of reference data from close-to-pristine populations of the species, i.e. those nesting in natural holes and along the edges of forests not subjected either to eradication of predators or to influences from big cities (which may offer safe nesting or wintering sites). This gap in our knowledge is especially important in the case of Tree Sparrow. This species is known to have very variable nesting habits, which may be a mechanism reducing losses due to predators, like weasels Mustela nivalis (Deckert 1973, Glutz v. Blotzheim and Bauer 1997). Sparrows when disturbed at their nests with eggs or nestlings usually deserted the holes at a very high percent – even 85-90% – (Pinowski 1968, Pinowski et al. 1972). For example, in Szczytnicki Park during 2000-02, when only solitary Tree Sparrow pairs remained, and unable to obtain mutual warning with their neighbours, these birds turned into an extreme shyness (R. Cisakowski; Tomiałojć 2011). Judging from literature, we still do not know precisely what kind of predators acted as main robbers of the broods or as main threat to adult Tree Sparrows during their nesting in natural holes and along the edges of natural forests (but see some data in Gatter 2007; Adamik and Kral 2008). Their natural population dynamics is not known (Glutz v. Blotzheim and Bauer 1997), chiefly when in the forest-steppe zone, where the species used somehow to co-occur in the deciduous gallery forests with several representatives of the Mustelidae (M. martes included), Glyridae and Accipitridae (Novikov et al. 1963). Though Deckert (1973) and J. Pinowski (in litt.) noticed, that Tree Sparrow broods in nest-boxes were quite safe at the presence of some species of marten, polecat Mustela putorius, weasel, squirrel Sciurus vulgaris and domestic cat, yet this is not necessarily valid for the broods in natural holes (Wesołowski 2011). Population of this raptor breeding in a farmland-woodland landscape did not necessarily influenced urban Tree Sparrows in winter differently recently than it was before, because urban areas since
long ago were penetrated by wintering Sparrowhawks *Accipiter nisus* of a NE origin. Firm data on an impact of the recently restored population of this raptor on adult populations of Tree Sparrow are also lacking (Tomiałojć and Stawarczyk 2003). In the sole Polish town, where around the year 2000 a small population of breeding Sparrow Hawks emerged – in Lublin – this could not cause Tree Sparrow decline, because the latter happened dozens of years earlier (Biaduń 2004).

From the present-day distribution maps and habitat selection descriptions (Tomiałojć and Stawarczyk 2003, map in Kuczyński and Chylarecki 2012) it is evident that Tree Sparrow reaches the highest large-scale densities in the farmland of central Poland, where only 10-15% are afforested. Contrarily, the species is very scarce amongst large forests. This allows to speculate that once its past increase in numbers and an expansion on the farmland, i.e. the habitat regionally prevailing for one to five (Lower Silesia) thousand years, could be triggered by better food resources and a higher nesting success in mid-field copses, as not easily found and penetrated by arboreal mammals. Also, colonization and increases in urban areas, could benefit not only from a better food and milder urban climate, but from generations-long release from predation, even from a fear of being predated. According to „ecology of fear” reasoning (Brown et al. 1999), it is possible that exactly the memory of possible risk from pine martens (a kind of „tradition”) may cause, that Tree Sparrows in Szczytnicki Park still refuse to return to nesting in trees, and to the forest-like half-open park habitat, even if recalling pristine conditions. Very high densities once demonstrated either in urban allotments (up to 20-26 p/10 ha) or in down-town parks (up to 59-61 p/10 ha), were found in areas for dozens of generations devoid of main natural enemies (Jakubiec and Bluź 1977, Mizera 1988, Tomiałojć 2011). Hence, recent return and replenishment in urban green areas of predators (Tomiałojć 2011), allows to predict low abundance of urban Tree Sparrows in the future.

Finally, here is a commentary on conclusions about an unclear role of predation pressure drawn of the attempts to evaluate an impact of recently restored in Western Europe pressure of raptors, chiefly of the Sparrow Hawk, on the songbirds, including Tree Sparrow (Thomson et al. 1998, Gatter 2007). On one hand, even clear negative correlation between such large-scale monitoring of predators and abundance of their prey would not necessarily mean a causal relation. On the other hand, there are weak points in such a conservative conclusion. The first one is – the raptors, and avian predators, are by no means the only enemies, nor the most important ones to hole-nesters, as small mammals may locally be crucial (Gatter 2007). Second one is: – comparing the averaged data on species abundances from large regions, may not be a sensitive enough measure of an intensity of prey-predator relation. Usually we cannot measure precisely enough the extent and pressure of various predators acting over large regions to be later suitable to correlate it with the changes in prey abundance; here non-adequate fragments from populations of a predator and of a prey can often be confronted: the data about the predator embrace only the areas where it actually occurs, while the data on
abundance of prey species often contain averaged two categories of values: data from the areas actually penetrated by predators, and the data from those not penetrated by them. The patches (refugia) temporarily or permanently inaccessible to predator, which often hunts according to a model of „an area concentrated search” (Curio 1976, Tomiałojć 1980a), may constitute „safe patches” of successful reproduction of the prey. Large-scale data may camouflage the true relations between prey and predator. The final reservation is, perhaps, even more important. While elaborating sample data from large areas researchers usually do not know how old is particular co-occurrence of a predator with its prey, in each sampled site. Is this a fresh co-occurrence of a still scarce and inefficient predator facing replenished prey (during predator’s absence), or it is a case of a long coexistence of two partners with co-adapted proportions between their abundances. These two states may quite differently influence the calculations of the correlation between prey and predator abundances and the judgments on possibility of an influence. Therefore I share a view of C.P. Bell (2011), on an urgent need of detailed case studies of the predator-prey relationship (c.f. Tomiałojć 1980a) as one of possible ways to find reasons of the recent songbird decline, perhaps additional to food or nest-site shortage, pathogens, or chemical contamination.

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THE USE OF NEST-BOXES BY TWO SPECIES OF SPARROWS
(PASSER DOMESTICUS AND P. MONTANUS) WITH OPPOSITE TRENDS
OF ABUNDANCE – THE STUDY IN WARSAW

ABSTRACT

The occupation of nest-boxes by House- and Tree Sparrow in Warsaw was investigated in 2005-2009 and in 2012. Riparian forests, younger and older parks in downtown, and housing estates were included in the study as 4 types of habitats corresponding to the urbanization gradient of Warsaw. 1035 inspections of nest-boxes suitable for both species (type A) were carried out during the breeding period and 345 nest-boxes of other types were inspected after the breeding period. In order to determine the importance of nest-boxes for both species on different plots, obtained data were analyzed using Nest-box Importance Coefficient (NIC). This coefficient describes species-specific rate of occupation of nest-boxes as well as the contribution of the pairs nesting in them. Tree Sparrow occupied a total of 33% of A-type nest-boxes, its densities were positively correlated with the number of nest-boxes, and seasonal differences in occupation rate were low for this species. The NIC and the rate of nest-box occupation for Tree Sparrow decreased along an urbanization gradient. House Sparrow used nest-boxes very rarely, only in older parks and some housing estates. Total rate of nest-box occupation for House Sparrow in studied plots was 4%, and NIC was relatively low. However, locally, installation of nest-boxes limited House Sparrow decline caused by reduced availability of its typical nest sites. Both species used only A-type nest boxes. The rate of nest-box occupation by House Sparrow decreased sharply since 1980s, and opposite trend was observed for Tree Sparrow. These alterations are consistent with the general changes in both species populations in Warsaw in recent decades: decrease in House Sparrow and increase in Tree Sparrow number. The presented results suggest that loss of nest sites may not be the main reason of decrease in House Sparrow population in Warsaw. Additionally, House Sparrow decline leads to increase in nest sites (including nest-boxes) available for Tree Sparrow, what may contribute to the expansion of the latter species.

Key words: House Sparrow, Tree Sparrow, nest sites, nest-boxes, decrease in Sparrows number, Warsaw, competition
INTRODUCTION

In Warsaw, similarly to many other large cities in Europe, the number of House Sparrows decreased significantly in recent decades (Luniak and Węgrzynowicz 2009). One of the possible reasons is a loss of nest sites in buildings (Siriwardena et al. 2002, Summers-Smith 2003). In most of Europe the population of Tree Sparrow declined as well (Summers-Smith 1995), however in Warsaw its number increased in last decades (Luniak and Węgrzynowicz 2009).

Both species are secondary hole-nesters, however, occasionally, they place their nests in tree branches or in shrubs (Summers-Smith 1995, Anderson 2006). Tree Sparrow nests often in nest-boxes, and their availability may largely affect the densities of this species. The rate of nest-box occupation by House Sparrow is more diverse and ranges from 0% to the values comparable with those for Tree Sparrow, depending on location. In the regions, were both species are found, the competition for nest-boxes between them may be observed (Pinowski 1967, Cordero and Rodriguez-Teijeiro 1990).

The aim of this study was to determine the importance of nest-boxes for both sparrow species in the large city (Warsaw) and to examine the relation between availability of nest-sites (nest-boxes in this case) and changes in numbers of House- and Tree- Sparrow.

AREA AND METHODS

I carried out the study in 2005-2009, and, on a small scale, in 2012, on 30 plots (total of 380 ha; Table 1) in Warsaw. The studied plots represented 4 types of habitats that correspond to the gradient of urbanization: riparian forests, younger parks, older parks and housing estates. The riparian forests on the banks of Vistula river were located in peripheries. The younger parks with trees up to 70 year old were located outside strict downtown, when the older ones (dominating trees over 70 years old) were situated in downtown or in its close proximity, and were surrounded by densely built-up areas. The housing estates were represented by 11 plots with diverse buildings and were situated on the border of downtown or in city outskirts. In this habitat, nest-boxes were installed on the trees among buildings, in small green squares (below 1 ha) or on the walls of the buildings. On most plots, breeding densities of both species were known before (Luniak and Węgrzynowicz 2009, A. Węgrzynowicz – pers. data). Tree Sparrows were found in all the studied habitats, but House Sparrows – only in older parks and housing estates.

The densities of nest-boxes in riparian forest and park plots typically ranged from 10 to 35 per 10 ha. In housing estates the densities didn’t exceed 2 boxes/10 ha, excluding two plots with 8-12, and one (Wrzeciono) with up to 33 boxes/10 ha.

In the breeding seasons I inspected A-type nest-boxes (Sokołowski 1971) suitable for sparrows (entry hole 33 mm). This group included also the nest-boxes with non-typical dimensions, but with entrance size comparable to those in A-type nest-boxes, that were
severally found in numerous spots. Additionally, I inspected the nest-boxes for swifts with entrance height of 35 mm, that were present in some housing estates. The nest-boxes were placed approximately at 4 m height on trees, and from the ground to the fifteenth floor on buildings. Most of them were cleaned up after each breeding season.

For the result analysis only the data from the first brood of both species were used, as the most representative (Pinowski 1967). The data on nest-box occupation were collected in the following way:

1. In 2005 I inspected 340 nest-boxes of type A on 18 plots, representing various habitats.
2. In 2006-2009 I studied broods of House- and Tree Sparrow, less or more regularly, on 16 plots (some of them were also studied in 2005). These data allowed to define the occupation rate for both species.
3. During the House- and Tree Sparrow surveys in 2005-2009 and 2012, I recorded the nest sites. Data from 10 plots (mostly housing estates) were accurate enough to calculate nest-box occupation rates.
4. In winter 2005/2006 I inspected (in cooperation with A. Tarłowski) a total of 345 nest-boxes in 7 parks. Forty seven of them were of A1 type (entrance 28 mm), 283 – B type (47 mm) and 15 – D type (85 mm).
5. Prior to the season 2006, 24 nest-boxes were placed by volunteers on buildings in housing estates located in different regions of the city, and were subsequently inspected by them in 2006-2009.

Altogether, excluding winter inspection, in 2005-2012 I carried out total of 1035 inspections of 502 nest-boxes (Table 1).

Table 1. Study plots and number of nest-box inspections.

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Number of plots</th>
<th>Area (ha)</th>
<th>Mean number of nest-boxes</th>
<th>Number of inspections</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riparian forests</td>
<td>3</td>
<td>31</td>
<td>72</td>
<td>106</td>
</tr>
<tr>
<td>Younger parks</td>
<td>11</td>
<td>129</td>
<td>164</td>
<td>322</td>
</tr>
<tr>
<td>Older parks</td>
<td>5</td>
<td>66</td>
<td>110</td>
<td>342</td>
</tr>
<tr>
<td>Housing estates (+V)</td>
<td>11</td>
<td>154 (+V)</td>
<td>156 (+V)</td>
<td>265</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>380</td>
<td>502</td>
<td>1035</td>
</tr>
</tbody>
</table>

RESULTS

Rate of A-type nest-box occupation

Of 502 nest-boxes of type A or of similar dimensions, Tree Sparrow occupied 166, i.e. 33%. The highest occupation rate was found on the plots in riparian forests on the banks of Vistula river (Table 2). Tree Sparrow used nest-boxes in 7 of 11 studied younger parks and in all 5 older parks, however the mean rate of nest-box occupation
was twofold higher in younger than in older ones (45% vs 23%), and this difference was statistically significant ($\chi^2 = 3.78; df = 1; P < 0.001$). Summarizing, the occupation of nest-boxes by Tree Sparrow in different seasons on studied plots ranged from 36 to 94% and from 8 to 42% in younger and older parks, respectively. The lowest rate of nest-box occupation was found in housing estates.

Table 2. Occupation of nest-boxes of type A (and of similar dimensions) and Nest-box Importance Coefficient (NIC) for Tree- and House Sparrow in different habitats. N – number of pairs with known nest sites

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Tree Sparrow</th>
<th>House Sparrow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Occupation</td>
<td>NIC</td>
</tr>
<tr>
<td>Riparian forests</td>
<td>62%</td>
<td>n.d.</td>
</tr>
<tr>
<td>Younger parks</td>
<td>45%</td>
<td>0.55 (N = 103)</td>
</tr>
<tr>
<td>Older parks</td>
<td>23%</td>
<td>0.26 (N = 57)</td>
</tr>
<tr>
<td>Housing estates</td>
<td>15%</td>
<td>0.13 (N = 34)</td>
</tr>
</tbody>
</table>

House Sparrow used nest-boxes only in older parks and in housing estates (Table 2), and the average rate of occupation (on all plots) was 4%. This species was found in 3 of 5 studied older parks, where it occupied, in different seasons, averagely 17-25% (maximally 52%) of nest-boxes. On 5 housing estates it used 1 nest-box on each and on another one – averagely 2 per season (maximally 7; see The effect of installation of nest-boxes on Tree- and House Sparrow abundance). Of 24 nest-boxes installed on buildings by volunteers, 1 was occupied by Tree Sparrow.

**Occupation of other types of nest-boxes**

During winter inspection in season 2005/2006, in single park I found 2 nests of Sparrow *Passer* spp. in nest-boxes of type A1 – with smaller entry hole (4% of all nest-boxes of this type), and in 5 parks total of 24 nests in larger nest-boxes of type B (8%). All the sparrow’s nests in B-type nest-boxes were placed on the nests of Starling *Sturnus vulgaris*, and were the autumn nests, as suggested by their appearance (lack of brood remains, fresh material). In contrast, later inspections showed that in A1-type nest-boxes the Tree Sparrows brooded the nestlings. In the park, where I found these nests, total of 7 nest-boxes of this type were installed and an entrance to each of them was protected with metal plate against damage by woodpeckers. In each of 4 seasons of the study, 1-2 of A1 type nest-boxes were occupied by Tree Sparrows.

**Dynamics of nest-box occupation**

I studied the changes in newly installed nest-box occupation by Tree Sparrow in 4 parks (N of nest-boxes = 62), and by House Sparrow in 5 parks (N = 37). The relative proportion in nest-box occupation (100% was defined as the highest occupation rate for each species within 5 years) was 23% for Tree Sparrow, and 11% for House Sparrow.
in the first year after installation, and 65 and 41% respectively, in the second year. In the third year, the occupation rate was high for both species, however the increase between year 2 and 3 was noticeably sharper for House Sparrow compared to Tree Sparrow. The maximum value for Tree Sparrow was recorded in year 5 after nest-box installation.

The above findings show that relative stabilization of nest-box occupation was reached in 3rd year after the installation for both species. The year-to-year occupation variability for Tree Sparrow ranged from 9% to 19% (aver. 13%), but was not calculated for House Sparrow due to insufficient data collected for this species.

**Importance of nest-boxes for both species**

A strong positive correlation between the Tree Sparrow density and nest-box number was shown for parks ($r = 0.70; P = 0.034$) and for all plots combined ($r = 0.73; P < 0.001$) but not for housing estates ($r = 0.58; P = 0.13$). This kind of relations was not found for House Sparrow, neither for all plots combined ($r = -0.21, P = 0.18$), nor for any of studied habitat type individually.

In order to determine the importance of nest-boxes for both species on different plots, I used the Nest-box Importance Coefficient ($NIC$), calculated using the equation: $NIC = N_p/(P - N_p + N_n)$, where $N_p$ is a number of nest-boxes used by Tree- or House Sparrow, $P$ – total number of breeding pairs of Tree- or House Sparrow, and $N_n$ – a number of nest-boxes of appropriate dimensions. This coefficient, therefore, describes the rate of nest-box occupation for the given species in relation to the contribution of pairs using nest-boxes in the total local population. It reaches 1, when all the pairs of given species occupy all the nest-boxes in given area.

The NIC for Tree Sparrow was the highest in younger parks, and the lowest in housing estates (riparian forests were excluded from this analysis as the number of pairs breeding there were unknown; Table 2). NIC values calculated for different plots and seasons varied more in the younger parks (0.40-0.73, exceptionally 0.09), than in the older ones (0.23-0.31).

The local importance of nest-boxes for House Sparrow was markedly lower than for Tree Sparrow in the older parks and housing estates. The maximum values in the former habitat reached 0.30 and in the latter – 0.10, however they were normally much lower (Table 2).

**The effect of installation of nest-boxes on Tree- and House Sparrow abundance**

In suburban housing estate “Wrzeciono” (18 ha), the number of House Sparrows decreased in the years of the study (from 53 pairs in 2005 to 20 in 2012; A. Węgrzynowicz – pers. data). This decline was caused by the renovation of buildings (insulation) that was carried out gradually in the time of the study and resulted in loss of nest-sites for birds. In the first two years (2005-2006), 3 pairs of Tree Sparrow nested on this plot (all
in holes in buildings), in three subsequent years – 7 pairs and then, after three years (in 2012) – 4 pairs.

In order to assess the effect of nest-box installation on abundance of both species in the conditions of simultaneous nest site loss in buildings, I placed 25 nest-boxes on this plot (19 on trees and 6 in one group on building) before the 2007 season. In 2006-2009 I didn’t observe any effect of newly installed nest-boxes on House Sparrow population (no occupation), however they contributed in an increase in a number of Tree Sparrows, which occupied two of them.

Another 34 nest-boxes (of different types but with entry holes appropriate for sparrows) were placed on buildings of “Wrzeciono” between 2009 and 2012. Some of them were hanged where the flat roof vents were available in previous years for House Sparrows for nesting, but which were covered in 2012, during the renovation. Between 2009 and 2012 another buildings were renovated, leading to further decline in House Sparrow number. However, in this period, House Sparrow occupied 7 (21%) of nest-boxes placed on buildings and, for unknown reasons, the number of Tree Sparrow decreased to 4 pairs, of which 1 nested in nest-box (on tree).

In the Saxon Garden (15 ha), the downtown park with old tree stand, the installation of 43 nest-boxes in 2006-2007 didn’t result in an increase in the number of House Sparrow (60 pairs in 2005 vs. 57 in 2008). This species occupied 8 of them, but in this particular case, the nest-boxes were chosen to substitute for nest sites in the trees, that were trimmed. In 2012 the number of House Sparrow on this plot decreased threefold and not one pair nested in nest-box. The number of Tree Sparrows increased from 5 pairs in 2005 (before the installation of nest-boxes) to 12 in 2008 (when they occupied 5 nest-boxes) and to 21 in 2012 (17 nest-boxes occupied).

DISCUSSION

The importance of nest-boxes for Tree- and House Sparrow populations

Availability of nest sites is one of the most important factors influencing sparrow abundance. Both species are relatively flexible with respect to the selection of their nest sites. They can built nests in trees or shrubs (Kulczycki and Mazur-Gierasińska 1968, Summers-Smith 1995), nest in the nests of martins, swallows (Tryjanowski and Kuczyński 1999, Czechowski 2007), or in base of the nests of large birds, such as storks (Indykiewicz 1998, Bocheński 2005) and use rock crevices and burrows dug by other birds into the ground (Chmielewski et al. 2005, Dott 2006). In the cities, Tree Sparrows usually nest in tree holes, nest-boxes, building gaps and in street lamps. The rate of use of different nest sites depends mainly on their availability, and no clear preference for any of them is observed for Tree Sparrow. In contrast, House Sparrow clearly prefers nesting in buildings, and uses other sites only when those in buildings are not available (Anderson 2006).
Locally, nest-boxes play very important role for Tree Sparrows. It was shown that nest-box installation may strongly increase Tree Sparrow number or even induce a colonization of new area by this species (e.g. Eliseeva 1961, Mizera and Kozłowski 1992, Summers-Smith 1995, Otto 2008a). Additionally, positive correlation between the numbers of Tree Sparrows and nest-boxes was observed – for instance in the villages of Spain (Cordero 1993), as well as in the large city in the present study. The importance of nest-boxes for Tree Sparrow may be particularly marked in cities, where tree holes are often not available, and building gaps are occupied by House Sparrows. This assumption is supported by the present study in Warsaw, where NIC values were higher in younger parks with sparse tree holes (0.55) than in older ones (0.26).

