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NUMBERS, DISTRIBUTION, AND ECOLOGY OF THE HOUSE SPARROW IN LVOV (UKRAINE)

General distribution, numbers, distribution across habitats, food requirements, behaviour, and some other aspects of the biology of House Sparrows *Passer domesticus*, also their spatio-temporal dynamics in human settlements and larger towns of Ukraine have been poorly known as yet. This issue is of particular importance now because of a decline of this species in many European towns (Bowers 1999, Summers-Smith 1999, 2000, Freeman and Crick 2002, Siriwardena *et al*. 2002, Jasso 2003, Böhner *et al*. 2003).

STUDY AREA

Lvov is one of the biggest towns of Ukraine, with 742 000 inhabitants in 1985. It is located in western part of the Wolyn-Podole plateau, in the forest-steppe area of Roztocze and Opolia, on the watershed of the main European catchment basins of the Baltic and Black Sea.

The city is located in the valley of the Poltva river and on slopes of the hills surrounding it on all sides, except for north-west. The mean height of the hills is 360 m above sea level, and no more than 290-300 m in the region of the Lvov valley. The highest point of the city

is Mount Vysokij Zamok, reaching 413 m. Within its administrative boundaries, the city covers an area of 155 km^2, and its built-up part (ecological area) is 66.7 km^2.

Central part of Lvov represents a typical "old town" characterised by dense 3-5-storey buildings from the 18th and 19th centuries, narrow, paved streets, and almost total absence of green areas. It covers an area of 572 ha. Around the old part of the city there are most of the urban parks with a total area of 887 ha. The outskirts of the city support modern multi-storey buildings occupying 1562 ha. The residential quarter in most cases represents former suburban villages engulfed by the expanding town. It occupies an area of 2713 ha. Industrial area covers 768 ha. Ruderal areas in ecological parts of the town are scarce, and typically these are abandoned housing lots, the number of which is declining with time. During the study period they occupied 61 ha.

MATERIAL AND METHODS

The study on the biology of the House Sparrow in the city of Lvov was conducted from 1980 until 2004. The distribution and abundance were examined in the breeding seasons of 1994 and 1995 and in the winters of 1993/94 and 1994/95 in ecological areas of the city, occupying 66.7 km^2 (Fig. 1), as part of the work on the atlas of nesting and wintering birds of Lvov.

For the purpose of the Atlas, the time of the beginning of the work and its duration in each season were chosen so that the breeding and wintering seasons of the urban population of House Sparrows were covered as completely as possible. In the nesting periods of 1994 and 1995, birds were surveyed from 15 April until 30 June, and in winter from 20 November until 20 February.

For mapping birds, we divided the study area according to habitat types, following the approach previously used in the work on the atlas of the distribution of birds of Warsaw (Luniak *et al*. 2001). In our opinion, this is a more objective method for estimating the distribution of birds in urban areas than the commonly used method of dividing the study area into squares.

With this method, the whole study area of 6 670 ha has been partitioned into separate habitats.

The following criteria were used to delimit habitat types in the ecological area of Lvov: 1) type of urban design, 2) proportion of greenery, and 3) inclusions of small structures foreign to particular habitat types (Bokotey 1996a, 1997).

The type of urban design, in turn, was subdivided into 4 categories: old closely built-up areas in the city centre (C), modern multi-storey quarters (M), residential areas (R), and industrial areas (I).

The proportion of greenery was determined from a 1:10000 map and also visually in the field. The proportion of green areas less than 10% was considered as small (g), 10-30% as medium (gg) and above 30% as high (ggg).

Inclusions of atypical designs were considered only when they influenced population density of the House Sparrow in a given part (for example, several tall buildings). Inclusions are denoted by the same letter as the types of urban design (C, M, R, I).

With these rules, 13 habitat types were distinguished in the ecological areas of Lvov (Fig. 1):

1-2. Old close housing in central part of the city (C) – 572 ha:
   1. with a small proportion of green areas (Cg) – 433 ha;
   2. with a high proportion of green areas and inclusions of areas with modern tall houses (CgggM) –139 ha.

