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### The development of bird communities in new housing estates in Warsaw

**Abstract.** The study was carried out in seven housing estates, in which 10 sampling plots (of 125 ha) were investigated over 1–3 years. A total of 18 samples (plots x years) represented areas from the stage at which construction work was just beginning to a 50-year-old housing estate. The original state of the avifauna prior to construction work, was compared using three plots (14 ha, 5 samples) located in undeveloped sites in extensively built-up areas.

The construction work initiating a new housing estate reduced the number of breeding species and the size of the breeding population to 1/3 to 1/4 of the species, and of total abundance in comparison with undeveloped areas. Over the first 20 years, the avifauna of new housing estates was species-poor (with up to 10 species), but populations were considerably larger (148–178 pairs, and 54 kg, per 10 ha). Such a development of the bird community resulted mainly from colonization by species nesting in buildings, and particularly from the growth of populations of House Sparrow and Feral Pigeon. In older housing estates (aged 17 to 50), the density of bird communities increased little (with 143–241 pairs, and 51–91 kg, per 10 ha), but the number of species did rise as the result of the development of vegetation. At that stage, nesting sites in buildings, and anthropogenic food, accounted for the occurrence of about 90% of the population of breeding birds. However, the diversity of the avifauna depended on the vegetation, which provided nesting sites for 2/3 of species.

#### INTRODUCTION

The subjects of this paper are:

1. the composition of the breeding and wintering avifauna (bird communities) of the habitats formed by newly-built housing estates in a large city;
2. The course of the changes in the avifauna of a housing estate from the construction stage through to its completion and full vegetational development;
3. The main ecological factors influencing these changes.

The work is based on studies carried out in the years 1982–1985 on seven Warsaw housing estates which had been chosen as typical of this kind of development in Poland. The results of this research have been presented previously as working paper (LUNIAK 1990).

The avifauna of Polish towns and cities is relatively well-known, but studies have most often been concerned with the birds of urban green areas. To date Polish data

cataloguing the breeding avifauna of housing estates has come from 14 study areas in Poznań, Koszlin, Siedlce, Słupsk, Wrocław and Września (LUNIAK, GŁĄZEWSKA 1987). Particularly worthy of mention in the foreign literature are the studies of IDZELIS (1981, 1992) on the transformation of the breeding avifauna in newly-built estates in Vilnius and other Lithuanian towns and cities, the similar work of GEIS (1975) in the city of Columbia, and the studies by OTTO and RECKNER (1976) in four estates in Berlin, CHUDINOVA and BRTEK (1982) in Bratislava, KRÜGER (1973) in Hoyerswerda-Neustadt (Germany), and PLATH (1985) in Rostock (Germany).

In this paper, housing estates are understood to be residential complexes consisting mainly of blocks with 3–15 storeys. These are situated in “patches” (and not linearly along streets) on areas of several ha to more than 100 ha. They include objects providing services for the inhabitants (trading pavilions, schools, kindergartens and car parks), or recreation (school playing fields and green spaces). As in other East European countries, housing estates are the main urban structures in the cities of Poland. They provide homes for the majority of city inhabitants.

#### STUDY AREAS AND METHODS

More detailed information relating to the housing estates studied and the methods applied is presented in the author's work cited in the introduction (LUNIAK 1990).

Table 1. Housing estates (plots) studied. Situation: C – in the centre of Warsaw, P – in peripheral zone. Age – years since buildings were inhabited, und – undeveloped areas.