The rate of occupation of nest-boxes as well as Nest-box Importance Coefficient for Tree Sparrow decreased in Warsaw along an urbanization gradient: from riparian forests, through younger parks, older downtown parks to housing estates. This was likely related to habitat preferences of Tree Sparrow – for example, on “Wrzeciono”, regardless of nest-box excess, the density of this species didn’t exceed 4 pairs/10 ha. Certainly, the importance of nest-boxes for Tree Sparrow is also limited by other factors, such as availability of alternative nest sites (tree holes in older parks and buildings in housing estates) or competition with House Sparrow.

The seasonal differences in rate of occupation of nest-boxes by Tree Sparrow in Warsaw were low (compare to Pinowski 1967, 1968), what suggests that Warsaw population is stable, likely due to abundance of additional, anthropogenic food. According to Pinowski (1968), large fluctuations observed in non-urban populations result from decreased availability of food (especially seeds) in severe winters.

The findings obtained in the present study show that nest-boxes were of little importance for Warsaw population of House Sparrow in 2000s – in the habitats, where this species was found, NIC varied from 0.01 to 0.06. On the other hand, however, in some years, local occupation rate of nest-boxes was relatively high, and their presence partially counteracted House Sparrow population decline, that resulted from the loss of nest sites. This was observed in downtown’s Saxon Garden, where some nest-boxes were occupied by this species following the loss of nest sites in tree holes. The results of experiment on “Wrzeciono”, where House Sparrows settled couple nest-boxes in response to building renovation, lead to the similar conclusion. Importantly, on “Wrzeciono”, House Sparrow occupied only these nest-boxes that were placed where the active nest sites were present prior to renovation. This confirms strong association of House Sparrows with their nest sites (Summers-Smith 1963, Anderson 2006).

**Occupation of nest-boxes in relation to changes in the number of House- and Tree Sparrow**

The occupation of nest-boxes in Warsaw by both sparrow species changed significantly from 1980s. The rate of occupation of A-type nest-boxes by Tree Sparrow in parks
increased from 16% in 1983-1989 (Kozłowski 1992) to 33% in 2005-2012. Particularly strong increase was found in the younger parks, where Tree Sparrow occupied 11% of nest-boxes of type A and B in the first period and 45% of type A in the second. In the older parks, this difference was less obvious (16 and 23% respectively) The increase in nest-box occupation by Tree Sparrow in Warsaw parks coincides with the expansion of this species (increase by 87%) in this habitat (Luniak and Węgrzynowicz 2009). At the same time, the number of House Sparrow in Warsaw decreased sharply – it left almost half of the parks (mainly young) studied in both periods (Luniak and Węgrzynowicz 2009). In 1980s House Sparrow occupied the nest-boxes in most parks (23% of A- and 20% of B-type; Kozłowski 1992), and the occupation rate was similar in both types of this habitat. Moreover, the installation of nest-boxes in parks resulted in local increase in number of House Sparrow (Nowicki 1992), what indicates that its population was limited by deficiency of nest sites. In 2000s the average rate of nest-box occupation in parks decreased to 6% (12% in the older ones, 0% in the younger ones).

Loss of nest sites, especially in buildings, as a consequence of present construction and renovation style in building industry, may be one of the potential causes of House Sparrow crisis in Europe (e.g. Siriwardena et al. 2002, Summers-Smith 2003). On the other hand, it is suggested that House Sparrow is especially connected with urban areas of lower socioeconomic status, therefore with buildings in worse condition that offer more nest sites (Shaw et al. 2008). Additionally, being flexible in choice of nest sites, House Sparrow is expected to build the nests in other available places (including nest-boxes), when those in buildings are lacking.

Therefore, it may be hypothesized, that, at least in Warsaw, the loss of nest sites is not the main cause of House Sparrow decline. In 1970s and 1980s, Warsaw population of this species was so large, that nest sites in buildings were insufficient, even though they were more numerous than today. This caused that sparrows started to occupy suboptimal habitats (younger parks in the outside the downtowns) and alternative nest sites (nest-boxes). As the population declined, the number of optimal nest sites in buildings was sufficient and sparrows stopped to use nest-boxes. Miera (2002) found similar relationship, where House Sparrows used also suboptimal nest sites during expansion, but nested only in preferred sites, when their number decreased.

It may be concluded that the nest-box occupation ratio reflects, to some degree, the general condition of local House Sparrow population. In Berlin, where the number of this species was relatively stable in recent decades (Böhner et al. 2003), House Sparrows occupied 26-98% of nest-boxes on housing estates (Feige 2007, Grasnick & Böhner 2008, Otto 2008b). In the cities, where strong loss was found, like urban Leicester or Lublin (SE Poland), House Sparrow occupied nest-boxes occasionally (Vincent 2005, Biaduń 2004). This is another argument to support the hypothesis that the decline of European House Sparrow population is not related to the loss of nest sites. However, one report from India shows that House Sparrow readily occupied newly installed
nest-boxes, regardless of the decrease in a population of this species in the studied
region (Bhattacharya et al. 2011).

Tree- and House Sparrow have similar habitat preferences, therefore they compete
for environmental resources in many areas (Anderson 1978, Summers-Smith 1995). Of
particular importance for Tree Sparrow is the competition for nest sites, in which
House Sparrow dominates (Cordero and Rodriguez-Teijeiro 1990, Cordero and Senar
1990). For example, Pinowski (1967) found that the rate of occupation of nest-boxes
by Tree Sparrow in villages near Warsaw was considerably lower on the plots where
House Sparrow was present. By occupying numerous nest sites, including nest-boxes,
House Sparrow may, to a high degree, affect Tree Sparrow abundance and expansion
rate. In 1980s, in Warsaw parks, where House Sparrow occupied up to 90-100% of
nest-boxes suitable for both species (Kozłowski 1992), the nesting opportunities of Tree
Sparrow were very limited. For comparison, in the parks of Poznań (W Poland), where
in 1980s nest-boxes were not used by House Sparrows, , the rate of their occupation by
Tree Sparrows averaged 48% and was significantly higher than in Warsaw at the same
time (Mizera and Kozłowski 1992). Additionally, both species compete also for food
(Anderson 1984), so high numbers of House Sparrows may limit food resources for
Tree Sparrow, leading to decrease in breeding performance (Salaet and Cordero 1988,
A. Węgrzynowicz – pers. data). The case of Saxon Garden illustrates the relationships
between numbers of both species. In this park, Tree Sparrow number and nest-box
occupation rate increased following a decline of House Sparrow. It is, therefore, very
probable, that the decrease in House Sparrow population in Warsaw with simultane-
ous decrease in nest-box occupation, contributed to Tree Sparrow expansion found by
Luniak and Węgrzynowicz (2009). Similar conclusion may be taken from the study of
Miera (2002) in small village in Brandenburg (Germany), where local Tree Sparrow
population was displaced by expanding House Sparrow, but then restored, when the
latter species regressed.

**Advantage of Nest-box Importance Coefficient**

Nest-box Importance Coefficient describes two parameters: rate of nest-box occupa-
tion by studied species (Np/Nn) and proportion of pairs occupying nest-boxes in the
local population (Np/P). NIC is affected by both parameters to the same degree, what
makes it useful tool to describe the importance of nest-boxes for given species in given
area, more convenient to use and interpret than would be these two parameters (Np/
Nn and Np/P) used separately.

The limitation of NIC is related to the Nn variable, i.e. number of nest-boxes. On
the areas with very high Nn only a part of nest-boxes will be occupied by given spe-
cies, as its population will be limited by other environmental parameters. In this case,
even if all the pairs will nest in nest-boxes, the value of NIC will be relatively low, and
its interpretation will lead to spurious conclusions. Therefore, in the areas, where the
density of nest-boxes is markedly higher than the densities of given species documented in literature, NIC should be interpreted with special care. Presentation of Nn value is always a good practice.

The proper use of NIC requires precise knowledge of the number and rate of occupation of nest-boxes in studied area. In practice, NIC should be best used on small plots (several dozen hectares). The examples of the use of NIC are: comparative ecological studies of two (or more) species or comparison of importance of nest-boxes for given species in different habitats (both cases are presented in this report). NIC may also be used for practical purposes, like planning or evaluation of protection procedures involving the installation of artificial nest sites.

Obviously, use of NIC is not restricted to nest-boxes; the importance of other nest sites for hole-nesters may be validated using this coefficient.

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WHAT COLOUR IS THAT SPARROW?
A CASE STUDY: COLOUR ABERRATIONS IN THE HOUSE SPARROW
PASSER DOMESTICUS

"...far too well-known to need any description of its appearance or habits, ...."
Alfred Newton. 1896,
A Dictionary of Birds, volume 4.

ABSTRACT

In this paper 16 distinct, heritable colour aberrations (mutations) in the House Sparrow are described, based on specimens found in museum collections, records of individuals seen in the wild and from bird breeders keeping aberrant coloured sparrows in captivity. Based on the frequency found in the museum specimens Brown is the most common mutation in the House Sparrow, followed by Ino and Albino. Besides the mutations there is also a, presumably, non-heritable aberration called Progressive Greying described. Progressive Greying is in fact by far the most common colour aberration found in the species but was, in the past, always assigned as ‘Partial Albino’ without its real nature being understood. This paper will give some insight in the nature of Progressive Greying.

Keywords: House Sparrow, Colour aberrations, Albino, Brown, Progressive Greying.

INTRODUCTION

Colour aberrations in the House Sparrow have been known for a long time although historically they were not recognised as such. Brisson named in his Ornithologia (1760) a white House Sparrow as Passer candidus (Latin for ‘shining white’) and referred also to Passer albus described by Aldrovandi (1599). According to Brisson this ‘species’ has white plumage, yellow bill and feet and dark eyes. Brisson also mentioned that specimens which are partly white and partly coloured do occur as well.

The specimen on which Brisson had based his description was kept in ‘Du Cabinet de M. de Reaumur’ of which Brisson was the curator. De Reaumur was a French scientist and his bird collection was one of the richest in his time.

Sparrman, a Swedish explorer and a student of Linnaeus, in 1786 also described a white sparrow kept in the Museum of Gustavus Carlson, Secretary of State to his
Swedish Majesty. He used the species name given by Brisson but placed the sparrows in the genus *Fringilla* just as his teacher had done. The Gentlemen's Society in London mentioned in their review of Sparrman's work (The Critical review or Annals of Literature, Vol. 67, 1789) that a similar specimen of *Fringilla candida* was also present in Link's Museum in Leipzig. So white and pied sparrows were not that uncommon then and white plumage still seems to be a common aberration in the House Sparrow.

Besides white feathers many more colour aberrations are known in the House Sparrow. However, naming aberrations correctly was always a reason for confusion (van Grouw 2013). A variety of names are (still) used, seemingly randomly, to identify the mutations. Most commonly and most often wrongly, applied is the name albino or partial albino (Rollin 1964; Buckley 1982, 1987; van Grouw 2006, 2010). Albino is widely used for all sorts of different colour aberrations, but in only a tiny proportion of cases is it used correctly. Partial albino as a term is wrong, as albinos cannot produce pigment at all and therefore being partial albino is simply impossible.

The confusion is mostly caused by the desire of ornithologists, now and in the past, to use names which describe the actual appearance of a particular aberrant coloured bird. However, the appearance of mutations may differ radically between species, sexes and the age of the bird; all depending on the original pigmentation.

For example, the appearance of the mutation Brown in a Rook *Corvus frugilegus* is nothing like Brown in a House Sparrow as both species are completely different in plumage colour in the first place. The same, of course, can apply when there is a difference in colour between sexes, as in the House Sparrow. And because the pigment distribution and/or concentration are often different between juveniles and adults, certain mutations correspondingly appear different according to the age of the bird. So the appearance of mutations also differs between plumage stages within the same species.

Finally, aberrant pigmentation due to mutations often is very light sensitive and will bleach rapidly, so in old plumage a bird can look quite different from its fresh plumage (see fig. 2 and 3).

All of this, plus the fact that the bird in the field might be too far away or is moving too quickly, makes it hard to distinguish the different mutations without breeding tests. And that is why there is still a lack of clarity in the ornithological world about the correct naming of them. However, if we keep the original colouration of the House Sparrow in mind while examining an aberrant specimen, and noticing the actual changes in the pigmentation, one will notice that these changes are all based on only a few basic principles. And being aware of these principles makes distinguishing the different aberrations easier.

**Pigmentation**

The main pigments that determine plumage colour are melanins. Melanins can be distinguished in two forms, eumelanin and phaeomelanin, and both forms are present in
the House Sparrow. Depending on concentration and distribution within the feather, eumelanin is responsible for black, grey and/or dark brown colours, whereas phaeomelanin is responsible for warm reddish-brown to pale buff. Both melanins together can give a wide range of greyish-brown colours.

The colour of the eyes is due to eumelanin only, while the bare parts contain eumelanin and carotenoids. Carotenoids are pigments responsible for pale yellow to scarlet red in birds and they have a vegetable origin. Carotenoids cannot be synthesised by birds and therefore they must be acquired from food. The yellowish colour in the beak and feet (and body fat and egg yolk) of the House Sparrow is due to carotenoids called xanthophylls. Although normally not visible in the plumage colour, House Sparrows seem to be able to form carotenoid-based colours in their plumage as well. Whether this is only in particular individuals, or that it only shows because of an ‘unnatural’ diet is unclear but the fact is that specimens with clearly visible yellowish tones in their plumage are found from time to time (see fig. 5). This yellow pigment is also xanthophyll. However, mutations affecting the carotenoid coloration are rare and, given that this coloration is not standard in the House Sparrow, only the melanin aberrations will be discussed further in this paper.

Melanins are produced in pigment cells (melanocytes) in the skin which add the pigment to the feather cells as the feathers grow. The addition of melanin does not always occur at a constant rate. In the House Sparrow, for example, the feathers have certain patterns and/or colour differences caused by the type, amount and distribution of melanin. During feather growth, sudden changes from the production of eumelanin to phaeomelanin may occur, giving rise to these different patterns. The development of melanin is the result of a chemical process called melanin synthesis, in which the amino acid tyrosine (released from nutrients in the food) and the enzyme tyrosinase (present in the melanocytes) are necessary to start the synthesis. Any disturbance or aberration in the melanin synthesis can influence the final plumage pigmentation. The aberration can be caused by a temporary, external factor or may have a heritable cause (mutation).

The six most common heritable colour aberrations found in birds are: Albinism, Leucism, Brown, Dilution, Ino and Melanism (for a detailed description of these aberrations see van Grouw 2013). This paper will examine the occurrence of these aberrations in the House Sparrow.

Leucism, Dilution and Melanism can be caused by several different mutations but all with a comparable effect while Albino, Brown and Ino are all caused by a single genetic mutation (van Grouw 2013).

The mutations in the House Sparrow

The information presented below is based on the examination of 362 aberrant coloured specimens found in 22 Museum bird collections (see acknowledgements) by the author.
Records of live aberrant coloured Sparrows seen in the wild and the practical breeding experiences gathered from bird breeders are also included in this review.

Given that aberrantly coloured birds have always intrigued people, these specimens were often especially targeted for (museum) collections. Therefore the number of aberrant coloured specimens in proportion to normal coloured birds in collections is much higher and does not represent the true ratio occurring in the wild. However, we can assume that the ratio between the different aberrations is quite representative, as any unusual bird was collected regardless of its actual colour.

For every mutation the general description will be given followed a discussion of its occurrence in the House Sparrow. Potential differences typical in the House Sparrow will be given as well as the inheritance of the aberration in this species, if known.

**Albinism**

Albinism, from the Latin *albus*, meaning white, is defined as a *total lack of both melanins in feathers, eyes and skin*. The lack of melanin results from the hereditary absence of the enzyme tyrosinase in the pigment cells. The result usually is a completely colourless bird. The red or pinkish hue that can be seen in the eyes and skin is caused by blood that is visible through the colourless tissue. Due to the absence of tyrosinase in an Albino, no melanins can be produced, thus, as mentioned above, there is no such thing as a ‘partial albino’.

Albino sparrows are rarely seen in the wild, although the mutation is not uncommon and occurs quite frequently in most populations. The reason for their apparent scarcity is that the absence of melanin in the eyes makes them highly sensitive to light, with a poor depth of vision. It is mainly their poor eyesight, rather than white plumage that makes albinos vulnerable, and most die soon after fledging.

The inheritance of Albino is recessive and therefore the number of birds that are carrier of the gene is probably far higher than expected. An individual must receive the gene for Albino from both parents (carriers) to be afflicted with the absence of tyrosinase. However, for every Albino that is hatched, two carriers are also hatched on average. And half of the offspring of a carrier mated with a non-carrier will also be carriers on average.

A rare mutation related to Albino, called Acromelanism, is also known in the House Sparrow. It is not found in the sample of museum specimens but the mutation does occur in captive populations (based on an individual caught from the wild). Acromelanism, from the Greek *akro*, meaning top or point, can be defined as a *melanin deposit in the body extremities mainly*. Due to the mutation the tyrosinase in the pigment cells is temperature dependent and at normal body temperature no melanin synthesis will take place. Melanin is only formed in parts that are lower than the normal, average body temperature. Therefore only the body extremities, as they are colder, are pigmented.
Acromelanism is well known in mammals and is, for example, responsible for the colour markings in Siamese cats and Himalayan rabbits. In all mammals Acromelanism is an allele of the albino gene (Robinson 1973, Searle 1968 and 1990) (alleles, from Greek meaning 'each other', are variant forms of a gene). In birds the author has found Acromelanism in several crow species, the Song Trush Turdus philomelos, Eurasian Blackbird Turdus merula, European Starling Sturnus vulgaris, Tree sparrow Passer montanus and the domesticated Ringneck Dove Streptopelia roseogrisea. Breeding tests have proven that in the latter species Albino and Acromelanism are allelic, with Acromelanism dominant over Albino but recessive to Wild-type (van Grouw 1997). Therefore it is reasonable to assume that in the House Sparrow Acromelanism also is an allele of Albino.

Melanins, as stated above, are mainly formed in the extremities e.g. beak/face and feet/claws as these are the coldest parts of the body. However, melanin production also depends on the environment temperature during moult and, during colder periods, melanin will also be produced sporadically in other parts of the plumage. As male House Sparrows have a higher melanin concentration than females the expression of Acromelanism shows clearer in males. The female's plumage is mainly white with only a light-brown face.

The inheritance of Acromelanism in the House Sparrow seems to be dominant.

**Leucism**

Leucism, from the Greek leukos (for white), can be defined as the lack of both melanins from all or parts of the plumage (and skin). The lack of melanin is a result of the congenital and heritable failure of the pigment-producing cells called melanoblasts to migrate to the skin during embryonic development. Pigment cells are therefore absent from some or all of the skin areas where they would normally provide the growing feather with colour. The extent of white feathering can vary, from just a few white feathers (partially leucistic) to the plumage being completely white (100% leucistic); the skin is colourless for individuals in the latter category. Partially leucistic birds may have a normal coloured bill and feet, depending on where the colourless patches occur, but all leucistic birds have normal coloured eyes. The white pattern in leucistic birds is often patchy and bilaterally symmetrical; most commonly the head, the wingtips, the feet and the belly are affected. The white pattern occurs in juvenile plumage and the amount of white feathering does not change with age. In the House Sparrow completely white individuals are found from time to time but Partial Leucism seems to be extremely rare.

White feathers in sparrows are however very common but the absence of pigment in the feathers is almost always caused by Progressive Greying. Progressive Greying arises after a bird reaches a certain age and is defined as the progressive loss of pigment cells with age. From the onset of the condition, the bird will gain an increasing number
of white feathers after every moult and in many birds the entire plumage becomes white eventually. Progressive Greying may or may not be heritable; some forms may be related solely to age while in others the progressive loss of pigment cells may be due to disorders such as vitiligo (pigment disease). Progressive Greying is the most common cause of white feathers in House Sparrows.

Leucism and Progressive Greying are hard to distinguish in the field, especially when the latter has reached an advanced stage. The white pattern caused by Leucism is normally patchy and bilaterally symmetrical, so a few white outer primaries on both sides and/or some white feathers in the face are typical. Progressive Greying in its early stages shows white feathers spread randomly while the skin (bill and feet) is often unaffected. Most forms of Progressive Greying finally results in the entire plumage being white.

Besides this random way of Progressive Greying, two other, distinct forms occur in the House Sparrow. In the first case the Progressive Greying starts in the flights and tail feathers while the rest of the plumage is hardly affected. In the second case the flights and tail feathers are the last feathers to be affected. These remarkable patterns may be simply due to the way House Sparrows moult in relation to the onset of Progressive Greying, but further research is necessary to either confirm or deny this.

