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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.
V – nest-boxes installed by volunteers.

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

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

Habitat	Tree Sparrow		House Sparrow	
	Occupation	NIC	Occupation	NIC
Riparian forests	62%	n.d.	–	–
Younger parks	45%	0.55 (N = 103)	–	–
Older parks	23%	0.26 (N = 57)	12%	0.06 (N = 169)
Housing estates	15%	0.13 (N = 34)	4%	0.02 (N = 316)

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: $NIC = Np/(P - Np + Nn)$, where *Np* is a number of nest-boxes used by Tree- or House Sparrow, *P* – total number of breeding pairs of Tree- or House Sparrow, and *Nn* – 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 simultaneous 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 occupation 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 species, 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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REFERENCES

Anderson T.R. 1978 – Population studies of European Sparrows in North America – Occas. Pap. Univ. Kans. Mus. Nat. Hist. 70: 1-58.

Anderson T.R. 1984 – A quantitative analysis of overlap in nestling diets of village populations of sparrows (*Passer* spp.) in Poland – Ekol. Pol. 32: 693-707.

Anderson T.R. 2006 – Biology of the ubiquitous House Sparrow: from genes to populations – Oxford Univ. Press, Oxford, New York.

Bhattacharya R., Roy R., Goswami C. 2011 – Studies on the response of House Sparrows to artificial nest – International Journal of Environmental Sciences 7: 1574-1581.

Biaduń W. 2004 – (Birds of Lublin) – Akademia Medyczna, Lublin (in Polish).

Bocheński M. 2005 – Nesting of the sparrows *Passer* ssp. in the White Stork *Ciconia ciconia* nests in a stork colony in Kłopot (Poland) – Int. Stud. on Sparrows 30: 39-34.

Böhner J., Schultz W., Witt K. 2003 – Abundanz und Bestand des Haussperlings (*P. domesticus*) in Berlin 2001 – Berl. ornithol. Ber. 13: 42-62.

Chmielewski S., Fijewski Z., Nawrocki P., Polak P., Sułek J., Tabor J., Wilniewczyc P. 2005 – (Birds of the Świętokrzyskie Mountains and their vicinity. The faunistic monograph) – Bogucki Wyd. Nauk, Kielce (in Polish).

Cordero P.J. 1993 – Factors influencing numbers of syntopic House Sparrows and Eurasian Tree Sparrows on farms – Auk 110: 382-385.

Cordero P.J., Rodriguez-Teijeiro J.D. 1990 – Spatial segregation and interaction between House Sparrows and Tree Sparrows (*Passer* spp.) in relation to nest site – Ekol. Pol. 38: 443-452.

Cordero P.J., Senar J.C. 1990 – Interspecific nest defense in European Sparrows: Different strategies to deal with a different species of opponent? – Ornis Scand. 21: 71-73.
Czechowski P. 2007 – Nesting of Tree Sparrow *Passer montanus* in the nest of Barn Swallow *Hirundo rustica* – Intern. Stud. on Sparrows 32: 35-37.
Dott H.E.M. 2006 – House Sparrows nesting in sites other than buildings in Scotland – Scott. Birds 26: 47-49.
Eliseeva V.I. 1961 – (On the reproduction of *Passer montanus* in artificial nestings) – Zool. Ž. 40: 583-591 (in Russian).
Feige R. 2007 – Der Haussperling (*Passer domesticus* [L.]) in einem Berliner Brutgebiet (Schillerhöhe) – Situation, Reproduktionserfolg und Artenschutzmaßnahmen – Diploma thesis, Hochschule Neubranderburg, September 2007.
Grasnick J., Böhner J. 2008 – Bruterfolg des Haussperlings (*Passer domesticus*) in einem Berliner Wohnblockviertel – Berl. ornithol. Ber. 18: 36-48.
Indykiewicz P. 1998 – Breeding of the House Sparrow *Passer domesticus*, Tree Sparrow *Passer montanus*, and Starling *Sturnus vulgaris* in the White Stork *Ciconia ciconia* nests – Not. Orn. 39: 97-104.
Kozłowski P. 1992 – (Nest-boxes as a site of bird broods in Warsaw urban parks) – Acta Ornithol. 27: 21-33 (in Polish).
Kulczycki A., Mazur-Gierasińska M. 1968 – Nesting of House Sparrow *Passer domesticus* (Linnaeus, 1758) – Acta Zool. Cracov. 13: 231-251.
Luniak M., Węgrzynowicz A. 2009 – House and Tree Sparrows in Warsaw (Poland) – changes in population numbers and habitat distribution, breeding success – Ecologia Urbana 21: 42-45.
Miera C. 2002 – Über die Nutzungsdynamik eines Nistkastenbestandes durch Haus- und Feldsperlinge (*Passer montanus, Passer domesticus*) in der Uckermark – Otis 10: 67-76.
Mizera T., Kozłowski P. 1992 – (Bird nesting in boxes in urban green areas of Poznań [Poland] and a comparison of the results with those from Warsaw) – Acta Ornithol. 27:35-47 (in Polish).
Nowicki W. 1992 – (Changes in the breeding avifauna of the parks of Warsaw (1975-1985), and the use of nest-boxes to manage it) – Acta Ornithol. 27: 65-92 (in Polish).
Otto W. 2008a – Brutvogelwelt im Wohngebiet Schillerhöhe in Berlin-Wedding – Berl. ornithol. Ber. 18: 29-35.
Otto W. 2008b – Besiedlung von Holznistkästen an Bäumen im Hochhausbereich des Märkischen Viertels (Berlin-Reinickendorf) – Berl. ornithol. Ber. 18: 17-28.
Pinowski J. 1967 – Die Auswahl des Brutbiotops beim Feldsperling (*Passer m. montanus* L.) – Ekol. Pol. 15: 1-30.
Pinowski J. 1968 – Fecundity, mortality, numbers and biomass dynamics of a population of the Tree Sparrow (*Passer montanus* L.) – Ekol. Pol. 16: 1-58.
Salaet M., Cordero P.J. 1988 – A preliminary report on the breeding biology of the House Sparrow and Tree Sparrow (*Passer* spp.) in Barcelona, NE Spain – P. Dept. Zool. Barcelona 14: 109-115.
Shaw L.M., Chamberlain D., Evans M. 2008 – The House Sparrow *Passer domesticus* in urban areas: reviewing a possible link between post-decline distribution and human socioeconomic status – J. Ornithol. 149: 294-299.
Sokołowski J. 1971 – (The handbook of birds protection) – LOP, Warszawa (in Polish).
Siriwardena G.M., Robinson R.A., Crick H.Q.P. 2002 – Status and population trends of the House Sparrow *Passer domesticus* in Great Britain – In: Investigation into the causes of the

decline of Starlings and House Sparrows in Great Britain, Eds. H.Q.P. Crick, R.A. Robinson, G.F. Appleton, N.A. Clark, A.D. Rickard. BTO, Thetford.
Summers-Smith. 1963 – The House Sparrow – Collins, London.
Summers-Smith J.D. 1995 – The Tree Sparrow – Bath Press, Bath, UK.
Summers-Smith J.D. 2003 – The decline of the House Sparrow: a review – Br. Birds 96: 439-446.
Tryjanowski P., Kuczyński L. 1999 – Shifting from outdoor to indoor breeding: house martin's (*Delichon urbica*) defence against house sparrow (*Passer domesticus*) – Folia Zool. 48: 101-106.
Vincent K.E. 2005 – Investigating the causes of the decline of the urban House Sparrow *Passer domesticus* population in Britain – PhD thesis, De Montfort University.