3-6. Modern multi-storey housing (M) – 1562 ha:
   3. with a small proportion of green areas (Mg) – 873 hał;
   4. with a medium proportion of green areas (Mgg) – 260 ha;
   5. with a medium proportion of green areas and inclusions of residential areas (MggR) – 263 ha;
   6. with a high proportion of green areas and inclusions of residential areas (MgggR) –166 ha.

7-9. Residential area (R) – 2713 ha:
   7. with a high proportion of green areas (Rggg) – 1822 ha;
   8. with a high proportion of green areas and inclusions of areas with old close housing (RgggC) – 519 ha;

9. with a high proportion of green areas and inclusions of areas with tall houses (RgggM) – 372 ha.

10-11. Industrial area (I) – 768 ha:

10. with a low proportion of green areas (Ig) – 285 ha;
11. with a medium proportion of green areas (Igg) – 483 ha.

12. Parks and cemeteries (PC) – 887 ha.
13. Ruderal areas (RA) – 61 ha.

As the surface area of most habitats was large, we divided them in a mechanical way into smaller plots to facilitate the census, so that an observer could cover the whole plot within 2-3 hours. In this way, 105 plots were established within the ecological boundaries of the city. The boundaries of neighbouring plots followed large streets and railways crossing the city. All the plots were numbered so that observers could easily define their position in the area when working.

As a rule, three surveys were made in each plot during the breeding season, and four when necessary. Successive surveys of the same plot were conducted as close as possible to the earlier established route, each time from the opposite end of the plot. No surveys were conducted on windy and rainy days. In winter, surveys on each of the 105 plots were conducted once a season.

In total, 105 routes were established of a total length of 755 km. Over the breeding season, the total length of the survey route was 2 250 km (562 hours of the field work), and in winter 1 530 km (398 hours).

The breeding seasons of 1994 and 1995 were warm with little precipitation. The winters of 1993/94 and 1994/95 were mild with a mean temperature of –2ºC and little snow.

Basically, the method of line-transect (Bibby *et al*. 1992) was used. The routes/lines were established so that the largest part of the plot was surveyed. Transect lines could be walked only once per survey. The speed of walking was 3-4 km/h.

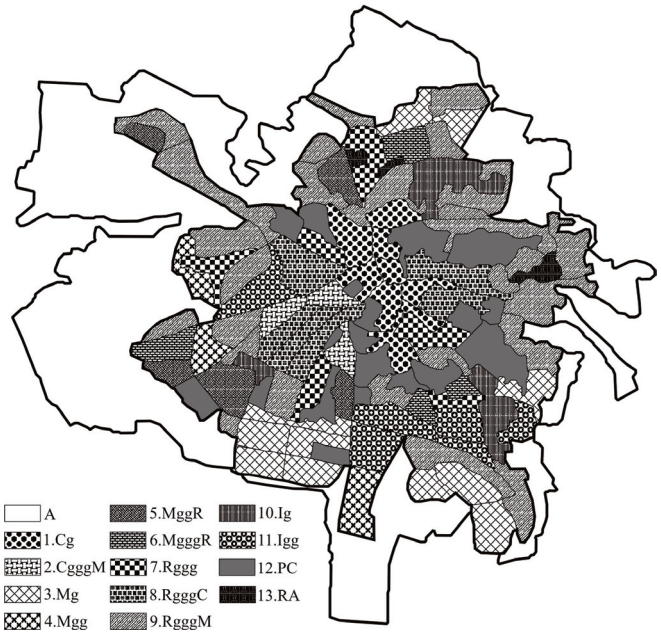

Fig. 1. Habitat types in the administrative boundaries of Lvov

A – urban areas beyond the ecological boundaries of the city; 1. Cg – old close housing in central part of the city with little green areas; 2. CgggM – old close housing in central part of the city with a high proportion of green areas and inclusions of areas with modern tall houses; 3. Mg – modern multi-storey housing with a small proportion of green areas; 4. Mgg – modern multi-storey housing with a medium proportion of green areas; 5. MggR – modern multi-storey housing with a medium proportion of green areas and inclusion of residential areas; 6. MgggR – modern multi-storey housing with a high proportion of green areas and inclusion of residential areas; 7. Rggg – residential areas with a high proportion of green areas; 8. RgggC – residential areas with a high proportion of green areas and inclusion of areas with old close housing; 9. RgggM – residential areas with a high proportion of green areas and inclusion of areas with tall houses; 10. Ig – industrial areas with a low proportion of green areas; 11. Igg – industrial areas with a medium proportion of green areas; 12. PC – parks and cemeteries; 13. RA – ruderal areas.