External, non-heritable factors such as illness or food deficiency can also be the cause of pigment loss (these are not included in the sample). In such cases, the bird is unable to extract sufficient quantities of tyrosine from its food, which results in disturbed melanin synthesis. The pigmentation will return to normal as soon as the external causes are removed. Progressive Greying was initially thought to be caused by a form of food deficiency (Rollin 1964) but whereas a dietary deficiency causes wide, white bars in the feathers and also often a poor feather structure, in Progressive Greying the feathers are entirely white and their structure is unchanged.

**Brown**

This mutation is defined as a *qualitative reduction of eumelanin*. The number of eumelanin pigment granules remains unchanged but the appearance of the pigment is altered (the eumelanin synthesis is incomplete as the eumelanin is not fully oxidised) and normally black pigment remains dark brown. The phaeomelanin is unaffected.

Eumelanin that is not fully oxidised is part of the original plumage colour in the House Sparrow, for example the dark-brown remiges and rectrices. So in these cases, the mutation Brown will turn the original dark brown feathers light brown (since the eumelanin will be less oxidised than normal). Aberrations due to incompletely oxidised eumelanin are very sensitive to sunlight and will bleach quickly. Consequently, older plumage becomes almost white and is hard to distinguish in the field (see fig. 2). For a correct identification, try to examine parts of the plumage that should be less affected by sunlight, such as the inner webs of flight feathers when the bird is wing-stretching.
This should determine whether the plumage has been bleached differentially by the light (see fig. 3). The colour of the eyes is not visibly affected by Brown but the feet and bill are slightly paler than those of normally-coloured birds.

The mutation Brown is widespread amongst House Sparrows and, after Progressive Greying, is the most frequently encountered colour aberration in this species.

Given that Brown is the result of only one recessive mutation, the occurrence of so many Brown House Sparrows is remarkable. But perhaps the fact that Brown is also sex-linked explains why it is not that uncommon. Sex-linked means that the gene is located at the X-chromosome (remember that in birds males have 2 X-chromosomes and females have an X and Y). The gene for Brown is symbolised as b and the unchanged form of this gene (= normal-coloured) is therefore B. Given that the males have two X-chromosomes they can have therefore three different genotypes for Brown; BB (normal-coloured), Bb (normal-coloured but heterozygous for Brown) or bb (Brown). Females are either normal (B-) or Brown (b-) but can’t be heterozygous for Brown.

When a male which is heterozygous for Brown but normal coloured, breeds with a normal female, half of his daughters (= 25% of his total offspring) will be Brown. And besides half of the daughters being Brown, half of the male offspring from a heterozygous father will also be heterozygous for Brown. By comparison, for recessive mutations which are not sex-linked you need both parents to be heterozygous to get 25% aberrant offspring.

This also explains why only Brown females are seen in the wild, as females need only one gene for Brown to express the mutation. To get a Brown male you need a heterozygous father and a Brown mother. The likelihood of this occurring in the wild is very minute but not impossible, of course. In many species Brown females successfully breeding in the wild have been recorded (Carrion Crow Corvus corone, Eurasian Jackdaw Corvus monedula, Common Magpie Pica pica, European Starling and House Sparrow).

**Dilution**

Dilution, from the Latin dilutior (paler or weaker), can be defined as a quantitative reduction of melanins – the number of pigment granules is reduced but the pigment itself is not changed. The lower concentration of granules forms a weaker (or diluted) colour as a result. This is analogous to a photograph in a newspaper: a high concentration of black ink dots close together are perceived as black, while fewer black dots in a same-sized area appears grey. Although many different mutations are known for reducing pigmentation, and therefore have the effect of diluting the colours, Dilution can be separated into two main forms.

The most common form is a reduction of both eumelanin and phaeomelanin. Black feathers will turn grey and reddish or yellow-brown will turn buff or cream-brown. The degree of dilution varies both between individuals and within a single mutation but most mutations cause a melanin reduction of about 50%. All birds with this form
of dilution look like a pale version of their normal counterpart, and are termed Pastel (derived from Latin Pastellus, a pale, delicate colour).

The second form is a reduction of eumelanin only, with phaeomelanin unaffected. Black feathers will turn grey, but reddish or yellow-brown stays reddish or yellow-brown. This form of Dilution is called Isabel (from the Latin Isabellinus meaning greyish-yellow). The phaeomelanin often seems to be even brighter in colour due to the reduction of the overlying eumelanin. In some mutations the reduction of eumelanin is almost complete and the parts of the plumage that were originally black appear virtually white. The absence of one melanin pigment while the other is still present and unaffected is often called Schizochroism (Greek, meaning colour dividing). However, mutations causing this are very rare; in most cases the affected melanin is not completely eliminated in the plumage while the skin may be even less affected, resulting in the bill and feet still being coloured. Therefore, nowadays, I recognise mutations formerly called Schizochroism as a distinct form within the dilution mutations, as the total lack of one melanin being nothing more than the most extreme degree of dilution.

In the first form, the pastel-group (a reduction of both melanins) many different mutations occur in the House Sparrow. Some are easy to recognise while others have very similar pigment reductions and are hard to distinguish from each other. The first mutation in this group and easily distinguished, causes a strong but equal reduction of both melanins. The general appearance is silvery-grey all over, but the original pattern is still visible (see fig. 19). This mutation is recessive in inheritance.

The second mutation in the pastel group reduces the eumelanin heavily while the phaeomelanin seems to be lacking almost completely. The general impression is a ‘whitish’ bird with clearly visible darker patterns (see fig. 20). This mutation is also recessive in inheritance.

The most common mutation in this group is very variable in expression and between individuals the reduction in the juvenile plumage can be from 50% to almost 100% (see fig. 21). The almost white youngsters will finally show a dilution of about 50% in adult plumages, while the darker juveniles appear barely affected adults. In this mutation the deep-black eumelanin seems to be less affected than the phaeomelanin and brown eumelanin.

Several other pastel mutations are recorded in the House Sparrow. All of them causing their own specific degree of melanin reduction and resulting in their own specific diluted appearance. However they all fall within the range of melanin reduction (and appearance) exhibited by the above mentioned variable pastel-mutation. Without breeding tests this makes them hard to distinguish from each other and therefore they are not separated in the sample of museum specimens. The variable pastel-mutation is recessive in inheritance and so are most of the others. However, at least one pastel-mutation is known for being recessive and sex-linked and this mutation affects the eumelanin more than the phaeomelanin.
Within the isabel group (a reduction of eumelanin only while the phaeomelanin is unaffected) two distinct mutations are found in the House Sparrow. The most common causes a eumelanin reduction of about 50% resulting in all the originally black parts appearing as solid grey. The second isabel mutation is variable in expression but on average the eumelanin is almost completely removed. Any remaining eumelanin is not uniformly deposited, resulting in patchy grey feathers, which distinguishes it from the first isabel mutation. The first isabel mutation is recessive in inheritance while the second is dominant.

**Ino**

Ino is defined as a *strong qualitative reduction of both melanins*. In Ino the melanin synthesis is incomplete, resulting in barely visible phaeomelanin and pale-brown eumelanin. The relevant gene also appears to mutate easily, as different mutations (alleles) from that gene occurring in many species (e.g. domesticated pigeon, ‘Ringneck Dove’, Japanese Quail, *Coturnix japonensis*, Zebra Finch *Taeniopygia guttata* and Bengalese Finch *Lonchura domestica*).

In the House Sparrow, also at least two different Ino-alleles are known. Depending on the relevant allele, the degree of melanin oxidation differs. However, the reddish-brown phaeomelanin is always very pale or even hardly visible in Ino, while the black eumelanin can vary from dark to very pale brown. In the dark form the incompletely oxidised eumelanin may show as a comparable colour as in the mutation Brown, but Ino can be distinguished from Brown in that the phaeomelanin is also reduced.

If the dark form of Ino may look like Brown; the light form seems to resemble Albino. In these birds the phaeomelanin has almost disappeared and there is also hardly any oxidation of eumelanin, so originally black patterns will turn very pale brown. In fresh plumage, the House Sparrow’s colour and pattern remains just visible, but worn plumage however will be heavily bleached and thus almost white. In Ino the eyes are reddish due to the reduction of melanin, but the eyesight of an Ino sparrow is much better than that of an Albino. Any adult wild bird with ‘white’ plumage and reddish eyes is an Ino and not an Albino. The inheritance of Ino, either the dark or the light form, is recessive and sex-linked, so only females will be found in the wild (see also under Brown for sex-linkage).

**Melanism**

Melanism, from the Greek *melanos* (dark-coloured), is an *abnormal deposit of melanin in skin and/or feathers*. Melanism is not necessarily an increase of pigment but may be the result of altered distribution; the ‘abnormal deposit’ of the same amount of melanin.

In general, the appearance of a melanistic bird is dark; mostly but not always blackish. There are three ways in which melanism can affect birds’ plumage:
1. Dark markings are bolder and noticeably ‘overrun’ their typical boundaries (the rest of the plumage is often somewhat darker as well).
2. The entire plumage is darkened and appears dark brown or black.  
3. Normal pattern and/or pigment distribution is changed but plumage is not darker.

The first category of melanism is not found amongst the 362 museum specimens examined but nevertheless has been observed in House Sparrow populations in the Netherlands and the UK.

So far only adult males and juvenile birds have been seen by the author. The overall appearance of the juvenile plumage is darker and there is also a noticeable darkening of the beak and feet. In the adult males the black bib extends all over the under parts. In winter plumage the dark under parts are less obviously as all feathers have a light coloured tip, just as the bib feathers in normal coloured males (see fig 32B.). These tips become worn down during winter, as usual, so in summer plumage the deep black under parts show best. Besides the increase of eumelanin in the under parts, in the upper parts also an increase of phaeomelanin is noticeable (see fig 32A and 33.). Remarkably the grey cap seems to be unaffected.

The second category seems to be the most common form. However, the overall ‘blackish’ plumage often found in sparrows is, in fact, due to artificial discoloration. It is often wrongly referred to as ‘Industrial Melanism’ but this form of darkening is not hereditary and is therefore not true melanism (Harrison 1963, Johnston 1963, Rollin 1964). The dark aspect is uniformly distributed over the whole plumage and is the result of dust-bathing in industrial areas polluted with cinder dust, ash and soot.

To confirm the statements above the author has examined at least 60 of these ‘sooty’ specimens (not included in the sample). No dark specimens were found with fresh, new plumage and the darkest birds had the oldest, most worn plumage. This agrees with an accumulation of soot in the feathers during a year. Also the scaling on the feet was very pronounced in these specimens as a result of dirt (soot) underneath the scale rims; the scales themselves were not remarkably darker.

Another case of probable artificial discolouration was found and described in Poland. In early 1900 Dybowski heard about a population of dark coloured House Sparrows in a village close to Jaroslaw in Poland. He acquired a few specimens and named the variety Passer domesticus var. Scheffneri, after P. Scheffner, Dybowski’s student, who drew his attention to these sparrows (Dybowski 1916). According to the description all birds were more or less solid chestnut brown coloured with hardly any pattern noticeable. Unfortunately the specimens from Dybowski’s collection seem to be lost so the real identity of this aberration cannot be revealed.

A further case of undisputed artificial discolouration was recently found in Ross-shire, Scotland. Many ‘pinkish-red’ House Sparrows occur in the local population and the cause of this aberration was for a while unclear. However, it turned out that a salmon farm was based in the area and that House Sparrows ate the salmon’s food pellets. The salmon food is enriched with carotenoids (from prawns) to give their flesh
the required pink colour. As House Sparrows are able to form carotenoid based colour in their plumage the red carotenoid from the salmon’s food seems to be the obvious cause for the reddish colouration. Carotenoids can only be taken up by the feather cells during feather growth. However birds are able to store an excess of carotenoids in their liver to be available for colouration of the feathers whenever required. So even when the sparrows take in carotenoids for only a few weeks during the winter, the effect will show the following summer during moult.

Although ‘artificial discolouration’ seems to be responsible for most of the cases of melanism within the second category, a true form of melanism is found in the House Sparrow. This true mutation causes a strong increase of eumelanin in the plumage, hiding the original pattern almost completely, with an almost solid black bird as a result. The bare parts, bill and feet, are not affected. The inheritance of this mutation is not yet known.

Within the third category different aberrations occur. The most common form is the distribution of reddish-brown in the normally black bib of male House Sparrows (not included in the sample). This aberration ‘heeft de gemoederen van de ornithologen altijd bezig gehouden’. Bonaparte (1850) named the variety as a distinct species, *Passer rufiplectus*, while Studer and Von Burg (1916) noting its commonness in a region of the Jura mountains, Switzerland, described it as a local race of the House Sparrow *Passer domesticus rufescens*.

A minimal amount of phaeomelanin, resulting in brownish feathers in this part of the plumage is not unusual. Van Heurn (2003) found in a sample of 515 adult male House Sparrows, all from the same place in the Netherlands, 122 (24%) specimens with some phaeomelanin in their bib. However in almost all cases the reddish-brown was restricted to only one or a few feathers partly brown and not visible without close examination of the feather bases. Counting only the specimens with clearly visible reddish brown in their bib, without moving feathers, the same sample yields 15 specimens (3%). In a sample of 557 adult male specimens Selander and Johnston (1967) found a comparable percentage, 25.5%, with some brown in their bib, varying from 1 partly brown feather to more than half the bib being brown. However, only 1.6% had clearly visible reddish-brown in the bib. Piechocky (1954) found 211 specimens (3.5%) clearly showing brown in their bib within a sample of 5992 male specimens.

As one can expect the rate of birds with brown bibs among museum specimens is slightly higher, as the obvious cases were probably especially targeted. Calhoun (1947) found 79 specimens (8.1%) with a brown tinged bib among 974 adult male specimens from the US kept in several American museums. In a sample of 460 adult male specimens from the UK kept in three different British collections (NMS, NHM and HZM) 25 specimens (5.4%) with a brownish bib were found.

According to the above the deposit of phaeomelanin in parts of the plumage that normally contain only eumelanin is quite common in the House Sparrow, and is very
likely hereditary. The same mutation is found in the Zebra Finch and is called ‘orange-breasted’. In this species the inheritance is recessive so therefore we can assume that orange-breasted in the House-Sparrow is also based on a recessive mutation.

As this mutation affects mainly the black markings, the effect is not visible in the female House Sparrow. In many male specimens the abnormal phaeomelanin distribution in the bib goes together with an increased phaeomelanin deposit in the plumage of the neck and back. Some even have scattered brown feathers on the head and/or rump.

A mutation that causes the opposite effect: the deposit of eumelanin in parts of the plumage that normally contain phaeomelanin only, also occurs. In the Zebra Finch this mutation is known as ‘black cheek’ and the inheritance is recessive. In the House Sparrow one adult male specimen was found in the sample. The author is not familiar with other records of this mutation occurring in the wild or kept in captivity. The normally deep reddish-brown parts (lesser wing coverts and supercilium/neck plumage) are changed into black while the phaeomelanin in the rest of the plumage is reduced. Given the fact that in female House Sparrows no plumage parts with deep reddish-brown phaeomelanin are present, we can expect that this mutation does not clearly express itself in females.

RESULTS

The results presented in table 1 are based exclusively on the sample of 362 museum specimens. Not all of the above described aberrations are found in the sample (e.g. Acromelanism and Melanism Category 1). Also the artificial discolorations and the aberrant brown in the bib are deliberately not included in the sample. Mutations in the Dilution group, especially the pastel-group, are often difficult to distinguish from each other in museum specimens and therefore they are not further separated into distinct mutations.

It is impossible to make the distinction between Albino and 100% Leucism in museum specimens when the eye colour is not mentioned on the label. Fledgling birds were deemed to be Albino. However, any totally white bird in a later life stage and with no eye colour mentioned on the label was assigned to Leucism, as an Albino would not have survived long after fledging. Therefore it is unlikely that any Albino is counted for Leucism. The proportion designates as Albino however may be slightly exaggerated as there may be a few leucistic fledglings among them.

Likewise, an occasional specimen in the final stage of Progressive Greying, and therefore completely white, might be wrongly identified as 100% Leucism. Usually the two can be distinguished, as House Sparrows with Progressive Greying normally don’t lose the pigments in their bare parts. However, the pale bill colour of females outside the breeding season is sometimes difficult to distinguish from a unpigmented bill of a leucistic bird in museum specimens.
Although the percentages are presumably not entirely accurate, on average it gives a good idea of the ratio between the different aberrations.

With 34.5% (125 specimens) Progressive Greying is the most common colour aberration found in the sample, and Brown is the second-most common (93 specimens = 25.7%). Given that most forms of Progressive Greying are probably not heritable, Brown is therefore the most common heritable aberration (mutation) found in the House Sparrow.

Dilution (56 specimens = 15.5%) seems to be quite common too but one has to keep in mind that many different distinct mutations occur that all cause a form of quantitative melanin reduction. Individually, these different mutations are all fairly rare. Within the pastel-group (42 specimens), 12 birds (3.3%) had the mutation causing a strong but equal reduction of both melanins with the general appearance being silvery-grey as a result (see fig. 19). Only four ‘whitish’ birds with clearly visible darker patterns (1.1%) were found whose plumage colour was due to the mutation that strongly reduces eumelanin and almost completely reduces phaeomelanin (see fig. 20). The remaining 26 specimens (7.2%) were not clearly distinguishable as distinct mutations but the majority probably belong to the variable pastel-mutation earlier described.

Within the isabel-group (14 specimens = 3.9%), 10 birds (2.8%) belonged to the recessive, eumelanin-reducing mutation, and four specimens (1.1%) were afflicted with the dominant form. Although mutations in the pastel-group are more common than in the isabel-group, the distinctive mutations in both groups are all quite rare. The Ino-mutation therefore appears to be the second-most common mutation (38 specimens = 10.5%). Although there are two distinguishable forms, a light and a dark, we consider them as a whole because the same gene is involved.

The commonness of this mutation is probably due to the fact that the gene is located on the sex chromosome and therefore females need only one gene to express the mutation (see under Brown for further explanation). Records of Ino-dark females breeding in the wild are known and therefore one would expect to have found a higher number of these in the sample. On the other hand the dark form of Ino is not very obviously different from normal-coloured and therefore might well be less targeted by collectors than other colour aberrations.

Albino is clearly different from normal-coloured and one can assume that most specimens noticed in the past would have been targeted. Because of their short lifespan after fledging however, few Albinos live long enough to fall prey to the collector. Nevertheless 17 Albino specimens (4.7%) were found in the sample.

Leucism (the heritable absence of pigment cells) is rare in the House Sparrow and only 12 specimens (3.3%) were encountered. Three of them (0.8%) were Partial Leucistic. The others (2.5%) were all 100% Leucistic.

Besides the abnormal phaeomelanin deposition in the bib, heritable Melanism (an abnormal deposit of melanin) in the House Sparrow is rather rare. 11 specimens (3%)
were found with an increase of eumelanin all over (Category 2) and only one specimen (0.3%) with the phaeomelanin replaced with eumelanin.

Finally, nine specimens could not be assigned to any of the above described mutations. Five of these specimens showed an aberration known among bird keepers as Grizzle (see fig. 40). In Grizzle each feather is an intermixture of white, as some barbs are white and others are normal-coloured. Comparable mutations are found in the Domesticated Pigeon, the Domesticated Canary *Serinus canaria* and the Zebra Finch. In these species, with age, after every moult, the number of white barbs increases until finally the bird will become almost completely white (or yellow in the case of the Canary). In that respect Grizzle seems to be a form of Progressive Greying. However, Grizzle is already evident in the juvenile plumage and therefore differs from Progressive Greying. As Grizzle is heritable in the species mentioned above, it can also be assumed to be heritable in the House Sparrow. The other four unknown aberrations were probably all caused by non-heritable factors as they all show features of different aberrations combined in each bird. Two of them show an incomplete melanin synthesis in combination with an abnormal deposit of melanin (specimens in the American Museum of Natural History). One specimen has distinguishing marks of a complete eumelanin reduction but also some normal-coloured feathers (specimen in National Museums of Scotland, see fig. 41). The last bird is mainly white (or yellowish because of carotenoid colouration) with some diluted feathers and some full coloured feathers (specimen in the Natural History Museum, Tring, see fig. 42).

In summary, Brown is the most common heritable colour aberration in the House Sparrow, followed by Ino and Albino. Although Dilution (a quantitative reduction of melanins) as an aberration is more common than Ino or Albino, the distinct, single mutations causing a diluted phenotype are all less common.

Brown, Ino and Albino are all mutations that cause a defect in the melanin synthesis while other mutations affect the melanin transfer: from the pigment cells into the feather cells (Dilution), the distribution between eu- and phaeomelanin in the plumage (Melanism), or the absence of melanin cells (Leucism).

Normal melanin syntheses is dependent on the enzyme tyrosinase and evidently genes affecting tyrosinase mutate easily in the House Sparrow.