Housing estate	Situation	Age	Plots ha	Years of study	
				Breeding season	Winter
Marymont-Potok	P	und	5 ha	1	–
		0–1	5 ha	2	2
		2–3	3 ha	2	2
Chomiczówka	P	und	4 ha	3	3
		und	5 ha	1	1
		0–1	5 ha	3	3
		1–2	5 ha	3	3
		3–5	21 ha	1	2
Wawrzyszew	P	5–10	9 ha	1	1
Brzeziny-Wrzeciono	P	15–23	18 ha	3	3
Wierzbno	C/P	17–25	24 ha	1	1
Muranów	C	30–35	17 ha	1	1
Żoliborz-WSM	C/P	ca 50	18 ha	1	1

The study was carried out on seven housing estates (Tab. 1), in which 10 sampling plots (125 ha) were investigated over 1–3 years. A total of 18 samples (plots x years) represented areas from the stage at which construction work was just beginning to a 50-year-old housing estate. The original state of the avifauna, prior to construction work, was known from three additional plots (14 ha, 5 samples) located in undeveloped parts of otherwise extensively built-up areas on the outskirts of two of the housing estates investigated (Tab. 1).

One of the seven housing estates was situated in a densely built-up part of central Warsaw, two estates on the edges of that part, and the remaining four in the peripheral (but not suburban) zone. Found in virtually all of the plots were small green areas (squares, the gardens of kindergartens) with vegetation developed to various degrees.

In the breeding season, the avifauna inventory technique was based on cartographic methods (PINOWSKI, WILLIAMSON 1974). Six to eight counts were made between mid March and mid June. This is generally customary in studies of the avifauna of built-up areas, and relates to the fact that they are species-poor. In winter studies, evaluation was based on three to four counts conducted in the morning hours between mid December and the end of February. Winter observation was made at a rate of about 10 ha per hour.

In the cases of three species (Feral Pigeon *Columba livia dom.*, Swift *Apus apus* and House Sparrow *Passer domesticus*) the numerical estimation of populations raised methodological difficulties known from works concerned more widely with the methodology of quantitative research in built-up areas (GÓRSKI 1981, LENZ 1971, MIZERA 1988, SAEMANN 1973, TOMIAŁOJC 1970):

**Feral Pigeon.** The impossibility of establishing the proportion of the birds observed to those nesting and the irregularity of the reproductive cycle of this species were the main problems. So, the measure of the size of the breeding population adopted was half of the average number of individuals recorded in one count. By convention, this is referred to as the number of pairs. Results obtained in the winter period give less cause for methodological doubts and were probably close to the reality.

**Swifts** were not abundant in any of the estates studied, and the researcher abandoned giving quantitative data on them.

**House Sparrow.** The sizes of breeding populations of this species were determined by estimation: in many cases individual pairs were not recorded. A considerable number of birds was probably overlooked – in the observation of tall buildings (when it is more difficult to hear calls), and especially in the winter period.

On four of the areas studied, the inventory was based on material from one year. Research carried out over three years at the Brzeziny-Wrzeciono housing estate, where environmental conditions are relatively stable, showed a similarity of the species composition between particular years of 87 to 95% (according to Jaccard's index – QS), and a similarity in the quantitative structure of between 91 and 93% (Renkonen's index – Re). The analogous comparison of material from that estate for the winter period of three years showed 86–92% similarity for the QS index and 77–86% for Re. These comparisons indicate that the influence of changes in the composition of avifaunas from year to year was not of great significance in the

presentation of an overall picture of the avifauna in the housing estates under study. The results of research by PLATH (1985), showed a similarly low degree of variability for the species composition of a housing estate between 10 and 20 years old.

Table 2. Avifauna of the breeding season. Age: Und – undeveloped areas, Bld – stage of building work, numbers – years since inhabitants settled, Frq – frequency of the species (number of plots x years in which the sp was recorded). Nest: grd – on the ground, bd – on buildings, tr – on trees, shr – in shrubs. Abundance of species presented as number of pairs per 10 ha. + – abundance below 1, x – abundance not determined, kg/10 ha – biomass of adult population.