RESULTS

Distribution and density of the population

The results of the study are illustrated in Fig. 2.

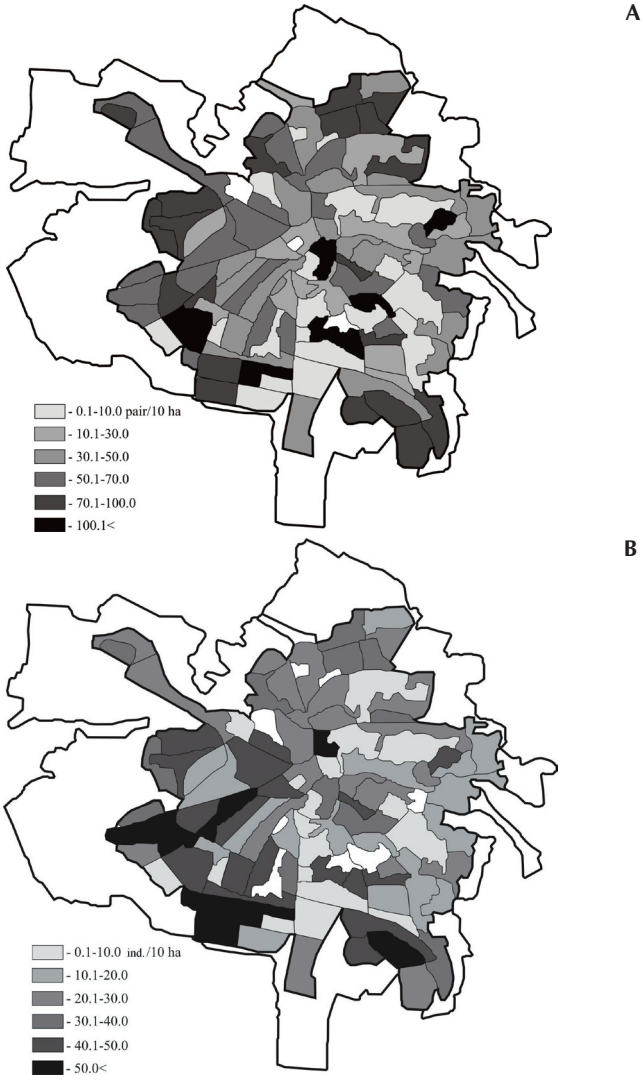

Fig. 2. Distribution and density of the House Sparrow (*Passer domesticus*) A – in the breeding season, B – in winter

In the breeding seasons of 1994 and 1995, House Sparrows occurred in all urban habitats and they were noted in almost all the plots, except for several parks and ruderal areas, without buildings. In the winters of 1993/94 and 1994/95, this species was recorded in 102 out of 105 study plots. The number of House Sparrows in the breeding season was 16-18 thousand pairs (256 pairs/km^2) and in winter 50-60 thousand individuals (830 ind./km^2). These were the most abundant birds both in the breeding season and in winter time. They accounted for more than 50% of the whole breeding avifauna and up to 40% of the wintering birds (Bokotey 1996a).

In all periods, sparrows reached the highest densities in areas of modern multi-storey housing (M), which were 44.4 pairs/10 ha in the breeding season and 79.4 ind./10 ha in winter. Their densities were especially high in habitats with a high proportion of green areas (MgggR, Mgg, RgggM).

A little lower densities were observed in residential areas (R) – 34.3 pairs/10 ha in the breeding season and 56.3 ind./10 ha in winter.

Even lower densities were found in the areas with old close housing in the city centre (C) – 26 pairs/10 ha in the breeding season and 40.1 ind./10 ha in winter.