As Progressive Greying seems to be non-heritable and probably caused by external factors, it is worth discussing in more detail. First, as the amount of white feathers is progressive, there is a huge difference in the amount between the specimens. Therefore the 125 specimens were categorised into four groups: up to 25% white feathers, up to 50%, up to 75% and up to 100%. Most birds were found, as one can expect, in the category up to 25% white feathers (44 specimens = 35% of all birds affected by Progressive Greying). Thirty-eight birds (30.5%) had between 25 and 50% white feathers, and 23 specimens (18.5%) were more than half white. Finally 20 sparrows (16%) had almost reached the final stage of Progressive Greying and had therefore three quarters or more of their plumage white.
No remarkable sexual difference in frequency was found although slightly more females appeared to be affected. All birds, without exception, had an adult plumage (House Sparrows have a complete post-juvenile moult and cannot be aged reliably beyond ‘adult’), and juvenile plumage was not found in specimens affected by Progressive Greying. This also proves that the loss of pigment begins only after a certain age.

Lastly, only 63 birds (17.4%) within the sample could be defined as fledglings or juvenile. So 82.6% of the birds passed beyond these critical life stages in spite their aberrant colour. Common belief that birds with colour aberrations do not survive for long in the wild due to being targeted by predators might be proven wrong with these results (humans are not taken into account as being predators).

DISCUSSION

Several studies on House Sparrow populations in the past have also recorded the frequency of colour aberrations. Unfortunately the different aberrations were never properly defined in these studies. However, given that, according to the results above Progressive Greying is the most common aberration, one can assume that the majority of the aberrations named White, Albino or Partial Albino in these studies were in fact a form of Progressive Greying. Selander and Johnston (1967) reported that only ‘partial albinism’ was found in their sample of 2,271 specimens from Europe and North America, “varying in extent from a single feather to a condition in which approximately one-third of the plumage is white”. In this sample 1.89% of the birds had one or more flights or tail feathers white, or two or more contour feathers white. Ilyenko (1960) found in a sample of 3,605 specimens from Moscow and the rural area of Chashnikov that 1.8% was ‘partial albino’. The same percentage, 1.83%, of birds with white feathers was found by Holyoak (1974) in a sample of 2,616 birds seen in and around London. All of Ilyenko’s birds with white feathers were found in urban Moscow and none in the rural area. Also Holyoak found the highest frequency of birds with white feathers in urban London (2.6%). In suburban areas he found a percentage of 1.1%, while in rural areas only 0.2% had some white feathers.

Lastly Ilyenko reported that white feathers were more than twice as frequent in females than in males. In the sample of Selander and Johnston there was no significant sexual difference in frequency although the amount of white feathers was more extensive in females. None of the authors found white feathers in juvenile birds.

The results from the studies mentioned above agree with the results found in our study: Progressive Greying is quite common, it occurs only in adults and it seems to be more common in females. Except in Holyoak’s sample no other aberrations were found by the other authors. Among his 2,616 House Sparrows Holyoaks recorded four birds he named ‘Diluted’ without defining the term. One can assume they were actually Brown, but the real identity of these four aberrant coloured birds is unknown.

Progressive Greying does seem to be non-heritable or, at least, it is not simply
based on one changed gene, while the other aberrations are all caused by a single gene-mutation and therefore are heritable. It is fair to conclude that the mutations are far less common than Progressive Greying. Given the fact that it is common, non-heritable and mainly found in urban areas, the cause of Progressive Greying appears to be an external factor related to human activity. It might be indirectly related to the diet or perhaps the pollution in the air? Further research is necessary to discover the nature of the true cause of Progressive Greying, especially as it is also common in several other species living in urban areas like the Eurasian Blackbird and the Eurasian Jackdaw.

ACKNOWLEDGEMENTS

The results in this paper are mainly based on specimens kept in many Natural History Museums and without the hospitality and help of the relevant curators and collection managers it would have been impossible for me to examine and identify the aberrant specimens over the years. Therefore I would like to thank first Paul Sweet, Thomas Trombone & Peter Capainolo, American Museum of Natural History, New York, for their effort to send me their aberrant specimens on loan. Also many thanks to all the other museum people (in random order) for their invaluable help: Jiri Mlikovski, Národní Muzeum Praha; Christane Schilling, Niedersächsisches Landesmuseum, Hannover; Anita Gamauf & Hans Martin Berg, Naturhistorisches Museum Wien; Steven van der Mije, Netherlands Centre for Biodiversity Naturalis, Leiden (former National Natural History Museum Naturalis); Gerald Mayr, Senckenberg Museum, Frankfurt am Main; Michaela Forthuber, Staatliches Naturhistorisches Museum Braunschweig; Stefanie Rick & Renate van den Elzen, Zoologisches Forschungsinstitut und Museum Alexander Koenig, Bonn; Tineke Prins & Kees Roselaar, Zoologisch Museum Amsterdam (now Netherlands Centre for Biodiversity Naturalis, Leiden); Sylke Frahnert, Zoologisches Museum Berlin; Cordula Bracker, Zoologisches Museum Hamburg; Georges Lenglet, Royal Belgian Institute of Natural Sciences, Brussels; Martti Hilden, Finnish Museum of Natural History, Helsinki; Anne Préviato, Muséum National d’Histoire Naturelle, Paris; Igor V. Fadeev, State Darwin Museum Moscow; Bob McGowan, National Museums Scotland, Edinburgh; Fausto Barbagli, Museo di Storia Naturale Firenze; Till Töpfer & Martin Paeckert, Museum fur Tierkunde, Dresden; Ulf Johansson Naturhistoriska Riksmuseet, Stockholm; Malcolm Pearch, Harrison Institute, Sevenoaks and Markus Unsöld, Zoologische Staatssammlung, München.

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the wonderful editing she did to make the text into very accessible English.

Table 1. Colour aberrations found in the House Sparrow based
on a sample of 362 museum specimens

<table>
<thead>
<tr>
<th>MUTATION</th>
<th>EFFECT ON COLOUR</th>
<th>NUMBER</th>
<th>PERCENTAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ALBINO</strong> = Total lack of both melanins in feathers, eyes and skin due to the heritable absence of the enzyme tyrosinase in the pigment cells.</td>
<td>All-white plumage all over, red eyes and yellow feet and bill.</td>
<td>17</td>
<td>4.7</td>
</tr>
<tr>
<td>Leucism</td>
<td></td>
<td>12</td>
<td>3.3</td>
</tr>
<tr>
<td><strong>Leucism 100%</strong> = the lack of both melamins from all parts of the plumage and skin due to the heritable absence of pigment cells from all of the skin areas</td>
<td>All-white plumage all over, yellow bill and feet and normal coloured eyes.</td>
<td>9</td>
<td>2.5</td>
</tr>
<tr>
<td><strong>Partial Leucism</strong> = the lack of both melamins from parts of the plumage and skin due to the heritable absence of pigment cells from some of the skin areas</td>
<td>All-white feathers next to normal-coloured ones. White pattern bilaterally symmetrical. Yellow bill and feet or normal coloured bill and feet and normal-coloured eyes.</td>
<td>3</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>PROGRESSIVE GREYING</strong> = the lack of both melamins with age in parts of the plumage due to progressive loss of pigment cells in the skin. Most forms seem to be non-heritable.</td>
<td>All-white plumage all over or all-white feathers mixed randomly with normal-coloured ones. Normal-coloured bill, feet and eyes</td>
<td>125</td>
<td>34.5</td>
</tr>
<tr>
<td></td>
<td>Upto 25% white feathers.</td>
<td>44</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Between 25 and 50% white feathers.</td>
<td>38</td>
<td>10.5</td>
</tr>
<tr>
<td></td>
<td>Between 50 and 75% white feathers.</td>
<td>23</td>
<td>6.5</td>
</tr>
<tr>
<td></td>
<td>Between 75 and 100% white feathers.</td>
<td>20</td>
<td>5.5</td>
</tr>
<tr>
<td><strong>BROWN</strong> = Qualitative reduction of eumelanin due to incomplete synthesis (oxidation) of eumelanin. Phaeomelanin unaffected.</td>
<td>Black becomes brown and brown becomes light-brown while reddish/ yellowish brown stays unaffected.</td>
<td>93</td>
<td>25.7</td>
</tr>
<tr>
<td><strong>Dilution</strong></td>
<td></td>
<td>56</td>
<td>15.5</td>
</tr>
<tr>
<td><strong>Dilution – pastel</strong> = Quantitative reduction of both melamins. Multiple mutations are known to cause comparable phenotypes.</td>
<td>Black and brown becomes silvery grey and reddish/yellowish brown becomes buff/cream</td>
<td>42</td>
<td>11.6</td>
</tr>
<tr>
<td><strong>Dilution – isabel</strong> = Quantitative reduction of eumelanin only. Two mutations are known for causing comparable phenotypes</td>
<td>Black and brown becomes silvery grey while reddish/ yellowish brown stays unaffected.</td>
<td>14</td>
<td>3.9</td>
</tr>
<tr>
<td>INO</td>
<td>Description</td>
<td>Black and brown becomes pale cream and reddish/yellowish brown becomes hardly visible. Eyes pinkish; yellow feet and bill.</td>
<td>38</td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>Ino – light</td>
<td>Strong qualitative reduction of both melanins due to incomplete synthesis (oxidation) of both melanins.</td>
<td>Black and brown becomes pale brown and reddish/yellowish brown becomes hardly visible. Eyes dark-pinkish; yellowish feet and bill.</td>
<td>22</td>
</tr>
<tr>
<td>Ino – dark</td>
<td>Qualitative reduction of both melanins due to incomplete synthesis (oxidation) of both melanins.</td>
<td>Grizzled-white plumage all over. Normal-coloured bill, feet and eyes.</td>
<td>16</td>
</tr>
<tr>
<td>MELANISM</td>
<td>Abnormal deposit of melanin</td>
<td>Increase of black and/or reddish brown</td>
<td>12</td>
</tr>
<tr>
<td>GRIZZLE</td>
<td>Lack of both melanins in parts of the feather barbs in each feather.</td>
<td>Coloured differently</td>
<td>4</td>
</tr>
<tr>
<td>TOTAL NUMBER ABERRANT COLOURED SPECIMENS</td>
<td></td>
<td></td>
<td>362</td>
</tr>
</tbody>
</table>

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Searle, A.G. 1990 – Comparative genetics of albinism – Ophtalmic Paediatric and Genetics 11: 159-164.
Sparrman, A., 1786 – Museum Carlsonianum, in quo novas et selectas aves, coloribus ad vivum brevique descriptione illustrates, suasu et sumptibus generosissimi possessoris.

2. Brown House Sparrows, three adult females. Aberrant coloured feathers are easily bleached by light. Old plumage (left) can be much lighter in colour than fresh plumage (right). Specimens in the collection of the Natural History Museum, Tring. Photo: Hein van Grouw.

3. An examination of plumage areas shielded from daylight eg. the inner webs of flight feathers, reveals the unaffected aberrant colour. Brown House Sparrows, females. Photo: Hein van Grouw.


5. House Sparrows, two adult males collected at the same time of the year. The right bird clearly shows yellow carotenoid colouration. Specimens in the collection of the Natural History Museum, Tring. Photo: Hein van Grouw.


8. House Sparrow, adult males, Acromelanistic. Bred and kept in captivity. **A:** Melanin production mainly in the body extremeties. **B:** bird moulted during a cold period resulting in sporadic production of melanin in other parts of the plumage. Photos: Pieter van den Hooven.


11. House Sparrow, adult female. White feathers caused by Progressive Greying. Typical pattern in which the body plumage is affected first. Specimen in the Natural History Museum, Tring. Photo: Harry Taylor BMNH.

12. House Sparrow, adult female, hatched in the wild but kept in captivity. White feathers caused by Progressive Greying. Typical pattern in which the flight feathers are affected first. Photo: Pieter van den Hooven.


18. Brown House Sparrow, adult male, bred and kept in captivity. Because Brown is recessive in inheritance and the gene is located at the X-chromosoom, males are not likely to be found in the wild. Photo: Pieter van den Hooven.

20. House Sparrow, adult male and female, Dilution – pastel, one of the distinct forms in the pastel-group; strong reduction of eumelanin while the phaeomelanin is almost lacking completely. Bred and kept in captivity. Photos: Pieter van den Hooven.

21. House Sparrows, three juveniles and an adult female, 29 June 2011, Ooijpolder, Nijmegen, The Netherlands. Two juveniles, from the same nest, showing the variable expression of melanin reduction within this pastel-mutation. Photo: Harvey van Diek.

22. House Sparrow, adult male and female, Dilution – pastel, exhibiting the average degree of melanin reduction within this variable pastel-mutation. In this mutation the black eumelanin is proportionally less affected than the phaeomelanin and brown eumelanin. Bred and kept in captivity. Photo: Pieter van den Hooven.


24. House Sparrows, adult female and adult male, both Diluted – pastel, and likely another distinct mutation within the pastel-group. Male in old and bleached plumage. Some new feathers show the true colour of this mutation. Specimens in the American Museum of Natural History (female) and the Natural History Museum, Tring (male). Photo: Hein van Grouw.
25. House Sparrow, adult male and female, Diluted – pastel. Another distinct form within the pastel-group. The eumelanin is affected more than the phaeomelanin. Specimens in the American Museum of Natural History. Photo: Hein van Grouw.

26. House Sparrows, adult female, juvenile male and adult male, Diluted – isabel. In this distinct form the degree of eumelanin reduction is always the same. Specimens in the American Museum of Natural History (female) and the Natural History Museum, Tring (males). Photo: Hein van Grouw.

27. House Sparrow, adult males, Diluted – isabel, bred and kept in captivity. This distinct mutation in the isabel-group can express a variable degree of eumelanin reduction between individuals but the reduction is always strong to almost complete. A: This bird still has some visible eumelanin left. B: This is genetically the same mutation as the bird in Figure 27A. However, in this individual the reduction of eumelanin is almost complete and therefore it can been termed as schizochroism. Note that eumelanin is still present in the eyes, beak and feet. Photo: Pieter van den Hooven.

28. House Sparrow, adult females, Diluted – isabel, bred and kept in captivity. This is genetically the same mutation as the birds in Figure 27. A: In this bird is still a fair amount of eumelanin left. B: In this bird the visible eumelanin is completely reduced from the plumage. Note that eumelanin is still present in the eyes, beak and feet. Photo: Pieter van den Hooven.


35. *Passer domesticus* var. *Scheffneri*, a dark coloured House Sparrow specimen thought by Dybowski to be a distinct variety. Plate from Dybowski 1915.

37. House Sparrow, adult male, Melanism category 3 with a clear reddish-brown bib due to an abnormal deposit of phaeomelanin. Specimen part of van Heurn's collection and now in NCB Naturalis, Leiden. Photo: Eelco Kruidenier.

38. House Sparrows, adult males. Melanism category 3 (brown bib) on the left and normal-coloured on the right. Notice that the increase of phaeomelanin is not only in the bib but also in the neck and mantle plumage. Specimens in the collection of the Natural History Museum, Tring. Photos: Hein van Grouw.

39. House Sparrow, adult male, Melanism category 3. Another distinct form in this category; in this case the phaeomelanin is replaced with eumelanin. Specimen in the Niedersächsisches Landesmuseum, Hannover. Photo: Niedersächsisches Landesmuseum.


41. House Sparrow, adult male. Aberrant colour probably due to a non-heritable factor. Plumage has distinguishing marks of a complete eumelanin reduction while a few primaries are normal coloured. Specimen in the National Museums of Scotland, Edinburgh. Photo: Hein van Grouw.

42. House Sparrow, adult male. Aberrant colour probably due to a non-heritable factor. Plumage has distinguishing marks of a complete melanin reduction, Diltion, and also some normal-coloured feathers on the chin. Specimen in the Natural History Museum, Tring. Photo: Hein van Grouw.
IMPORTANCE OF NEST SITES AVAILABILITY
FOR ABUNDANCE AND CHANGES IN NUMBER OF HOUSE- AND TREE SPARROW IN WARSAW

ABSTRACT
House- and Tree Sparrows were censused on 55 plots (684 ha), representing 3 habitats: housing estates, parks and allotment gardens in Warsaw from 2005-2009 and in 2012. Also, the data on nest sites of both species were gathered. Data from 70s/80s of the other authors enabled to determine the changes in number of sparrows. The population of House Sparrow decreased on average by 48% and the sharpest decline was found in allotment gardens. The decline continued in the period of studies, i.e. in 2005-2012. Tree Sparrow showed an increase from 70s/80s by 68% although in 2005-2012 the population was stable or even decreased. House Sparrows nested mainly in crevices in buildings, and suboptimal nest sites – such as nest-boxes and holes in trees – were occupied only in these areas where food condition were particularly good. Resources of optimal nest sites on studied area was almost entirely sufficient for House Sparrows population. Number of House Sparrow was related to area/presence of buildings. Renovations of buildings strongly influenced local number of this species, however they were not the main cause of its decline. Although nest-boxes were occasionally used by H. Sparrow, their presence could not stop the decrease in numbers caused by loss of nest sites. Tree Sparrow showed greater plasticity in their choice of nest sites. In parks their abundance was correlated with the number of nest boxes. It was suggested that in this habitat, the observed decrease of House Sparrow with simultaneous abandonment of nest-boxes (and other nest sites) may have contributed to the increase in Tree Sparrows.

Key words: House Sparrow, Tree Sparrow, breeding densities, population dynamics, changes in number, nest sites.

INTRODUCTION
Populations of House- and Tree Sparrow decreased considerably during the past few decades. The signals of House Sparrow decline comes from countries of Western Europe, from Finland, Austria, Great Britain, Spain, Belgium and Germany (Väisänen & Solonen 1997, Weggler & Widmer 2000, Gil-Delgado et al. 2002, De Laet & Summers-
Smith 2007), North America (Bosakowski 1986, Larivée 1991) and recently also from India (Bhattacharya et al. 2011). Particularly sharp declines have been observed in big European cities, such as Glasgow, Edinburgh, London, Ghent, Brussels or Hamburg (Dott and Brown 2000, Mitschke & Mulsow 2003, De Laet & Summers-Smith 2007).

Data from Eastern and Central-Eastern Europe are sparse, however they also indicate a decline of this species (Biaduń 2004, Janiszewski et al. 2004, Bokotey & Gorban 2005, Konstantinov & Zakharov 2005).

The decline of Tree Sparrow populations is revealed mostly in Western Europe – for example in England in 1977-2005 by as much as 94% (Baillie et al. 2007) and moreover in Germany, French, Swiss, Nederland and Italy (Blattner & Speiser 1990, Summers-Smith 1995, Dinetti 2007). In contrast, in north and, locally, eastern part of Europe, its population recently increased (Summers-Smith 1995, Vepsäläinen et al. 2005). Situation of Tree Sparrow in Eastern Europe is insufficiently recorded; nevertheless most of data indicate a decrease in numbers (e.g. Tomiałojć & Stawarczyk 2003, Reif et al. 2008).

Possible causes of decrease in number of both sparrow species are: shortage of food for nestlings and adult birds, increase of predation and – particularly in the case of House Sparrow – lack of nest sites, related to renovations of buildings and introducing of modern architecture (Siriwardena et al. 2002, Summers-Smith 2003, Bell 2011).

The aim of the study was to determine the changes in House- and Tree Sparrow number from 70s/80s to 2000s in Warsaw – one of the biggest cities in Central-Eastern Europe. Also the impact of nest-site availability on abundance and changes in number of both species was considered.

**METHODS**

The studies were carried out from 2005-2009 and 2012. Sparrows were censused on 55 plots (684 ha total): 23 housing estates (327 ha), 25 park areas (parks, cemeteries, zoological garden; 271 ha) and 7 allotment gardens (86 ha) each year. In March to April, three or four counts were conducted on each plot. Sparrows were indicated on maps. Birds that showed territorial behavior (chirping, carrying of nest material, copulation, nest-site defense etc.) were recorded as breeding pair. During censuses nest sites of both species were noted.

Thirty-six of the 55 plots studied in 2000 were previously investigated in 70s and 80s by the other authors (Luniak 1980, 1981, 1994, Luniak et al. 1986, Nowicki 1992). This enabled us to determine changes in sparrow numbers over time. Sparrows were counted on most plots in one year only, but some repeat counts were made. In some of the plots the availability of nest sites changed during studies (usually as a result of renovations of buildings or introducing of nest-boxes – see **Results**).

In order to analyze the factors influencing the occurrence of sparrows, maps on which birds were indicated were divided into 1-hectare squares.
RESULTS AND DISCUSSION

Abundance and changes in numbers of sparrows

House Sparrow occurred in almost all housing estates, about ¼ of parks and in 4 of 7 allotment gardens (Table 1). The average density in housing estates was 6 times higher than in parks, and 40 times higher than in allotment gardens. The maximal density reached 117 pairs/10 ha in housing estates, 56 pairs/10 ha in parks and only 6 pairs/10 ha in gardens.

On 27 of 36 plots studied in 70s/80s and again in 2000s, the number of House Sparrow decreased, numbers increased in 4 plots and no change was found in 5 others (Table 1). The sharpest decline took place in allotment gardens, although House Sparrows also disappeared from 57% of parks, where it was present during previous investigation. The total number of House Sparrows on studied plots decreased from 70s/80s to 2000s by 48%.