Low densities of the House Sparrow were noted in the industrial areas of the city (I) – 12.3 pairs/10 ha in the breeding season and 23.3 ind./10 ha in winter.

The lowest densities occurred in parks (PC) and ruderal areas (RA) – 2.4 and 5.0 pairs/10 ha in the breeding season and 5.6 and 9.9 ind./10 ha in winter, respectively.

Gradient of population density and its determinants

In Lvov, the density of the House sparrow population declined from the areas of modern multi-storey housing with a high proportion of green areas and inclusions of residential areas (MgggR) to parks and cemeteries (PC) (Table 1).

Table 1.
Population density and percentage of the House Sparrows in different habitat types of Lvov during the breeding seasons of 1994 and 1995 and in the winters of 1993/94 and 1994/95

Habitat	Breeding season		Winter	
	density pair/10 ha	proportion, %	density ind./10 ha	proportion, %
MgggR	61.9	62.5	94.0	44.1
Mgg	41.5	46.6	74.3	32.4
RgggM	41.2	68.0	61.8	37.9
Mg	39.2	59.4	75.6	43.4
MggR	35.1	54.8	73.9	35.5
Rggg	31.8	67.6	64.3	38.7
RgggC	29.9	46.7	43.0	33.3
Cg	29.2	46.3	50.5	23.1
CgggM	22.8	31.6	29.8	28.1
Ig	13.3	57.8	19.0	24.0
Igg	11.2	50.9	27.6	14.9
RA	5.0	20.8	9.9	8.0
PC	2.4	6.5	5.6	4.5
Whole area	28.0	47.6	48.4	28.3

The highest population density was in plots with the highest proportion of green areas as they provide shelter from enemies and food for raising nestlings. The structure of buildings erected in the mid-20th century provides convenient nest sites to a height of the 3-4th storey. Typically, this corresponds to the height of trees growing around buildings and enables sparrows to hide easily and fast from predators. The high density of human population and abundance of open trash/garbage containers in these areas guarantee a rich supply of available food.

In residential areas (R), population density was a little lower. This may be a consequence of the reduced number of nest sites. Typically, private houses are totally coated with plaster and attended, and spar-

rows are not welcome neighbours, especially in the breeding season, when they stain the walls of houses with faeces. In this habitat, food is not so abundant. Trash containers are not so numerous as in the areas with multi-storey architecture, the human population is relatively low, and breeding of poultry, which provided food also for sparrows, nowadays is rather rare in the city. In addition, the abundance of sparrows is influenced by high numbers of predators such as Sparrowhawks (*Accipiter nisus*) and domestic cats.

Still lower densities of sparrows were noted in the areas with dense old close housing in the city centre (C).

Here, nesting conditions were rather good as the old city is in the state if neglect and there are many places for constructing nests. Also foraging conditions are rather good because of a high abundance of feral pigeons (11 pairs/10 ha) that are fed by people. A rather low population density in this area can be a result of some underestimation. In the city centre there are many back-yards inaccessible to observers and frequently visited by sparrows.

The low density of the House Sparrow population in industrial areas (I) can be related with limited food resources and also with a considerable underestimation of sparrow numbers due to the fact that the entrance to many industrial establishments can be very complicated.

The lowest population density in parks (PC) and ruderal areas (RA) may often be a consequence of the absence of buildings.

Population dynamics

The number of House Sparrows in the city probably declined over the last 20-year period. In one of the study plots of 1.3 ha located in one of the areas with modern multi-storey buildings constructed in 1960-70, with a high proportion of green areas, 46 pairs nested in 1997, 37 in 2000 and 31 in 2004.

One of the main factors responsible for this decline was changes in the habitat structure due to urbanisation processes. Each year the area of residential housing diminished, whereas increased the area of modern multi-storey architecture almost completely deprived of green ar-

eas, thus unsuitable for nesting. Also the area of ruderal habitats among buildings, covered with weeds, where sparrows forage frequently, especially in the post breeding period, is shrinking. These areas are being occupied by large supermarkets that do not provide suitable nest sites for sparrows.