On 4 plots that were monitored in 2005-2009, the number of House Sparrow pairs decreased from 81 to 44. On 8 plots investigated in 2012 the total number of pairs were lower by a half than in 2005-2009.

Table 1. Abundance and changes in number of House Sparrow

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Housing estates</th>
<th>Parks</th>
<th>Allotment gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequence</td>
<td>96%</td>
<td>28%</td>
<td>4/7</td>
</tr>
<tr>
<td>Density range (pairs/10 ha)</td>
<td>2.9-116.7</td>
<td>0.5-55.5</td>
<td>1.2-6.2</td>
</tr>
<tr>
<td>Mean density (pairs/10 ha)</td>
<td>40.2 (SD = 27.7; N = 23)</td>
<td>5.9 (SD = 13.3; N = 25)</td>
<td>1.0 (SD = 2.2; N = 7)</td>
</tr>
<tr>
<td>Changes from 70s/80s to 2000s</td>
<td>- 33% (↓ on 4 plots, ↑ on 2)</td>
<td>- 45% (disapp. from 13 plots, ↓ on 3, ↑ on 1, ↑ on 2)</td>
<td>- 95% (disapp. from 3 plots, ↓ on 4)</td>
</tr>
<tr>
<td>Changes from 2005 to 2009</td>
<td></td>
<td>- 46% (↓ on 3 plots)</td>
<td></td>
</tr>
<tr>
<td>Changes from 2005-2009 to 2012</td>
<td></td>
<td>- 58% (↓ on 7 plots, ↑ on 1)</td>
<td></td>
</tr>
</tbody>
</table>

The results from Warsaw confirm a decline of urban House Sparrow populations in Central-Eastern Europe. However, the decrease in this region seems to be less pronounced than in cities of Western Europe. For example, in Edinburgh, the number of House Sparrows decreased tenfold over 15 years (Dott & Brown 2000) and in Hamburg from 60s to the end of 90s – by 75% (Mitschke & Mulso 2003). In some areas in Europe the decline has recently stopped or slowed down (e.g. Sanderson 2001, De Laet & Summers-Smith 2007). Censuses carried out in 2005-2009 and 2012 suggest that in Warsaw the decline is continuing and probably has even accelerated.

The frequency of breeding Tree Sparrows was high in all habitats (Table 2). Mean
density of this species grew from housing estates to allotment gardens, although the maximal value found was in one of the parks.

Table 2. Abundance and changes in number of Tree Sparrow

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Housing estates</th>
<th>Parks</th>
<th>Allotment gardens</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>74%</td>
<td>88%</td>
<td>7/7</td>
</tr>
<tr>
<td>Density range (pairs/10 ha)</td>
<td>0.6-13.3</td>
<td>0.8-64.4</td>
<td>13.3-49.0</td>
</tr>
<tr>
<td>Mean density (pairs/10 ha)</td>
<td>2.3 (SD = 3.5; N = 23)</td>
<td>9.9 (SD = 14.2; N = 25)</td>
<td>31.9 (SD = 11.7; N = 7)</td>
</tr>
<tr>
<td>Changes from 70s/80s to 2000s</td>
<td>increase from 4 to 29 pairs (coloniz. of 5 plots, ↑ on 1)</td>
<td>+ 85% (coloniz. of 2 plots, ↑ on 11, ↓ on 3, ↓ on 4, disapp. from 1)</td>
<td>+ 30% (↑ on 4 plots, ↑ on 2, ↓ on 1)</td>
</tr>
<tr>
<td>Changes from 2005 to 2009</td>
<td>- 30% (↓ on 3 plots, ↑ on 1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Changes from 2005-2009 to 2012</td>
<td>- 6% (↓ on 1 plots, ↑ on 3, ↑ on 1)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

From 70s/80s to 2000s the number of Tree Sparrows increased by 68%. The species colonized new habitat – housing estates, and numbers increased markedly in two others, particularly in parks (Table 2). However from 2005 to 2009 total density on 4 monitored plots decreased by ⅓. On the other hand, number of breeding pairs on 8 plots studied in 2005-2009 and in 2012 was relatively stable.

The increase of Tree Sparrow in Warsaw contradicts trends of this species in most parts of Europe (Summers-Smith 1995), as well as in other cities of Poland, where considerable decreases have been found (e.g. Biaduń 2004, Tomiałojć 2007, 2011). Moreover, number of this species decreased in the area surrounding Warsaw (J. Pinowski – pers. comm.) One of possible explanation for the observed increase in Warsaw is that Tree Sparrows from agricultural areas near Warsaw, where some disadvantageous habitat changes took place, moved to the city, where they found better conditions to live.

### Choice of nest sites

House Sparrows showed preferences for nesting in crevices in buildings (optimal nest sites), then, in order: in metal constructions, summer-houses/sheds, tree holes and nest-boxes (suboptimal sites). In housing estates they nested almost entirely in shelters and crevices in buildings (Table 3). In parks, half of pairs occupied tree holes and from 7 to 20% the other types of nest sites. It is characteristic, that suboptimal nest-sites, such as nest-boxes and tree holes, were used only in 3 park areas with particularly rich resources of food. One of them was the zoological garden, where sparrows benefited from the food for animals. Two further areas (Saxon Garden and Krasiński Garden) were old downtown parks surrounded by closely built-up areas. These parks were characterized
by relatively high frequency of people. Blair (1996) and Fernández-Juricic et al. (2003) stated that the presence of people is a key factor for House Sparrows in finding food. The more people that visit a park, the greater is the amount of food waste. Thus, the area visited by many people is more attractive for sparrows. Also, Summers-Smith (1958) and Dawson (1972) stated that suboptimal nest sites were used more readily in places, where food conditions were particularly good.

Table 3. Nest sites of House Sparrow

<table>
<thead>
<tr>
<th>Nest site (N)</th>
<th>Housing estates (539)</th>
<th>Parks (203)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>97.2%</td>
<td>20.2%</td>
</tr>
<tr>
<td>Summer-houses, sheds etc.</td>
<td>0.2%</td>
<td>13.8%</td>
</tr>
<tr>
<td>Metal constructions</td>
<td>0.2%</td>
<td>11.3%</td>
</tr>
<tr>
<td>Nest-boxes</td>
<td>2.4%</td>
<td>7.4%</td>
</tr>
<tr>
<td>Tree holes</td>
<td>–</td>
<td>47.3%</td>
</tr>
</tbody>
</table>

On the basis of observation and experiments with nest-site availability (see below) it was established that Tree Sparrows preferred nesting in buildings and summer-houses/sheds, than in nest-boxes and were least likely to nest in tree holes. Tree Sparrows occurring in housing estates nested mostly in buildings, and were a little less numerous in tree holes and nest-boxes (Table 4). In parks and in allotment gardens most pairs occupied nest-boxes and in the former habitat – also tree holes, and in the latter – summer-houses.

Table 4. Nest sites of Tree Sparrow

<table>
<thead>
<tr>
<th>Nest site (N)</th>
<th>Housing estates (48)</th>
<th>Parks (195)</th>
<th>Allotment gardens (93)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>41.7%</td>
<td>4.6%</td>
<td>–</td>
</tr>
<tr>
<td>Summer-houses, sheds etc.</td>
<td>–</td>
<td>–</td>
<td>32.3%</td>
</tr>
<tr>
<td>Metal constructions</td>
<td>4.2%</td>
<td>1.0%</td>
<td>–</td>
</tr>
<tr>
<td>Nest-boxes</td>
<td>25.0%</td>
<td>74.9%</td>
<td>63.4%</td>
</tr>
<tr>
<td>Tree holes</td>
<td>29.2%</td>
<td>19.5%</td>
<td>4.3%</td>
</tr>
</tbody>
</table>

**Importance of number of nest-sites**

The number of House Sparrow pairs in 1-hectare squares was significantly correlated with area covered by buildings ($r = 0.38; P < 0.001; N = 319$). This relationship is most probably related to availability of nest sites – the larger the area of buildings, the higher is the potential number of holes and crevices suitable for sparrows. Similar relationship was found by Heij (1985), Bland (1998) or Summers-Smith (2009).

In park areas there were statistically important differences in frequency of House Sparrows in 1-hectare squares with- and without buildings ($\chi^2 = 7.10; df = 1;
The presence of buildings in such habitats often predicted the occurrence of H. Sparrow (e.g. Bednorz et al., 2000, Biaduń 2004).

There was no significant difference in the frequency of House Sparrows in squares with- and without nest-boxes in Warsaw parks.

The number of Tree Sparrows in 1-hectare squares in housing estates was not related to area covered by buildings. In parks, the number of pairs in squares was positively correlated with the number of nest-boxes ($r = 0.49; P < 0.001; N = 249$). In old parks (tree stands over 80 years old) this relation was considerably weaker ($r = 0.32; P = 0.001; N = 109$) than in younger ones ($r = 0.60; P < 0.001; N = 140$). There was a lack of tree holes in the younger tree stands. The frequency of Tree Sparrows in squares with- and without buildings in parks was similar (62 and 53% respectively; $\chi^2 = 0.33; P = 0.743; ns$).

**Changes in the number of sparrows in relation to renovations of buildings**

Renovations of buildings considerably influenced the local number of House Sparrows in housing estates. On two study plots (peripheral block of flats) – Chomiczówka and Wawrzyszew the number of breeding pairs decreased between 1983-1985 and 2005 by 75% and 44% respectively, after all the buildings had been insulated. Between 2005 and 2012 buildings were renovated again, and the number of pairs declined over this period by a further 75% and 84%. On plot Muranów (older, downtown estate) the population of House Sparrows decreased by 27% from 1985 to 2005 (no renovation in this period), and by a further 61% from 2005 to 2012, when approx. $\frac{1}{3}$ of buildings were renovated. However, in two housing estates with older buildings, that were not renovated densities of House Sparrow increased from 1983 to 2005 by 13% and 47%.

One of the studied parks was abandoned by the species after renovation of small buildings, which was the only place where House Sparrows nested. Renovations of these buildings did not influence the number of Tree Sparrows.

**Effect of the introduction or addition of nest-boxes**

In Wrzechońo (peripheral estates with blocks of flats), where buildings had been gradually renovated during the period of sparrow monitoring (2005-2009), 25 nest-boxes (8 on buildings, 17 on trees) were erected after the first season of studies. Although the number of House Sparrows declined as result of the loss of nest sites in buildings, nest-boxes were not occupied. However, in 2012, when another 34 nest-boxes were erected on buildings, 7 of them were occupied by House Sparrows.

In parks, where breeding House Sparrows were absent, the installation or addition of nest-boxes did not change the population of this species. However, in one of the parks where sparrows occurred as the breeding species (Krasnyscy Garden), the population grew after introducing of nest-boxes. In a second one (Saxon Garden), the erection of
nest-boxes did not increase sparrow numbers, however they occupied some of them (11 of 43), after the loss of tree nest sites (holes in trees that had been trimmed).

Tree Sparrow positively responded to the introduction of nest-boxes in Wrzeciono: they occupied 2 of them and increasing the population from 3 to 7 pairs. However further erection of more nest-boxes did not influence the population and further on this plot. In all parks, where the number of nest-boxes was increased from 2005-2012, the densities of Tree Sparrows increased. For example in Powiśle Park, where in 2006 two nest-boxes were present and in 2007 – 16, number of breeding pairs of this species increased from 6 to 13.

**Use of nest sites resources**

Optimal nest sites (in buildings) were common in housing estates and, in smaller number, in parks. In blocks of flats, that had been renovated, there were few unoccupied nest sites available in buildings. In housing estates that were not renovated (or only to a small degree), some (but not much) free nest sites were found in buildings. It is probable, that their presence enabled sparrows to move there from renovated built-up areas, which could explain the increase in the number of H. Sparrow in some elder estates (see Table 1). Suboptimal nest sites unoccupied by House Sparrows existed in all habitats. Small numbers of them were present in housing estates after renovation as well as in not renovated. In parks, where House Sparrows occurred, the numbers of such sites were moderate, and in parks without House Sparrows – availability was high. They were also numerous suboptimal nest sites in allotment gardens. Thus, in most cases, the number of House Sparrow was limited only by availability of optimal nest-sites. In housing estates it was also limited to some degree by general abundance of nest sites (optimal + suboptimal), as the holes in trees and nest-boxes were sparse in this habitat. However, there was a surplus in the total number of nest-sites in remaining habitats, indicating that the population of House Sparrows in Warsaw, as a whole, was not limited by a shortage of nest sites.

**Importance of competition for nest sites**

Nesting niches of House- and Tree Sparrow overlap and in some areas both species compete for nest sites (Cordero & Rodriguez-Teijeiro 1990). The decrease in House Sparrows in housing estates in Warsaw probably did not influence the observed Tree Sparrow expansion. On plots, where the abundance of House Sparrows decreased thereby making the number of “free” nest-sites increase, there was no response in the Tree Sparrow population. Also, the situation of the Tree Sparrow on plot Wrzeciono (see above), where a lot of unoccupied nest-boxes existed suggest that the population in this habitat was not limited by availability of nest sites, but rather by the other factors (probably connected to food resources).
However, observations carried out in some parks, showed that House Sparrow declines could have an effect on Tree Sparrow increases. In Saxon Garden, the number of Tree Sparrows increased from 12 pairs in 2008 (it occupied then 5 of 43 nest-boxes) to 21 pairs in 2012 (17 in nest-boxes), while the number of House Sparrows decreased respectively from 57 pairs (11 in nest-boxes) to 20 (all out of nest-boxes).

CONCLUSIONS

**House Sparrow**

1. Number of House Sparrow declined by a half from 70s/80s, and the process is continuing
2. The species abandoned most urban green areas though in some of housing estates its number increased
3. Most pairs nested in crevices in buildings, and suboptimal nest sites were occupied only in cases of particularly attractive food conditions
4. Densities or occurrence of House Sparrows on particular plots were influenced by the area/presence of buildings
5. Insulation of buildings considerably reduced the number of local pairs in housing estates
6. Nest-boxes were rather meaningless for House Sparrow population, although, locally, they could increase in number or reduce to a some degree the rate of decrease caused by the loss of optimal nest-sites
7. On study plots there was a surplus of potential nest sites for House Sparrow, suggesting that a shortage of nest sites was not the main cause of the decline of the H. Sparrow in Warsaw

**Tree Sparrow**

1. Number of Tree Sparrow increased by 70% from 70s/80s to the present and colonized the new habitat (housing estates)
2. It was more flexible in its choice of nest sites than House Sparrow
3. The abundance of Tree Sparrow was clearly influenced by the number of nest-boxes, particularly in younger parks
4. The area/presence of buildings was meaningless for this species
5. The decline of House Sparrow population probably contributed to the increase of Tree Sparrow number

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Summers-Smith J.D. 1958. Nest-site selection, pair formation and territory in the HS (*Passer domesticus*). Ibis 100: 190-203
BLUES 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 (Banbura et al. 1994, 1995, own unpublished observations). 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

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

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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THE BREEDING POPULATION OF ROOK CORVUS FRUGILEGUS IN MAJOR CITIES OF PODLASKIE VOIVODSHIP (NE POLAND)

ABSTRACT

Until now, there was no relevant data about the rook breeding populations in cities of north-eastern Poland. The main research was conducted in 2012, whereas in Białystok, which is the capital of Podlaskie voivodeship, the data was collected also in 2007. During the research 2329 nests forming 42 colonies were noted in three major cities, i.e. Białystok, Suwałki and Łomża. Mean density in mentioned cities was 5.17 pairs/km², 9.71 pairs/km² and 33.09 pairs/km² respectively. In Białystok and Łomża the colonies were located only in the city centre, while in Suwałki they were observed also in the suburbs. Between 2007 and 2012 in Białystok has been a slight increase in the number of colonies and of their average size and, simultaneously, a decrease in the number of pairs nesting separately.

Key words: Rook, Corvus frugilegus, major cities, Podlaskie voivodeship, breeding colonies, nests

INTRODUCTION

Since the 1920s there has been a constant growth in the number and size of rookeries in urban areas. This phenomenon is particularly noticeable in western Poland, which is a consequence of the change in foraging preferences, i.e. bigger percentage of anthropogenic food in the diet (Tryjanowski and Rzępała 2007). As a result of this, the rooks nesting population density in cities is now the highest on record for Poland and it is regularly about 1000 pairs in one city, in several to several tens of colonies (Hordowski 2009, Indykiewicz 2007). Until now, the rook breeding population has been studied in most major cities in western, southern and the south-eastern part of the country. However, there is still no data from the cities of north-eastern Poland. The purpose of this study is to summarize current knowledge on the breeding population of Rook in major cities in Podlaskie voivodeship.
STUDY AREA

Białystok (53°07’N 23°10’E, 102 km²), Suwałki (54°05’N 22°56’E, 66 km²) and Łomża (53°10’N 22°05’E, 33 km²) are the largest cities in north-eastern Poland and they are the only cities in Podlaskie voivodeship with the district rights. Each of those cities is in a different climatic region: Podlaski, Suwalski, Mazowiecki. The average human population density for the three cities is 2894 people per km², 1053 people per km², 1935 people per km² respectively. In Białystok, total annual precipitation is less than 650 mm, in Suwałki is 600-650 mm and in Łomża is 550-600 mm. The lowest mean annual temperature is has been recorded in Suwałki (6.1°C), and the highest in Łomża (7.1°C), whereas in Białystok it is 6.8°C.

METHODS

The first data about rook nesting populations in cities of Podlaskie voivodeship was collected in Białystok in 2007, during 2 days in the first ten days of April. In 2012 the research was conducted also during 2 days but in the last ten days of April. The study carried out in Suwałki and Łomża took one day for each city. The colony assumed a cluster of minimum 3 nests. In cases when it was impossible to clearly define whether closely located gathering of nests interact (voice/eye contact, common foraging), a minimum of 3 nests distanced more than 250 meters from other separated colony was arbitrarily considered to be a detached rookery. Their localizations were applied on a map and described in details (e.g. urban tree clumps, park, cemetery, alley, single tree etc.). The number of nests and trees forming a single colony were noted, divided by species or genera. In 2007 the number of trees composing individual colonies was not recorded.

RESULTS

In three major cities of Podlaskie voivodeship we counted 2329 nests, which represent 31% of their total number recorded in 24 cities (from 40 censused cities) in 2012 (N=7509).

Białystok

In 2007 we observed 515 nests forming 21 rookeries. An additional 12 pairs nested outside the colonies. The average colony size was 18.8 (SD = 35.2, n = 21) nest and the mean density 5.17 pairs/km². Small colonies, i.e. up to 20 nests, made up 90% of the total number. Nesting trees were of 10 species (unrecognized N = 14). Most nests were placed on European alders Alnus glutinosa (30.2%), Grey poplars Populus canescens (27.5%), Norway maples Acer platanoides (16.5%) and Canadian poplars Populus x canadensis (13.5%). Colonies were located in all parts of the city, i.e. in the city centre as well as in suburban areas.
In 2012 in 23 colonies (mean size 25.9, SD = 23.7, n = 23) 596 nests were registered and they were placed on 228 trees from 20 taxa (species or genera), including 3 coniferous. Four pairs were observed nesting outside a colony. The mean density was 5.84 pairs/km². Small colonies made up 83% of the total number. The dominant species among the nesting trees were Norway maple (34.2%) and Grey poplar (26.8%). The percentage of the remaining species was less than 5%. Most nests were located on Grey poplars (33.4%) and Norway maple (33.4%). In 2012, all the colonies were in the city centre.

**Suwałki**

In 2012 we registered 641 nests on 162 trees (10 taxa including one coniferous) forming 10 colonies (average size 64.1, SD = 100.2, n = 10). Single pairs nesting outside flocks were not observed. Mean density was 9.71 pairs/km². Small colonies accounted for 80% of the total number. European ash *Fraxinus excelsior* (37.0%), Norway maple (36.4%) and Canadian poplar (15.4%) were dominant species among the nesting trees. The percentage of the remaining species was less than 5%. Most nests were located on European Ash (46.8%), Canadian poplar (25.0%) and Norway maple (21.2%). Colonies were found in all parts of the city, i.e. both in the city centre and the suburbs.

**Łomża**

In Łomża, 9 rookeries (average size 121.3, SD = 126.6) consisting of 1092 nests on 253 trees (22 taxa including 6 coniferous) were observed. Single pairs nesting outside colonies were not registered. Small rookeries accounted for 56% of the total number. Mean density was 33.09 pairs/km². Norwegian maple (28.9%) and Small-leaved lime (22.9%) were dominant species among the nesting trees. The percentage of other species was less than 5%. Most nests were noted on Norwegian maple (27.5%), Small-leaved lime (20.8%) and Oaks *Quercus* sp. (12.3%). All colonies were in the city centre.

One of the most important places for rookeries in the three cities was city parks where 29% of nests were located.