An important factor of population decline is also the glazing of open balconies as this deprives birds the opportunity for warming in cold winters and occasionally for nesting. During the recent decade, the amount of such loggias increased by 60-70%.

In recent times, the number of open trash containers has markedly decreased in the city centre, and they are replaced by closed plastic containers preventing the access to food resources for birds. In the places without open containers, the number of sparrows declines rapidly. Besides, more and more often trash is disposed in polyethylene bags so that birds cannot use food.

Also an increasing use of petards by the inhabitants on holidays should be noticed, especially in the evenings and at nights. During two evening-hours in winter holidays, the number of explosions can vary from 50 to 120. Such distressing noise can disrupt roosting sites, and frequently causes movements of sparrows from place to place. As a consequence, they choose places of poorer quality, where they are more prone to predation.

According to some authors (Jasso 2003), the decrease in the House Sparrow population is partly due to the increasing traffic that kills mainly young birds. In Lvov this factor is not so important because the state of streets does not allow fast driving. Diseases are known as a cause of House Sparrow mortality in Britain (Summers-Smith 1999) but not in Lvov.

One of the most important factors of the decline in the House Sparrow population in Lvov may be a decrease in the abundance of insects fed to nestlings, as noted by Bower (1999). This finding requires further investigations.

Mass roosting

In winter, House Sparrows typically form flocks of 5 to 20 individuals, less often up to 50 individuals. The largest flocks we observed comprised 75, 94 and 130 birds. The mean flock size was 10 individuals (n=2133). But in recent years, the flock size markedly dropped. Most often sparrows roost in the same number. Nonetheless, during the last 25 years we recorded five cases of mass roosting in Lvov, each of which disappeared long before the breeding season. The reasons and mechanisms of the formation and disappearance of such roosting are unknown.

The first mass roosting we observed in the city centre in the winter of 1980/81. In mid-December, 200-250 sparrows started to aggregate in shrubs of hawthorn (*Crataegus spp*.). Their numbers increased to 1.5 thousand birds after a heavy snowfall early in January. By the end of this month the number of sparrows increased to 2300 individuals, and they were joined by 60 Starlings (*Sturnus vulgaris*). At the end of February, the birds disappeared.

The largest roosting of House Sparrows was observed in the square at the railway station in the winter of 1984/85 (Bokotey 1996a). During frosty weather in January, 4700 House Sparrows and 400 Starlings roosted in the canopy of hawthorn. This roosting was continued until 7 March. In following years no more than 250-300 birds roosted there, and only in 1987/88 their number increased to 2300. Later, several hundred birds roosted until 1995, and then this site was no more used for roosting although habitat conditions remained almost unchanged.

Other mass roosting of House Sparrows in Lvov occurred in September 1988, in limes and young chestnuts lining busy streets of the city centre. About 700-800 birds were roosting in 14 trees. They disappeared in mid-January 1989. In the period from September to January 1989, this roosting site was occupied by 750-900 birds. In following years it was abandoned.

Competitive interactions

In the conditions of multi-storey architecture (3-4 storeys) with a high proportion of green areas, House Sparrows can compete for nest sites

with Swifts (*Apus apus*) that nest in colonies under roofs. In areas with tall buildings (9 or more storeys) competition between these species do not exist because Swifts occupy upper storeys while sparrows nest lower. In these areas, we observed competition with the House Martin (*Delichon urbica*). Occasionally, Sparrows can occupy nests of House Martins but they are not always able to raise even one brood because of frequent conflicts with the hosts of these nests.

We know two cases of the nesting of the Black Redstart (*Phoenicurus ochruros*) in old nests of sparrows in one of the central parks of the city. In another central park, the Jay (*Garrulus glandarius*) nested under the roof of a building where a House Sparrow nested previously.

In residential housing we know more than 30 cases of competition with starlings for nest boxes. Starlings were the winners in all these cases.

House Sparrows also nested in burrows of the Sand Martin (*Riparia riparia*) on the outskirts of Lvov. They occupied eight abandoned burrows from the preceding year, and successfully raised the young. (Bokotey 1996b).