**DISCUSSION**

**Białystok**

In both years of the studies (2007 and 2012) rooks tended to form small colonies. A similar phenomenon has been noted in other major cities in Poland, e.g. in Warsaw or Gorzów Wielkopolski (Jerzak and Piekarski 2005, Mazgajski 2001). Birds breeding in big rookeries need to fly to profitable feeding grounds which provide sufficient food, often located outside the city. The energy expenditure necessary for this is disproportionate to the security offered by nesting within the urban area. Because of this, in major cities, rooks are more likely to breed in many small colonies (Mazgajski 2001). In May
and June 2012 rooks were observed foraging in cities on grass verges dividing roadway lanes or green areas located in the vicinity of a rookery – up to 500 metres. These places are a substitute for pastureland and meadows, which are essential for rooks during the breeding season, (Tomiałojć 2009). Moreover, feeding grounds situated at this distance are crucial for the functioning of a colony (Kasprzykowski 2003).

There were no significant fluctuations in the number of rookeries in each year of studies, however, their locations changed. There were fewer colonies situated in suburban districts and more in the city centers in 2012, and the number of nests increased also (Indykiewicz 2007). In 2012 we observed a disappearance of rookeries settled in the suburbs, which represented 35% of the total number in 2007. In Lublin the situation is the converse where rookeries in the city centre are declining and the percentage of those in the peripheral zone of the city is growing (Biaduń 2005). The difference in Białystok may be due to a lower availability of suitable feeding grounds with low cut grass (pers comm). The dominant areas are wastelands, which are covered with high herbaceous vegetation during period of rookeries’ greatest demand for food.

As in Lublin, Siedlce and Gdańsk, a slow steady growth of almost 12% (Biaduń 2005, Kasprzykowski 2001, Wójcik 2005) in the rook breeding population was perceived. The biggest colony (78 nests) was found in the city centre, on Sienkiewicz Street, by the Białka river, which is one of the most stable rookeries in Białystok. It may be the result of its localization (at considerable distance from architectural structures) and food accessibility (nearby we can find several places where people regularly feed ducks).

Unlike in Lublin, there was a slight increase in the number of breeding colonies, but despite a 27% increase, the average size of colony never exceeded 100 nests, which is typical for other big cities in Poland (Biaduń 2005). The mean density, average size of colony and the number of colonies in Lublin were amongst the largest observed in major Polish cities, e.g. Bydgoszcz and Toruń (Indykiewicz 2005), Częstochowa (Czyż 2008), Gorzów Wielkopolski (Jerzak and Piekarski 2005), Łódź (Janiszewski et. al. 2004), Gdynia, Gdańsk and Sopot (Wójcik 2005), Szczecin (Solowiej 2000), Katowice, Opole, Zabrze, Bytom, Chorzów, Gliwice (Czapulak and Betleja 2002), Poznań (Ptaszyk 2003), Warsaw (Mazgajski 2001, Luniak et al. 2001), Wrocław (Tomiałojć 2009). Such larger rates were recorded only in few big cities, e.g. in Lublin (Biaduń 2004, 2005) and Rzeszów (Kawa and Pelc 2001).

High diversity of nest tree species was caused by the fact that about 25% nests were settled on the trees growing in city parks. Those same tree species are common in other regions of the country also, e.g. alders, maples and poplars are one of the dominant tree species on which rooks tend to nest in Poland (Hordowski 2009). Between 2007 and 2012 we observed a twofold increase in the number of nest tree species, which is apparently the result of birds’ moving from the suburbs to the city centre parks, where species differentiation of dendroflora is much higher.

During the research in the cities of Podlaskie voivodeship, rooks breeding outside
the colonies were registered only in Białystok, however in 2007 this phenomenon was more noticeable than in 2012 when the recorded number of pair nesting separately decreased by 66%.

**Suwałki**

Most rookeries were found in the city centre. In contrast to Białystok and Łomża, few of them were found in suburban districts. The number of nesting trees was half that found in Białystok in 2012 but it was similar to the number from 2007. This may has been related to the fact that only 9% of the nests were on trees growing in the city park. This example can indicate that the presence or absence of parks determines the species composition of rook nesting trees in cities where parks are the primary nesting places (Indykiewicz 2005).

The average size of colony was twice that recorded in Białystok. Mean density was also higher than that noted in other Polish medium-sized cities such as Gniezno (Adamiak 2010), Ostrów Wielkopolski (Dolata 2005), Leszno (Tobółka et al. 2011), Żywiec and Zakopane (Jakubiec and Cichocki 2005) and Przemyśl (Hordowski 2009). The percentage of small colonies was similar to that recorded in Białystok but the largest was four times bigger. The most abundant nesting tree species, i.e. European ash and Norway maple, are the most commonly observed species which rooks choose to nest on in Poland (Hordowski 2009).

**Łomża**

The mean density of rooks in Łomża was the highest observed in any Polish city in 21st century (Hordowski 2009, Indykiewicz 2007, Kasprzykowski 2005). It was five times higher than that recorded in Białystok, and three times higher compared to that recorded in Suwałki. However, it was similar to the mean density documented in Siedlce in the late 1990s and in early 21st century (Kasprzykowski 2001, 2005). Small colonies constituted about a half of all those recorded in Łomża, which is approximately 30% less than in the aforementioned cities. The number of nesting trees was similar to that noted in Białystok, which was mainly due to the fact that almost half of the nests were on trees growing in city parks.

No breeding colony consisted of less than 15 nests. The average size of a colony was double that in Suwałki and almost five times larger than that documented in Białystok. Large colonies are more stable and are essential for the whole population (Indykiewicz 2007, Kasprzykowski 2005). Unfortunately, they were located in the city centre and were subjected to intense human impact. Therefore, even though large colonies are generally speaking more stable, in this case they were vulnerable to the adverse effects of human activity (Czyż 2003, Tomiałojć and Stawarczyk 2003). Large rookerries are normally found in small and medium-sized cities (Hordowski 2009, Jermaczek et al. 1990, Kasprzykowski 2001, 2005).
The analysis of nesting trees across Poland (N=74995) prepared by Hordowski (2009) indicated the presence of only 2 nests on *Thuja* sp. We observed a single nest on Chinese Arborvitae *Platycladus orientalis* in Jakub Waga Park in Łomża.

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SEASONAL CHANGES IN GROUP SIZE AND FORAGING ACTIVITY IN AN URBAN POPULATION OF MAGPIES (PICA PICA)

ABSTRACT

We studied seasonal variation in group size and feeding activity in an urban population of Magpies in Zielona Góra, Western Poland. Each month from 1984 to 1987 we counted the species along a 10 km transect across the city and noted the number of single birds, pairs and flocks as well as flock size. In 1999 and 2000 we regularly observed Magpies foraging on the lawns of a park of Zielona Góra and recorded the number of pecks, as a measure for feeding activity. Magpies were most often encountered as single birds in April and May, as pairs in March, and in flocks in August. This pattern is predominantly dictated by the constraints of the breeding season and by reproductive success. The mean flock size was highest in August. Pecking rate showed a minimum in the summer months, with no sex-specific difference. However, males were much more active in foraging during winter, probably due to their larger body size and the respective higher energetic requirements.

Key words: Magpie, urban population, group size, foraging activity.

INTRODUCTION

The Magpie Pica pica is as a corvid species with a rather variable social organization, ranging from territorial pairs, family groups, and flocks of non-breeding individuals to large winter roosts (Birkhead 1991, Glutz von Blotzheim 1993, Kooiker & Buckow 1999, Vines 1981). One of the main factors determining the number of individuals in an area is the abundance, distribution and availability of food (e.g. Newton 1980, Schoener 1971). Food can also have a pronounced effect on group size, and flocking is often seen as an indication of clumped food resources. Furthermore, males and females often have different foraging strategies, especially during the breeding season when offspring must be reared.

During the last decades, Magpies have increased strongly in many cities of their European breeding range (Jerzak 2001b, Kooiker & Buckow 1999), probably as a result of favourable conditions such as low predatory pressure and abundant natural and
anthropogenic food. The species is now considered as well adapted to urban environments (Jerzak 2001a), and urban populations can be distinguished on a variety of factors from rural ones (Birkhead et al. 1986, Krystofková et al. 2011).

Since 1970 we have been conducting a long-term study on several aspects of the population biology of the species in the city of Zielona Góra, western Poland (Jerzak 2001a, b). Here Magpies have reached one of the highest abundances ever recorded for cities, with up to 30 pairs/km² (Bocheński et al. 2011, Jerzak 2001a). In the present paper we report the results of a study of seasonal changes in group size and foraging activity, an aspect which has rarely been studied in dense populations in the urban environment.

MATERIAL AND METHODS

Study area

Data on group size and foraging were collected in Zielona Góra, the capital of the Lubuskie province in western Poland (51° 56´ N, 15° 30´ E). The city is inhabited by about 118,000 inhabitants and has a size of 58.3 km², of which about 23 km² is built-up area. It is mainly surrounded by forest.

Behavioural observations

On one Sunday each month from 1984 to 1987, we searched for Magpies along a 10 km transect across the town (about 4 km in city and 6 km in suburb). Whenever the species was detected, we noted whether it occurred as a single individual, a pair, or in a flock, i.e. three or more individuals. In flocks, the total number of individuals was counted.

In 1999 and 2000, we studied the foraging rate in one of the city parks with lawns each month. Foraging was quantified by noting the pecks per minute, separately for males and females. Males and females can be identified by behaviour (Birkhead 1991). The total observation time amounted to 8 hrs and 38 min.

RESULTS

Occurrence of groups

The probability of detecting single birds, pairs or flocks, respectively, clearly changed in the course of the year. Flocks were most often seen in August, but the likelihood decreased throughout fall and reached a second peak in January (Table 1, Fig. 1). Only occasionally were flocks encountered from March to May. In March Magpies occurred mainly in pairs. Single birds were common in April and May, which is the period of nest-building and egg-laying in Zielona Góra (Jerzak 2001a).
Table 1. Percentage of encounters with Magpies as single birds, in pairs or in flocks in Zielona Góra (in brackets = the absolute number of encounters)

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<td>Single bird</td>
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<td>54.1</td>
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<td>26.7</td>
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<td>Pair</td>
<td>38.0</td>
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<td>43.2</td>
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<td>Flock</td>
<td>42.6</td>
<td>34.8</td>
<td>19.9</td>
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<td>Total</td>
<td>100.0 (131)</td>
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<td>100.0 (121)</td>
<td>100.0 (26)</td>
<td>100.0 (108)</td>
<td>100.0 (75)</td>
<td>100.0 (152)</td>
<td>100.0 (59)</td>
<td>100.0 (122)</td>
<td>100.0 (168)</td>
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Fig. 1. Number of single birds, pairs and groups of Magpies encountered each month in Zielona Góra

Flock size

In the course of the study we detected 198 magpie flocks, with a total of 944 individuals. The average number of birds per flock was 4.8 (SD = 2.8). Flock size was highest in August (followed by May) and especially low in June and July (Table 2).

Table 2. Total number of Magpie groups and individuals as well as average number of birds per group encountered during each month in Zielona Góra

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<td>23</td>
<td>15</td>
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<td>28</td>
<td>10</td>
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<tr>
<td>Individuals</td>
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<td>79</td>
<td>101</td>
<td>22</td>
<td>24</td>
<td>85</td>
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<td>57</td>
<td>124</td>
<td>49</td>
<td>100</td>
<td>141</td>
<td>944</td>
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<td>Individuals per group</td>
<td>5.9</td>
<td>4.7</td>
<td>5.1</td>
<td>5.5</td>
<td>6.0</td>
<td>3.7</td>
<td>4.0</td>
<td>6.3</td>
<td>4.4</td>
<td>4.9</td>
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Most flocks consisted of three or four birds (Fig. 2), and larger groups could usually be seen during the winter months. Groups in May consisted mostly of pairs with their fledged young.

![Fig. 2. Frequency of different sizes of Magpie flocks (n = 198) encountered in Zielona Góra](image)

**Foraging**

There were pronounced seasonal changes in foraging activity (Fig. 3). As the breeding season progressed, the pecking rate declined to low levels of 5.1-7.5 pecks/min. from June to September. Maximum levels with up to 15 pecks/min. were reached in winter and early spring. The low pecking rate noted in February must be seen as an artefact, because heavy snow cover strongly impeded the observations.

![Fig. 3. Seasonal variation of foraging activity of Magpies in Zielona Góra](image)
The foraging rate was higher for males from late fall (October) to early spring (March); Fig. 4, table 3. Foraging of females started to increase in January and reached

![Graph showing seasonal variation of foraging rates of Magpie males, females and birds of unknown sex in Zielona Góra](image)

**Fig. 4.** Seasonal variation of foraging rates of Magpie males, females and birds of unknown sex in Zielona Góra

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<td>Ma</td>
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Table 3. Foraging rates of Magpies in Zielona Góra. S = sum of pecks/sum of sec. observation time, M = mean number of pecks/min., N = number of foraging bouts, Fe = female, Ma = male, Un. = unknown sex, T = Total for all birds. Missing data for males and females in February are due to heavy snow cover.
a maximum in April with 14.7 pecks/min., a level much higher than that recorded for males at this time (6.9 pecks/min.). The pecking rate remained on lowest levels for both sexes throughout the summer months, with a minimum reached in July. Please note that missing dates for males and females in February are due to heavy snow cover which strongly impeded observations.

DISCUSSION

Magpie groups

The pronounced seasonal changes in the occurrence of flocks and in group size in the Magpie are to a large extent influenced by the constraints of the breeding season and the reproductive success. Pairs were most often encountered in March. This is the period when magpies prepare for breeding, i.e. both partners are engaged in nest building/repairing, and mate guarding during foraging is commonly observed (e.g. Glutz von Blotzheim 1993). However, single birds were more often seen than pairs in April and May, when the female usually incubates the clutch or stays inside the nest to keep the nestlings warm and, if necessary, defend the nest while the male does most of the food provisioning.

After leaving the nest, fledglings and parents stay close together for a certain period of time during foraging, accounting for the rather high group size observed in May. When young birds separate from their parents and feed on their own, the group size decreases, i.e. from May to June/July. It increases again in August when juveniles of neighbouring territories associate in juvenile groups which roam in their parents’ home ranges.

Magpie flocks in Sheffield ranged from ten to 52 birds (Birkhead 1991). In that area the average number of individuals in groups of non-breeding birds varied in the course of the year and was highest (four to six individuals) from December to February (Birkhead et al. 1986). Flocks with three or more Magpies, often exceeding 100 birds, are common from September to April. In Danish farmland this period extends from November to February (Møller 1983).

Foraging behaviour

The results of our study clearly indicate that foraging rates are highest during winter and lowest in summer (see also Møller 1983). This general pattern can be explained by (1) a higher energy requirement during the cold period of the year and (2) a more constrained availability of food in winter when grounds are more likely to be frozen and, consequently, ground-dwelling invertebrates less active. Especially snow cover causes the pecking rate of Magpies to increase, as shown in a study by Møller (1983). It must be noted, however, that the general time spent feeding is highest during late spring and summer when food is abundant and pairs must take care for nestlings and
fledglings (Birkhead 1991, Glutz von Blotzheim 1993, Møller 1983). But longer daylight in summer, and hence a longer period suitable for foraging, also allows to slow down the foraging pace, i.e. pecking rate. Furthermore, due to more abundant and varied food in summer Magpies can forage more selectively at that time of the year (comp. Møller 1983).

Møller (1983) noted foraging rates of 13.1-14.1 pecks/min. for Magpies in Danish farmland, which are higher values than those observed in the present study in the urban environment of Zielona Góra (9.4-9.7 pecks/min.). Furthermore, Danish Magpies occupying territories of higher quality pecked at lower rates than those holding low quality territories (Møller 1982). The lower pecking rates in Zielona Góra, therefore, may indicate that territories in an urban environment are better in terms of food abundance and/or quality. An additional positive factor in cities is certainly anthropogenic food, often available to Magpies in garbage bins (Jerzak 2001a) or left on the ground. Also the milder urban climate compared to rural areas, with grounds less often frozen and fewer days with snow cover (Kuttler 1998), results in more favourable feeding conditions.

In a study by Tucker (1989) the number of earthworms, which are important food for Magpies in some areas, was found to be up to five times higher on grassland than on stubble fields or ploughed land. A similar pattern exists for other invertebrates (ibid.). This high abundance of invertebrates is probably an important factor which had favoured the colonization of the urban environment by magpies, as cities usually offer plenty of lawns.

Sex differences in foraging activity were most pronounced in winter, with males feeding at a higher rate than females. Males have a higher body mass (Birkhead 1991, Glutz von Blotzheim 1993) and, therefore, need more energy, which is especially important in winter with its limited food supply. In February and March, the period of nest building, there is an additional burden on males because they are usually more active than females in gathering nest material. In April, the difference in feeding activity changed pronouncedly in favour of females, which now need a high energy intake for the production of eggs. We found almost no sex differences from May to September, when days are long (see also Møller 1983) and insect food abundant.

REFERENCES


The author (OC) is a scholar within Sub-measure 8.2.2 Regional Innovation Strategies, Measure 8.2 Transfer of knowledge, Priority VIII Regional human resources for the economy Human Capital Operational Programme co-financed by European Social Fund and state budget.
SPECIES COMPOSITION OF BIRDS COLLIDING WITH NOISE BARRIERS IN BIAŁYSTOK (NORTH-EASTERN POLAND)

ABSTRACT

Until now in Poland there was no relevant data about the species composition of birds colliding with reflective plate glass in building construction and noise barriers. The research was conducted in 2010-2012. For the first two years the research was conducted only in breeding season, field control was carried out from 2 to 5 days. Since November 2011 an all year-long monitoring was started and the area was controlled once a week. In winter 2011/12 and spring 2012 there was conducted an experiment on time of carrion loss.

In total there were 269 dead birds representing 43 species. The victims of window strikes were mainly common species, small or medium size passerines, residing and foraging in the low vegetation up to several meters above the ground (89%). According to the status of the species: 55% were resident or partially resident, 38% were short-distance migrants and 7% were long-distance migrants. At the base of the experiment on speed of carrion loss (N = 30), it was found that 17% of dead birds were removed after 1 week, 43% after 2 weeks and 23% after 3 weeks.

There were 4 injured and stupefied birds found, despite the first aid all birds died from 3 to 48 hours after collision.

Key words: species composition, noise barriers, collisions, Białystok, carrion.

INTRODUCTION

Transparent and reflected glass or plastic surfaces used in the construction industry, including noise barriers, are the significant threat for wild birds. Klem (2006, 2009) claims, that it is the second human-related factor of avian mortality, after habitat loss. He estimates, that avian mortality from collisions, across the United States was from 100 million to billion birds per year. Some scientists claim, that the number might be five times higher (Hager et al. 2008). Apparently, almost all bird species are exposed to collision with glass panes, from common birds to rare and endangered ones (Klem 2009, Zbyryt 2012). Collisions occur due to two main factors: (1) reflection of the light
and as a result the mirror effect and (2) transparency of glass. This issue appeared also in Poland, especially in bigger cities. It is caused by the civilization development which introduces technological innovations like modern glass architecture (blocks, skyscrapers, transparent noise barriers). Currently in Poland, there is almost no available data about the scale of this phenomena and the list of the bird species striking glass panes. Therefore, this paper is an attempt to fill the gap.

STUDY AREA

Białystok (53°07'N 23°10'E, 102 km²) is the largest city in NE Poland. Population density is 2.9 people per km². The city has a warm summer continental climate, characterized by warm temperatures during summer and long and frosty winters. The region is one of the coldest in Poland, with the average temperature in January being – 4.3°C and the average temperature in a year 6.8°C. Mean annual rainfall values oscillate around 590 mm and the vegetation period lasts 200 to 210 days. Forests are an important part of Białystok's character, and occupy around 1750 ha (17% of the administrative area of the city). There are two nature reserves: Las Zwierzyniecki (with a dominant assemblage hornbeam Carpinus betelus) and Antoniuk (with a dominant mixed forest of Scots pine Pinus sylvestris, Spruce Picea abies and Hazel Corylus avellana). The road along which the study was conducted was built a few years ago. The noise barriers installed are surrounded by houses, allotments and part of the nature reserve “Las Zwierzyniecki”.

METHODS

From 2010 to 2012 studies were conducted in order to estimate the avian mortality caused by collisions with transparent acoustic barriers at the St Pio's Street in Białystok. On the southern part of the road both sides of the barriers were controlled, on the northern part, because of the private property, only the inner side of the barriers was controlled. The total length of the study route of the single field control was about 1800 meters. In 2010-2011 the research was conducted only in summer (breeding season), field control were carried out from 2 to 5 days. In November 2011 an all year-long monitoring has started and the area was controlled once a week in order to better recognize the scale of the phenomena. The data recorded were: species, sex, age, victim’s location and the background of the acoustic barrier panes (sky, trees, shrubs, buildings). Additionally, in winter and spring an experiment was conducted on the speed of carrion loss. All victims were noted and left in the controlled area in order to verify their presence in subsequent field visits.

RESULTS

In total there were 269 dead birds representing 43 species (Tab. 1). It is almost 10% of Polish avifauna (state on 30th of June 2012). The dominant species among victims of
<table>
<thead>
<tr>
<th>Species</th>
<th>Summer 2010</th>
<th>Summer 2011</th>
<th>Winter 2011/12</th>
<th>Spring 2012</th>
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collisions was Hawfinch *C. coccothraustes* (17.5%), followed by Great Tit *Parus major* (12.3%), Song Thrush *Turdus philomelos* (9.7%), Fieldfare *Turdus pilaris* (8.6%), Blue Tit *Cyanistes caeruleus* (7.8%), Blackbird *Turdus merula* (5.2%), Starling *Sturnus vulgaris* (4.5%), Wood Pigeon *Columba palumbus* (3.3%), Goldfinch *C. carduelis* (2.6%), Blackcap *Sylvia atricapilla* (2.2%), unidentified (2.2%). A great majority of fatalities were common, small and medium passerines (89%), 55% were resident or partially resident, 38% were short-distance migrants and 7% were long-distance migrants. The majority of collisions (64%) were noted at the part of the study area adjacent to the nature reserve “Las Zwierzyniecki”. The largest number of fatal collisions with acoustic barriers took place in summer 2010 (N = 124). In summer 2011 and 2012 there were 55 and 35 dead birds respectively.

The experiment on the speed of carrion loss (N = 30) found that 17% of dead birds were removed after 1 week, 43% after 2 weeks and 23% after 3 weeks. In one case the disappearance of carrion took 20 weeks. In winter 2012, tracks and visual observation of carrion feeders were noted. Cats and dogs were found the most often at the study area (recognition by tracks during 12 field visits). There were no corvids Corvidae like Magpie *Pica pica* or Hooded Crow *Corvus cornix* and no martens *Martes* sp. or foxes *Vulpes vulpes*, which could influence the speed of carrion loss.

There were 4 injured and stupefied birds found, despite the first aid all birds died from 3 to 48 hours after the collision.

**DISCUSSION**

There are no prior data on the species composition and the scale of bird mortality from collisions with reflective plate glass in building construction in Poland. Some casual information can be found on ornithology internet forums or in the daily press (Zbyryt, 2012). We can conclude from the analysis of the “Records Of Dead And Weakened Birds”, conducted by Eagles Conservation Committee in 1998-2009, that out from 546 cases of specific cause of death or mutilation of falconiformes and owls, 6% were the victims of window collisions (Anderwald 2009). Unfortunately, there are no data on the species composition of birds colliding with this kind of man-made structures. Recently,
Polish scientists have shown much more interest in the influence of power plants on birds, which may be noticed e.g. in the environmental impact assessment (EIA) (PSEW 2008). It has been estimated that each year 10-40 thousand birds die due to the collision with wind turbines, however in the case of striking transparent architectural objects, those numbers could be in the billions (Klem 2009).

In this study, the main factor that affected the number of bird collisions was the transparency of noise barriers which reflected trees and shrubs, the so-called mirror effect. The use of bird silhouettes appeared to be ineffective, and the location of noise barriers along the edge of a nature reserve may have exaggerated the collisions. In 2010 additional bird silhouettes were fastened to soundwalls. This time they mimicked falconiformes (previous ones resembled rooks). Following this there was a reduction in bird strikes caused by the mirror effect and transparency during summer. Nevertheless, mortality rates were still high, which suggested that even using the silhouettes of birds of prey with a view to protecting birds from the collisions with reflective plate glass in building construction is ineffective (Trybus 2003). Collisions often occur a short distance from bird figures applied to the noise barriers (pers. obs.) and the applied figures aroused a lot of controversy among local residents (Zbyryt 2012).

It was found during the studies that only a small percentage of dead birds were long-distance migrants. This may indicate that the analyzed barriers were not on a bird migration route. In addition our data suggest that transparent noise barriers are a bigger threat to resident or partially resident birds. The location of reflective barriers should take into account both bird density close to the soundwall (Klem 1989, Klem et al. 2004), and also the attractiveness of the area (Hager et al. 2008). The largest number of collisions were recorded in the immediate vicinity of the nature reserve, which is the most appealing site for birds. During studies conducted in Switzerland (Sierro and Schmid 1999) researchers showed that most, (34%), collisions with noise barriers occurred in the spring season (April-May) and then systematically decreased. A similar situation happened during our studies. In our study 6% of collisions were recorded in the winter season 2011/12 compared to 40% in the summer of 2012 and 54% in the spring of 2012, confirming significant differences between the seasons. Just as in the Swiss research, the victims of window strikes were mainly common species, birds of small or medium size passerines, residing and foraging in the low vegetation up to several meters above the ground.

The studies affirm that transparent architectural objects can be a significant source of bird mortality, especially for local populations. It has been proven in Australia that each year 1,5% of the globally endangered Swift Parrot *Lathamus discolor* breeding population dies as a result of collision with reflective plate glasses (BirdLife International 2000, Klem et al. 2004). In 2010 three dead specimens of Middle Spotted Woodpecker *Dendrocopos medius* were found next to a noise barrier. One of the birds had a brood patch, indicating that as a consequence of her death, the nestlings probably also died.
The total population of this species in the nearby nature reserve has been estimated to be 3-4 pairs. It is a species listed in Appendix I to the Bird Directive. Besides this, we have also found Red-backed Shrike *Lanius collurio*, which is also on that list, among the window victims. Surprisingly, the dominant species among the fatalities was Hawfinch which spend most of their time high up in the trees and flies at height (Svensson et al. 2009), while noise barriers reach 1/3 the height of the surrounding trees.

Predators and scavengers can significantly reduce the number of collision victims found (Klem 1990). If we take into account our experiment into the disappearance of carcasses, we can conclude that most of the birds, which suffered an instant death due to the window impact, were found. On the basis of direct observation (made during every control) and tracks in the snow (winter season) no increased scavenger activity was noted. In addition, no synurbic Corvidae populations exist in the vicinity which could remove dead birds (Sierro and Schmid 1999). The percentage of bird fatalities perceived more than once at the same place (66%) leads us to assume that at least 2/3 of the collision victims were found. It should be emphasized that this is only the number of specimens which died at the scene of the accident. It is still unknown how many birds died due to the complications resulting from the strike. In most cases the backbone does not get broken; a large number of victims die after some time as a result of created intricacies (Klem 1990, Veltri and Klem 2005), which additionally hinders estimating the scale of collision phenomenon. This was confirmed by the death of four birds (the small size of the body) discovered as the victims of collisions with screen that have died in the period from 3 hours to 2 days after they received aid.

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Supplemental feeding of birds in human settlements of Western Poland

INTRODUCTION

Humans are probably the only species which obtain satisfaction from helping other species, including the feeding of animals. Since the end of the XIX century it has been proposed to feed birds, but only in the recent decades – due to the massive growth of urban populations with an accompanying increase of the urban areas and the synanthropisation and urbanisation of many animal species – bird feeding became more common and can be conducted throughout the year. In supplemental feeding of birds we can distinguish between targeted actions and involuntary actions. Among ornithologists two extreme attitudes are apparent: The suggestion to completely abandon feeding and stop providing nest boxes on the one hand, and the strong propagation of both supplementary feeding and putting up nest boxes to enrich the composition and abundance of birds on the other hand (Berthold and Mohr 2008). The results of several studies indicate that supplemental feeding of birds must follow specified rules (Berthold and Mohr 2008, Graszka-Petrykowska 2008, Szokalski and Wojtatowicz 1989). This view has been commonly accepted now. In cities species inhabiting the built-up and green areas as well as water birds are usually fed (Berthold and Mohr 2008). Despite the fact that the problem of feeding birds has been studied often an in depth in Western Europe and North America, in Poland there are no publications on this topic so far.

Supplemental feeding of birds has also biological consequences, increasing survival and breeding success in the next season (Doerr and Silvy 2002, Robb et al. 2008).

Key words: birds, supplemental feeding, human settlements.

STUDY AREA

The studies were conducted in Lower Silesia and the Lubuskie province, i.e. in areas characterised by relatively mild winters with little snow cover (Lorenc 2005). Observations were carried out in the large cities of Wroclaw and Zielona Góra as well as in two non-urban areas, Trzebiel and Sokołowsko. Counts of birds in Wroclaw was
conducted on three plots during the seasons 2010/2011 and 2011/2012, respectively. In each season, 2 to 5 (average 3.7) counts were made on each study site between the third decade of December and the third decade of February. Controls in the Lubuskie province were completed in March 2012, and in Sokołowsko in April and May 2012.

Within the cities emphasis was put on (1) estates of compact, high-rise buildings, (2) residential areas, (3) parks, and (4) downtown fragments of the Odra valley. In the village areas, the village centre as well as peripheral sites were studied.

In the Lubuskie province, the following areas were investigated:
Trzebieł – outskirts (7 ha), characterised by an assembly of single-family houses, near a forest. Housing and farm buildings prevail, and some residents breed poultry.
Trzebieł – centre II (15 ha), with two-storey blocks and detached, dispersed houses. Trees are present.
Zielona Góra – painters’ estate (16 ha), a complex of detached houses with gardens.
Zielona Góra – sun estate (6 ha), consisting of four-storey blocks.
Zielona Góra – friendship estate (7 ha), characterized mostly by eleven-storey high-rise buildings.
Areas examined in Wroclaw were:
– Szczytnicki Park (30 ha), bordered by Mickiewicz Street, Hevelius street, the Japanese Garden, and the 9th May Street. The study area covered the southern part of the park, adjacent garden plots and the area of the garden department.
– Downtown (40 ha), from the bank of the Odra river to the Słowacki Avenue and Wit Stwosz Street and from the Kuźnicza Street to the Warsaw Insurgents Square. Outside the park, relatively small areas of green can be found between the buildings in the courtyards, along certain streets and along the river.
– Biskupin (40 ha), from the Olszewski Street to the bank of the Odra and from the Rodakowski Street to the Baciarelli Street. The predominant type of buildings are villas surrounded by gardens. The study plot covered a part of the villa estate of Biskupin and a fragment of the Nadodrzański Park.
– Downtown part of the Odra from the Sand Bridge to the University Bridge, together with walkways through the Sand Island and the Mill. There are five bridges and overpasses, as part of a highly frequented promenade area.
Observations in Sokołowsko in the Arid Mountains, south of Walbrzych, were made on one feeder at the edge of the town, adjacent to trees and the bordering forest.

METHODS

Supplemental feeding of birds may be intentional or involuntary. Therefore, the investigated sites were divided into:
– feeders, i.e. specific constructions for providing birds with food, often covered and protecting the food from precipitation, and
accidental feeding spaces – places of dumping food remains, garbage, poultry feeding sites, etc.

During the field observations in Zielona Góra and Trzebiel all feeders at houses, on balconies and on lawns and trees were counted. Also, accidental feeding sites were recorded, such as unprotected garbage and chicken coops with food left for domestic fowl. Counts in Wroclaw were conducted along fixed transects in the morning between 8:00 and 11:00 h. Start and end point of any transect alternated between consecutive counts. Observations in Sokolowsko consisted of recording the presence of particular species at feeding spots from dawn to dusk.

Studies of feeding water birds were conducted nine times, from 19 Jan. to 05 March 2012, in five selected places in the city centre in the afternoon hours, i.e. the time of highest number of pedestrians. The number of people feeding was counted for five minutes for each site and day of observation. Additionally noted was:

- who feeds (adults, adults with children)
- what an amount of food was provided (large portion is a bag full of food)
- which bird species used the feeding spot.

RESULTS

1. Distribution and number of feeding places in different urban and rural environments

Feeders were found on all examined plots (Tab. 1). The highest number of feeders per unit area was located in the block estates, where people often placed feeders on balconies. Also many dangerous garbage cans where birds could get food were recorded in these estates. In the study area of the painters’ residence in Zielona Góra birds were fed most often in feeders placed in the individual gardens. On the plot of the detached houses in Trzebiel only two feeders were found, but birds used food spread for domestic fowl. The lowest number of places at which birds could find food provided by people

<table>
<thead>
<tr>
<th>Plot</th>
<th>Size</th>
<th>Number of feeding places (k+p), with ( k = ) feeders and ( p = ) random feeders</th>
<th>Number of feeding places per 1 ha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trzebiel outskirts</td>
<td>7 ha</td>
<td>8 (2+6)</td>
<td>1.15</td>
</tr>
<tr>
<td>Trzebiel centre</td>
<td>15 ha</td>
<td>9 (6+3)</td>
<td>0.6</td>
</tr>
<tr>
<td>Painters’ estate (ZG)</td>
<td>16 ha</td>
<td>12 (10+2)</td>
<td>0.75</td>
</tr>
<tr>
<td>Sunny estate (ZG)</td>
<td>6 ha</td>
<td>22 (17+5)</td>
<td>3.7</td>
</tr>
<tr>
<td>Friendship estate (ZG)</td>
<td>7 ha</td>
<td>25 (19+6)</td>
<td>3.6</td>
</tr>
<tr>
<td>Szczynicki Park (Wr)</td>
<td>30 ha</td>
<td>5 (3+2)</td>
<td>0.2</td>
</tr>
<tr>
<td>Downtown (Wr)</td>
<td>40 ha</td>
<td>20 (5+15)</td>
<td>0.5</td>
</tr>
<tr>
<td>Biskupin (Wr)</td>
<td>40 ha</td>
<td>10 (9+1)</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Table 1. Number and density of feeding places in different types of estates. ZG = Zielona Góra, Wr = Wroclaw.
was recorded in the central part of Trzebiel. Here, not many feeders had been put up, people do not breed poultry, and most garbage cans were closed.

2. Location of feeders in various types of estates

In all investigated plots combined (161 ha), a total of 111 feeding places was recorded, corresponding to a density of 0.7 / ha. Density values were similar for cities and villages. In the villages, random feeders slightly dominated, whereas in the cities specially prepared feeders were most numerous. The data from three plots in Wroclaw, including the built-up areas and parks, indicate that feeders (37) were more often located near buildings (37) than away from them (7). In the villages all feeders were close to buildings.

3. Bird species using feeding places

A total of 23 species were recorded at feeders in Wroclaw and Sokolowsko (Fig. 1), of which 14 were noticed only for Wroclaw and 15 only for Sokolowsko. 6 species were shared by both cities, so the composition of the birds visiting the feeders was greatly influenced by the surrounding environment. Finches dominated with 9 species. Tits were also numerous with 4 species but the majority of them were found in Sokolowsko. Also 4 species of corvids were recorded, mostly in Wroclaw.

The presence of particular species during 19 controls conducted in each place varied, with a range from 5.2 to 47.4% in Wroclaw and 5.2 to 100.0% in Sokolowsko. The average frequency was markedly lower in Wroclaw (16.9%) than in Sokolowsko (53.3%), indicating that birds visited the feeding places in mountain conditions more often.

![Figure 1. Species composition and frequency at feeders in Wroclaw and Sokolowsko (N = 19). Abbreviations of species names follow Jakubiec 2003](image-url)
The composition of species and their frequency clearly differed between three plots in Wroclaw (Fig. 2). In the built-up areas House sparrows and, to a lesser degree, Street pigeons dominated, whereas in green areas Tree sparrows and Great tits were the most abundant species. Other species occurred in low frequency, indicating only occasional visits to the feeders.

![Figure 2. Species composition and frequency at feeders in three plots in Wroclaw](image)

### 4. Supplemental feeding in parks

Apart from providing food for birds in feeders, people also feed outside the estates. Unsystematic observations in the park adjacent to the Popowice estate in Wroclaw indicated that a group of people feed almost year-round, especially from autumn to spring. These persons probably visit the park every day with bags full of food (mostly bread). Some of them are individually recognised by Street pigeons and corvids, which approach as a group and wait for food as soon as the respective person appears (see photo).

### 5. Supplemental feeding of water birds

In 18 (40%) out of 45 five-minutes trials people were seen feeding water birds. The respective value at single study sites ranged from 1 to 8 out of 9 observations (Fig. 3), indicating that at some plots birds were fed permanently and at others less often or only exceptionally. Of the investigated five places in Wroclaw, feeding was most often
observed at Żabia Kładka where two or three people were providing food at the same time. Other places were located on pedestrian communication routes and feeding was less common there. Also, only at the area of Żabia Kładka adults with children were seen feeding, indicating that providing food for the local birds was the goal of the walk.

Occasional observations indicate that both the number of people feeding water birds and the intensity of feeding is drastically reduced in periods of a significant temperature drop. During such conditions in winter counts of water birds from 1962-1995 in Wroclaw only a few people were seen feeding.

The food provided by humans was extensively and regularly taken by birds wintering in Wroclaw (Fig. 4), which, in addition to water birds, also included corvids and Street pigeons. Birds were used to getting fed, and readily approached when they saw people appearing in each of the studied sites.

**Figure 3. Intensity of supplemental feeding of water birds in five places in the centre of Wroclaw (N = 9)**

The food provided by humans was extensively and regularly taken by birds wintering in Wroclaw (Fig. 4), which, in addition to water birds, also included corvids and Street pigeons. Birds were used to getting fed, and readily approached when they saw people appearing in each of the studied sites.

**Figure 4. Composition of species using the feeding site at the Odra (abbreviations of species names follow Jakubiec 2003)**
Supplemental feeding of birds – biological and social importance

Feeding birds is biologically meaningful. The study by Doerr and Silvy (2002) showed that supplemental feeding can increase survival in times of food shortage, however, other data suggest feeding is not effective in an unfavourable habitat. Feeding of birds outside the breeding period can also increase reproductive success in the next season (Robb et al. 2008).

The idea of the city garden by Ebenzer Howard which originated in England in the second half of the XIX century during the industrial revolution, has fundamentally changed the view and development of the urban environment. With urban populations still growing rapidly, awareness about anthropogenic influences on the environment is rising and causes many citizens to search for contact with nature in various ways. Therefore, feeding birds, which still was still rare at the beginning of the XX century, is commonly practised now by many people who clearly obtain satisfaction from this activity, as also indicated by our observations.

SUMMARY

1. Supplemental feeding of birds in all types of estates in western Poland is currently a common practise.
2. The composition of bird species visiting the feeders is greatly influenced by the surrounding environment.
3. The distribution of feeders and places of feeding is uneven, and their location is influenced by the distance from buildings or the routes of pedestrians.
4. Especially House sparrows, Street pigeons, and corvids use feeding spots in the built-up areas, whereas tits, especially Great tits, and granivorous species do so in green areas.

Acknowledgement: The authors would like to thanks Aleksandra and Marcin Fil from Sokołowsko for conducting observations and transferring data.

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The Working Group on Urban Sparrows is investigating the decline of urban sparrows *Passer*, in urban and suburban habitats. At the second meeting in 2009 (De Laet et al 2009) it was decided to define a standardized census procedure that would enable meaningful comparisons of the House Sparrow *P. domesticus* breeding density in urban/suburban habitats throughout this species’ range. A breeding-season mapping census based on ‘active’ nests was proposed, together with a simplified method of describing different types of urban/suburban habitats (De Laet et al 2011).

The theme of the third meeting was: ‘What next’. Here we bring the abstracts of the talks given on the meeting. The hand-outs from the talks can be obtained by a simple email to the address above.

At the end of the first day we honored Denis Summers-Smith for his effort during many, many years to bring the decline of the urban House Sparrow under the attention of policy makers, scientists and the general public and offered him a award from all the WGUS members.

**Presentations on the first day**

1. URBAN SPARROW DECLINE: A WORLD – WIDE PERSPECTIVE

   J. Denis Summers-Smith

   (e-mail: jdss1@sky.com)

A major decline in urban House Sparrows (*Passer domesticus*) was first recorded in the 1990s in north-western Europe. More recent studies have shown that the decline is not limited to this area, but has now occurred over the whole of the Eurasian region and, moreover, involves two other species of sparrows that have taken over the urban sparrow role in areas where the House Sparrow does not occur: the Italian Sparrow (*P. italiae*) in Italy and the Tree Sparrow (*P. montanus*) in the Far East..

Vincent (2005) found that in some populations of House Sparrows in Leicester, England, complete broods were dying of starvation and the young from those nests that were successful were below normal weight at fledging. She attributed this to reduced availability of the invertebrate food required to rear the nestlings. This hypothesis was confirmed in study colonies in London where the provision of supplementary invertebrate food resulted in increased productivity, compared to those colonies in which it was not. However, this did not result in an increase of the population in those
colonies where supplementary food was provided (Mallord et al. 2009). This suggests that, although lack of invertebrates is a necessary factor in the decline, an additional factor is involved.

The widespread nature of the urban sparrow decline suggests that this additional factor must be common over the whole Eurasian area. It is proposed that this is increased atmospheric pollution by the exhaust emissions from vehicular traffic; including both vehicles with petrol and diesel engines. Such pollution is already a matter of concern through its effect on the respiratory system and neurological development in human children growing up in built-up areas. Urban sparrows are exposed to similar conditions and it is likely that they are affected in the same way.

The following circumstantial evidence is given in support of this hypothesis:
1. The later onset of the decline in Eastern Europe, where increases in urban traffic has lagged behind that in the more developed regions, is consistent with the suggestion that vehicular traffic pollution is the cause of urban sparrow decline.
2. House Sparrows have been studied in a 10 ha area of social housing in a small town in NE England since 2004. This is a good area for House Sparrows with ample availability of nest sites and invertebrate food. There is no through traffic as access is limited by a single one-way road. The population of House Sparrows has increased markedly in this area. It is suggested that is a consequence of reduced atmospheric pollution allowing the development of a more resistant population.
3. In contrast to the situation in England, there has been an increase in the House Sparrow population in the west of the British Isles (Wales, Scotland, Ireland) where atmospheric pollution levels are reduced through dilution by the prevailing unpolluted westerly wind.