Predators

Four species of avian predators attacking House Sparrows were found in Lvov. First of all, this was the Sparrowhawk, hunting for sparrows at resting and roosting sites. Out of 163 attacks observed beyond the breeding season, 37 were successful, including 22 that took place one hour before the dusk.

In the years of invasion of the Merlin (*Falco columbarius*) in Lvov, they hunted mainly on sparrows, more often on the outskirts of the city where there were more mixed flocks of House and Tree Sparrows (*Passer montanus*). Of 39 attacks, 20 were successful. In 9 cases House Sparrows were the prey and in 11 cases these were Tree Sparrows. This predator hunts mainly in the morning. No evening hunting was recorded.

In winter, we observed Long-eared Owls (*Asio otus*) and Tawny owls (*Strix aluco*) hunting for sparrows. Their remains were found in

pellets collected in the city. Also the Barn Owl (*Tyto alba*) preyed upon sparrows. For the last time, it was seen in the city of Lvov in 1985 (Kijko and Jakubena 1995).

Also the Jay is known to prey on House Sparrows. It captured a young bird from the flock, killed it and swallowed whole.

DISCUSSION

Densities of House Sparrows at the beginning of the breeding season in 6 to 26 European towns, depending on the habitat type, during 1950-1975 are summed up by Pinowski and Kendeigh (1977, App. 3.1). In residential areas with apartment complexes it was 109.0±85 ind./10ha (max. 226, min. 18, n=19), in commercial and shopping areas 84.5±38.1 ind./10ha (max. 381, min. 1, n=10), in residential areas 72.3±107.9 ind./10ha (max 381, min. 1, n=21), in suburban areas with one family houses 61.1±46.4 (max. 188, min. 4, n=19), in old parks of larger towns 38.2±69.1 (max. 360, min. 1, n=26), in small allotments and gardens in towns 10.7±12.6 ind./10ha (max. 35, min. 1, n=6). These sparrow densities in different urban habitats were recorded before the decline observed in western Europe during 1980-2000 (Summer-Smith 1999, 2000, Sirivardena *et al*. 2002, and others). Sparrow population was also declining in eastern Europe, as found by Konstantinov *et al.* (1996) in different towns of Russia.

Against this background, sparrow densities in different urban habitats of Lvov were the highest (Table 1), although scarce data from 1960-1970 suggest that sparrow numbers are declining there.

Population densities of the House Sparrow in Lvov in 1993-1995 were close to their densities observed at the end of the 20th century in the city centre of Warsaw (1987-1990) and in Lublin (1975-2003) (Nowicki 2001, Biaduń 2004) (Table 2). These three towns of similar sizes are located sufficiently close to each other, at a distance of 350 km.

Similarity in population densities among all these towns can result from the similarity in their architecture and climate. In all the three cases, the authors conclude that the population of the House Sparrow has declined over the recent decades.

Table 2.

Population density of the House Sparrows (per 10 ha) in different habitat types of Lvov, Warsaw and Lublin at the end of XX century

Habitat type	Lvov		Warsaw (Nowicki 2001)		Lublin (Biaduń 2004)	
	Breeding	**Wintering**	**Breeding**	**Wintering**	**Breeding**	**Wintering**
Old city centre	32.6	45.3	37-64	62-111	63.6	141.9
Modern multi-storey housing	43.0	79.0	37-61	64-106		
Residential area	32.9	60.7	39-70	74-133		
Industrial area	11.9	24.8	9-16	24-51	10.1	1.5
Parks, cemeteries	2.4	5.6	3-5	17-31	4.1	2.7

CONCLUSIONS

Although House Sparrows continue to be the most abundant birds in Lvov, their numbers are probably declining. This is mainly due to changes in urban habitats resulting from urbanisation processes such as contracting of the residential areas, development of new microhabitats with very little greenery and architecture unsuitable for nest construction, building houses in ruderal areas covered with weeds. Also important is the limitation of access to traditional sources of food in winter, such as trash containers, also decrease in the number of allotments at houses where poultry are raised, and increasing disturbance to birds at night caused by the explosions of petards.

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