2. HOUSE SPARROWS IN SOUTHWEST LONDON

Dave Dawson
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Four studies document the numbers and distribution of House Sparrows in south-west London. In 1989, House Sparrows were the most abundant species in the back gardens of houses in the London Borough of Sutton. There, the highest population density was in the small gardens of terraced housing, but the large, greener gardens of detached houses had only a quarter of this density. Two studies in Wimbledon Park documented a rapid population decline beginning around 1988, at an average rate of 20% per annum, and reducing the population to under 5% of previous levels by 2000 – the population remains at that low level to date. A study in 2007-10 of a 25Km transect from the inner edge of the London Green Belt to the urban centre found four factors correlated with high House Sparrow population density: many domestic garden outbuildings; nearness to allotment gardens; some nearby amenity grassland; and many garden hedges
and other low woody vegetation. Some 17 other possible explanatory variables were considered, but did not correlate significantly with House Sparrow density. These studies do no more than suggest possible reasons for the decline and they also illustrate that no single census method is optimal for all purposes.

3. THE EFFECTS OF SUPPLEMENTARY FEEDING ON PRODUCTIVITY AND POPULATION SIZE OF SUBURBAN HOUSE SPARROWS – EVIDENCE FROM A REPLICATED FIELD EXPERIMENT ACROSS LONDON

John W. Mallord, Christopher J. Orsman, Nancy Ockendon, Bill Haines and Will J. Peach RSPB
(e-mail: john.mallord@rspb.uk)

Little is known about factors limiting avian demography and abundance, or about the impacts of widespread supplementary feeding, in urban landscapes. Previous studies have highlighted lack of invertebrate prey as a potential cause of population decline amongst suburban house sparrows.

We conducted a supplementary feeding experiment to test the hypothesis that invertebrate availability limits reproductive success and population size in urban house sparrows. The study was conducted across Greater London where house sparrow abundance declined by 60% over the preceding decade. Supplementary invertebrate prey was provided throughout four successive breeding seasons at 33 house sparrow colonies spread across Greater London. The quantity of invertebrates provided did not vary with colony size. Year-round seed was also provided *ad libitum* during the third and fourth years of the study. Thirty-three unfed colonies served as controls.

Per capita abundance of recently fledged young sparrows was higher at fed sites, during all four years of the study. This effect of feeding on reproductive output was significant in small (123% increase) and medium-sized colonies (51% increase), but not in large colonies.

There was no overall impact of feeding on the abundance of territorial adult male sparrow. However, feeding significantly increased the abundance of territorial males at small colonies (by 34%), while the combination of invertebrates plus seed had a positive effect on adult population trends at intermediate-sized colonies. Adult abundance declined rapidly at large colonies but feeding had no impact on the rate of decline.

We calculate whether per capita provision of mealworms was sufficient in large colonies to satisfy the invertebrate needs of nesting sparrows, and investigate whether there are any correlations between fledgling and juvenile abundance and adult trends with various habitat and environmental covariates and the abundance of potential predators and competitors.
4. LONDON HOUSE SPARROW PARKS PROJECT: TWO YEARS ON

Jacqueline Weir RSPB
(e-mail: jacqueline.weir@rspb.org.uk)

Recent research in Leicester and London has suggested that a lack of invertebrate availability during the breeding season may be limiting chick survival in UK urban/suburban house sparrow populations (Peach et al., 2008; Mallord et al., in prep). There is growing evidence that food availability limits reproductive success of a range of songbirds in urban-suburban habitats (Chamberlain et al. 2009). A trial is being run in London parks to investigate the effectiveness of three different habitat management regimes in providing seed and invertebrate food for house sparrows.

The habitat management treatments being tested are:

a. Long grass: a change in mowing regime to allow grass to set seed and remain long over winter
b. Wildflower meadow: cultivation and sowing with native meadow species, then management as a traditional haymeadow
c. Wildlife Seed Mix': cultivation and sowing with a mix of species based on agri-environment scheme Wild Bird Cover plots, re-sown annually

Each trial plot is paired with a control plot of the usual management regime (short amenity grass). The plots are monitored for bird use (by all species), seed availability, and invertebrate abundance. Existing house sparrow breeding populations and their productivity are being monitored.

The project will soon enter its third and final summer. Results to date indicate that all plot types are showing higher invertebrate abundance and diversity than control plots. The composition of invertebrate communities appears to differ between treatments, and invertebrate abundance in the wildflower meadows may be increasing over time. Plot usage by seed eating birds, in particular by house sparrows, has been highest in the Wildlife Seed plots during late summer. Possible reasons for the observed patterns will be suggested. Future work on the project and possible applications for the results will be discussed.

The project is run in partnership with eight Borough Councils and other organisations across London, with nineteen parks involved. Funding has been gratefully received from SITA Trust, through the Landfill Communities Fund.
MUS (Monitoring Urban Species) is a simple scheme for breeding birds in the built-up area. It started on initiative of SOVON (Dutch Centre for Field Ornithology) in cooperation with Birdlife the Netherlands. It is a point counting (5 min. each) on 8-12 points (random chosen by computer) in a postal area. There are 3 periods of counting: 1-30 April, 15 may- 15 June (both dawn) and 15 June-15 July (evening, especially for Swift). In 2007-2010 the number of counting’s grew from more then 1200 to almost 1600, in 450-550 postal areas. More than 30% of the volunteers are female and 75% are new birders for SOVON.

After three years we had the first trends/year changes of 35 species and in the forth year there were 60. Winter influenced birds as Grey Heron, Winter Wren, Kingfisher and Robin showed a decline. But also a successful urban species as the Common Blackbird and Feral Dove declined and the Common Starling has a steep decline. The stable species are for example the Mallard, Common Wood Pigeon and Carrion Crow. In the group of winners there is a remarkable position of water birds as Greylag Goose, Canada Goose, Tufted Duck and also Egyptian Goose, Common Coot and some Gulls. Also increasing are the Peregrine Falcon, Stock Dove, Swift, Bleu and Great Tit, Jackdaw and last but not least the House Sparrow (index 100, 98, 108, 111 in 2007-10). The two cold winters (2009 & 2010) had no influence on the trend of the House Sparrow in the urban area. The increase is formally noticed in the higher part (above sea level and sand) and stable in the lower part (sea level and under it and clay) of the Netherlands. The density in the higher part is also 60-80% higher. But there are great differences in both groups. So is the province of Flevoland (polder, lower part) the best with 39 House Sparrows/postal area in the second round and also in the lower part Noord-Holland and Zuid-Holland doing not good with 11,3 and 11,4 and also Utrecht with 16,9 House Sparrows. These last three are the most urbanized areas of the Netherlands. Comparing a old city as Amsterdam and a new Almere (>1980) the numbers are 6&10x (1 & 2 round) higher in Almere. The distribution in Almere is homogeny through the whole city, but in Amsterdam there are huge lacks in the centre and the districts near to it. In the most cities the Swift is present in the city centres, so it seems that nesting sites are not a problem for the House Sparrow. Probably the lack of enough food (whole year, seed and insects) is the major cause of the lack of House Sparrows. If we compare Almere and Groningen (both 190,000 inhabitants) the distribution of the House Sparrow in Almere is more regular. Almere is also the fastest growing city in the Netherlands. The buildings and houses are most low rise and there are much green corridors through the whole city. When we zoom
on the building period there are no great differences between higher and lower part of the Netherlands before WW II. The deviation becomes in the period after WW II and the numbers are higher (and deviation) in the younger periods. The cause of that difference is interesting for investigation.

Through MUS we have a good scheme for monitoring urban birds and the House Sparrow. There was a moderate increase of the House Sparrow in 2007-10 what gives a little hope for the future. If it is a temporarily increase or the beginning of the recovery of the great decline in the last decades (50%) is the question. Every year extra the results and index become more significant and we looking forward to the fifth year. We will monitor it in the future with MUS. www.sovon.nl

6. HOUSE SPARROW, EVIDENCE BASED CONSERVATION IN THE NETHERLAND

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Introduction

The house sparrow once was by far the most common bird in The Netherlands. Since 2004 it is red listed, the total decline is over 50%. Locally the house sparrow has disappeared. In 2005 Vogelbescherming Nederland, the Dutch Birdlife Partner, started a programme for conservation of urban birds, including the House sparrow.

Population development of the house sparrow is well known, but very little is known of breeding success, dispersal, survival rate and composition of the population in different habitats. To get better understanding of possible reasons of decline a survey on colour banded house sparrows started in May 2007. The survey is supported by Birdlife Netherlands.

Survey

The survey is carried out by René Oosterhuis on three locations: Leek [sub urban, 10,000 inhabitants] and Lettelbert [rural village, 200 inhabitants], in the second half of 2010 a third location was added: the city of Groningen [urban]. On these locations each year 50 house sparrows are trapped and colour banded with a unique colour
combination. Of all individuals sex, age, body weight, fat score and body measures are noted.

The goal of the survey is to find out more about

- Survival rate
- Maximum age
- Dispersal
- Differences between habitats

Sightings of color banded house sparrows are recorded with camera traps on the trapping site and on feeding stations in the neighborhood. Date, time, breeding related activity [song, transport of nest material, transport of food, feeding young etc] are noted. Also the percentage of banded house sparrows is noted to estimate the population size.

On the same locations of this survey a breeding bird monitoring scheme is carried out. To find out how the local population trend is related to the national trend.

**Results so far**

On January 1st 2011 776 house sparrows were color banded; 526 in Leek [suburban], 173 in Lettelbert [rural] and 68 in Groningen [urban]. Camera traps make on average 1000 records of color banded sparrows each month. Since the start of the survey 45,000 records are taken, of which 95% on trapping location.

House sparrows in Leek [suburban] have the highest mortality in summer, while house sparrows in Lettelbert [rural] have the highest mortality in winter.

House sparrows banded in Leek [suburban] are seen within 2 km around the trapping site. A remarkable difference with House sparrows ringed in Lettelbert [rural], which are seen over much bigger distances. On the other hand the rural House sparrows are more sedentary and less likely to roam (Fig. 1).

![Figure 1. Clear difference in dispersal of house sparrows in suburban (left) and rural (right) situation. Green star = catching site, red star = sightings of colour banded sparrow.](image-url)
Presentations on the second day

1. SUSTAINABLE URBAN DEVELOPMENT AND THE HOUSE SPARROW AS A BIO INDICATOR

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In 2002 The Flemish Bird protection society started with a national House sparrow weekend on which the public was invited to count tsirping House sparrow males in their garden.

ABLLOvzw and UGent (Terrestrial Ecology Unit) analyzed in 2007 the first 5 years and found there were:
- Less repeat counts
- No standardized methodology to count House sparrows
- No zero counts

In cooperation a House Sparrow workgroup was started in 2010 with a constant or increasing number of counters that count every year on the same place and same time in a standardized way to create a long term urban investigation. After one year we found that the Flemish part of Belgium is characterized by small house sparrow groups (Fig. 2).

In Ghent it was found (Vangestel 2010) that urban green connectivity is important for the urban House sparrow. A sustainable urban development is important for the House sparrow and other urban birds. Flanders is characterized by an important degree of urban sprawl. It is important to combine rural and urban features together in a sustainable way. A solution for his is the lobe-city model in which built-up city-lobes are separated by blue-green fingers. The blue-green fingers are penetrating deep into
the city centre. Blue-green fingers decrease the urban heat-island effect. The lobe-city model creates a solution for the urban House sparrow and for urban biodiversity in general.

2. ON THE EXPANSION OF A HOUSE SPARROW COLONY IN ANDIJK (NETHERLAND)

Liset Karman. Foundation White Sparrow (nl)

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Since the winter of 1997-1998, two of the board members of what in 2009 became Stichting Witte Mus (Foundation White Sparrow) have been supporting the House Sparrow. This was done on their own property in Andijk, the Netherlands. I am one of those two people.

Since we supported the local group of less then ten House Sparrows, this group has grown to a free living colony of more than 50 breeding pairs, breeding 3 or 4 times a year, producing many hundreds of juveniles each year.

We started our mission to help the local population of less then ten House Sparrows due to a plaque of mosquito's. This plaque is quite common when living near the IJsselmeer. The IJsselmeer is a lake with mostly sweet, still water, where insects can reproduce with little disturbance.

To control these insects we started winter-feeding the few House Sparrows that lived in our garden.

Within about 3 years it became obvious that, not only the insects were down to a more acceptable level, but the House Sparrows had multiplied to a small flock in summer.

We then started noticing in spring that the Sparrows were fighting amongst each other for food.

To us that was a sign to keep supplying seeds for a longer period in the year than just the three winter months.

And so we did. Until eventually we were feeding the House Sparrows the whole year round.

Our reasoning behind doing what we did was that we figured the House Sparrow knew better what it needed than we did. So we watched and “listened” to what the House Sparrows showed us.

From this “listening” came many adjustments of the garden in order to suit the House Sparrows and make life better for them.

The result in 14 years time is that there now lives a colony of at least 50 breeding pairs around and on our property. They are capable of hatching 4 nests each, and they mostly do. The nests consisted in 2009 of an average of 4 fledglings. Which meant that by autumn the flock had grown to hundreds and hundreds of House Sparrows.
After about four years the first Sparrow Hawk appeared. But with these hundreds of young House Sparrows many more predators came along. They made it clear that safety during the day and during the night, is very important for the survival of a House Sparrow. In this aspect the alarm calls of other birds play an important role.

We now are trying to find a balance between a colony of House Sparrows big enough to be able to spread itself over a bigger part of the country, a colony that stays healthy nevertheless, and the amount of predators coming for the colony.

Apart from that we are helping create more environments in the Netherlands where the House Sparrow can thrive.

We believe that it would be better for the environment and the House Sparrow if they need not live so concentrated as they do on our property. But we also believe there must be a sort of breeding ground, from where the surrounding area can be repopulated with House Sparrows.

References among others:
http://www.youtube.com/user/stichtingWitteMus
http://www.stichtingwittemus.nl/

ACKNOWLEDGEMENT

We are very grateful to the RSPB for the hospitality in their office in Newcastle and this for the second time and to Jacqui Weir.

Also to the Flemish organization ABLLOvzw for sponsoring the meeting by paying both lunches and thee/coffee breaks. They also gave the author as their part-time assistant, the opportunity to organize the meeting.

Finally we thank all the participants for their valuable contribution.

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Broadly defined synurbization of birds and its protection was the theme of the conference, which took place in Zielona Góra on 14-16 September 2012. The conference was organized by *Polish Zoological Society and Faculty of Biological Science* of the University of Zielona Góra. The conference evoked a large interest caused mainly by growing problems of birds protection in the cities, which result from habitat damage during thermal efficiency improvement, buildings renovation, infill building and also inadequate modification of green areas, which endangers biodiversity in urban environment. On the other hand, colonisation by birds in this relatively new environment, allows us to monitor the changes occurring in their biology and behavior on microevolution level. Thanks to the conference people of great experience who have investigate city birds for decades and also young nature scientists who fight for birds protection in cities were able to meet. The meeting allowed the exchange of experiences during lectures and also behind the scenes.

On Friday afternoon on 14 September the meeting began with multimedia presentation titled “Birds of Middle Oder Valley” prepared by the well-known nature photographer Grzegorz Sawko. Bird portraits were interlaced with photographs of changing seasons at the Oder. The presentation was received with great applause. Even more popularity was enjoyed by Ludwik Tomiałojć (Museum of Natural History at Wrocław University) presenting a scientist’s impression from a month trip to Siberia – little known place on the Earth. Undoubtedly, every ornithologist would like to see a real taiga and add to his list new bird species in those difficult to access places.

The official opening of the Ornithological Section of Polish Zoological Society was made on Saturday 15 September by professor, PhD Janusz Gil the Deputy Rector of Science. It is worth mentioning that such honoured scientist as prof. Maciej Luniak, prof. Jan Pinowski and prof. Ludwik Tomiałojć, who do researches on birds in human estates, took part in the conference. Each of them received a certificate of appreciation awarded by president of Ornithological Section of Polish Zoological Society from the hands of Vice-rector.

The first plenary lecture concerned the review of the European avifauna in cities atlas (Maciej Luniak from Museum and Institute of Zoology at Polish Academy of Sciences). A discussion about methodology of gathering data and grid usage aroused a large interest. The following plenary lecture given by Ludwik Tomiałojć was based on researches, which he had conducted in Wrocław and Legnica for over 40 years. Nowadays, when grants last on average 1 to 3 years, not many people may pride themselves on such long data collecting period. It enabled him to analyze changes occurring
in central parks avifauna under conditions of different predators’ pressure (Dun Crow, marten).

An important presentation highlighting the problem of bird protection in cities to all legal intents and purposes was given by Paweł Dolata, lawyer and enthusiast for birds (southern Great Poland, OTOP – Polish Society for the Protection of Birds). Knowledge of the law allows for simple effective enforcing from City Halls and enables investors to perceive birds in cities and to introduce impact minimization and environmental compensation when it comes to various investments.

The next presentation discussed behavioral adaptations of birds colonizing cities (Piotr Tryjanowski, Krzysztof Dudek from Poznań University of Environmental and Life Sciences).

Jerzy Bańbuda (University of Łódź) relying on long-term researches presented the impact of urban habitat on breeding conditions of Great Tit and Blue Tit as compared to forest population.

Great interest was aroused by the presentation on the influence of big cities on migration distance of Great Tit Parus major (Brygida Manikowska-Ślepowrońska, Jarosław Krzysztof Nowakowski, Bird Migration Research Station at Gdańsk University). It was proved that big cities have an influence on migrating birds and some of them are facing the dilemma of whether to winter in the city or migrate further. Whether birds in cities should be fatter, which may encourage them to changes in their migration behavior, was also discussed.

Martin Hromada (Univeristy of Zielona Góra) and Piotr Tryjanowski pointed in their presentation titled “Condemned to success” at the necessity of broadening geographical researches on birds in cities. These migrating birds, which we observe in spring and summer in our cities, spend autumn and winter for example in Africa. How does the synurbization of those birds proceed there?

The presentation titled “The fatality cause of House Sparrows and Eurasian Tree Sparrows in Warsaw’s parks and country areas” prepared by prof. Jan Piniowski brought out a discussion about the importance of research on birds physiology inhabiting various environments. An interesting summary concerning long-term changes in breeding birds population in Lower Silesia was presented by Zbigniew Jakubiec (University of Zielona Góra). Later on, Karolina Chosińska (University of Zielona Góra), Zbigniew Jakubiec and Leszek Duduś presented ideas on the subject of fattening birds in human estates.

Persons studying cities ecology are waiting for the beginning of a settlement of Common Raven in human estates. It will entirely change the composition of city avifauna. For that reason, with a large interest awaited for the presentation of first data concerning synurbization of that species in Poland. In conclusion it was stated that the Common Raven has already started settling in some city outskirts (Dorota Zawadzka, Grzegorz Zawadzki from the Committee of Eagle Protection).
One of the presentations concerned Common Kestrel *Falco tinnunculus* population inhabiting across eastern border in Grodno (Dzmitry Vintchevsk, Siargey Sakowicz, APB BL Belarus). Apart from breeding biology, details on nourishment of urban Common Kestrel was discussed.

On the last day of the conference the meeting inaugurated Andrzej Węgrzynowicz (Museum and Institute of Zoology at Polish Academy of Sciences) discussing population biology of House Sparrows and Eurasian Tree Sparrows in Warsaw. He presented data on changes conditioned by the availability of nesting places. For House Sparrows buildings were important whereas for Eurasian Tree Sparrows nesting boxes were important. Other lectures presented by speakers summarized current knowledge about particular species or bird groups occurrence in cities. Dawid Sikora presented data concerning birds grouping in open areas of Wilanów in Warsaw and Adam Zbyryt (PTOP – Polish Society for the Protection of Birds) discussed the issue of Rooks in the largest cities in the Podlasie province.

The paper closing the conference given by Marcin Bocheński (University of Zielona Góra) and Michał Kuźmiak (University of Zielona Góra) titled “Bird fatality on transparent acoustic baffles in Zielona Góra” raised a lively discussion about the impact of these baffles on birds, examination methods of this issue and protection problems related with the topic.

During the poster session were presented over 20 posters which gave the opportunity to discuss and exchange scientific and practical experiences in environmental protection.

Abstracts of speeches and posters are available on Polish Zoological Society and Faculty of Biological Science website.

It is worth paying attention to the fact that the conference took place during the Wine Fest – a well-known event for which Zielona Góra is famous for. Many participants of the conference after a solemn dinner in Haust Brewery indulged in the Wine Fest and had an occasion to taste all kinds of wine.

All participants found the meeting to be important and worthwhile and spent in a nice and pleasant atmosphere. Once more one could see that birds in the cities constitute a challenge for modern researchers and environmental protectors.

Leszek JERZAK, Marcin BOCHEŃSKI, Olaf CIEBIERA

The author (OC) is a scholar within Sub-measure 8.2.2 Regional Innovation Strategies, Measure 8.2 Transfer of knowledge, Priority VIII Regional human resources for the economy Human Capital Operational Programme co-financed by European Social Fund and state budget.
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