Age:	Und	Housing estates					Frq	Nest
		Bld	1	2-5	5-23	17-50		
Plots x years:	5	2	4	4	4	3		
Total area – ha:	14	10	15	34	27	59		
<i>Oenanthe oenanthe</i>		1					1	grd
<i>Phoenicurus ochruros</i>	1	5	4	1	+		9	bd
<i>Passer montanus</i>	15	1	1	2			5	bd
<i>Passer domesticus</i>	25	8	33	59	66	61	17	bd
<i>Columba livia d.</i>	3	3	7	37	67	94	16	bd
<i>Sturnus vulgaris</i>	16	2	5	6	4	7	16	bd
<i>Pica pica</i>	1	1	+	+	1	1	8	tr
<i>Parus major</i>	4		+	+	1	3	7	bd
<i>Streptopelia decaocto</i>	4		+	+	1	7	7	tr
<i>Parus caeruleus</i>	2		1			2	4	bd
<i>Corvus monedula</i>	13			15	19	14	10	bd
<i>Apus apus</i>				x	x	x	6	bd
<i>Delichon urbica</i>					8	+	4	bd
<i>Turdus merula</i>	1					2	3	tr/bd
<i>Sylvia curruca</i>	1					1	3	shr
<i>Charduelis chloris</i>	3					1	3	tr
<i>Corvus corone</i>	1					1	3	tr
<i>Fringilla coelebs</i>	1					1	2	tr
<i>Oriolus oriolus</i>	0					1	1	tr
7 other sp.	5							
Breeding sp	23	7	9	10	10	16		
	9-20	2-7	4-8	4-9	5-10	12-15		
Pairs/10 ha	98	21	54	128	167	190		
	90-130	12-30	42-116	124-137	148-178	143-241		
Kg/10 ha	18	3	8	35	54	69		
	15-20	0-6	5-14	18-44	53-54	51-95		

## COMPOSITION OF THE AVIFAUNA

Nineteen species were found on housing estates in the breeding season (Tab. 2) and 17 in winter (Tab. 3). Recorded in at least 10 of the 17 samples (plots x years), the most widespread breeding species were House Sparrow, Feral Pigeon, Starling and Jackdaw. In addition, Magpie, Great Tit and Collared Dove were often noted, as was Black Redstart where building work was being carried out. In winter, Rook also came into this group, but there were no Starlings or Black Redstarts.

Table 3. Avifauna of the winter season. Abundance of species presented as the number of ind/census/10 ha, XX – high abundance. Other explanations – see Tab. 2.

Age:	Und	Housing estates					Frq
		Bld	1	2-5	5-23	17-50	
<i>Corvus frugilegus</i>	XX	13	29	38	136	168	17
<i>Passer domesticus</i>	XX	10	59	53	122	126	17
<i>Columba livia dom</i>	+	1	10	64	152	158	16
<i>Pica pica</i>	X	1	1	2	+	2	16
<i>Parus major</i>	X	1	1	1	2	12	16
<i>Corvus monedula</i>	X	+	1	15	24	17	15
<i>Passer montanus</i>	X	1	4	1	4	1	11
<i>Galerida cristata</i>			+	1	+		4
<i>Turdus pilaris</i>	+			+	1	5	7
<i>Parus caeruleus</i>	X			+	+	2	7
<i>Turdus merula</i>	+			+	+	2	6
<i>Streptopelia decaocto</i>	X				+	11	6
<i>Corvus corone</i>	+				+	+	4
<i>Carduelis chloris</i>	+					1	4
<i>Sturnus vulgaris</i>	+					3	2
<i>Larus ridibundus</i>					+	+	2
<i>Accipiter nisus</i>	+				+		
3 other sp.	X						
Species	17	7	8	11	15	15	
		5-8	5-7	6-10	8-15	12-14	
Ind./census/10ha	ca 270	26	105	174	424	502	
		19-34	13-175	85-219	286-530	451-558	
Kg/census/10 ha	ca 29	7	19	39	122	143	
		6-9	3-30	17-58	86-151	111-168	

In areas where buildings had been occupied for at least two years, the number of birds was relatively high (e. g. compared with that in city parks). This applied to both the breeding season (Tab. 2) and winter (Tab. 3). The same four species (Pigeon,

House Sparrow, Jackdaw, and Starling or Rook) were numerically dominant in both seasons. In particular areas these constituted 93–99% (in winter 92–97%) of the total numbers of birds and 98–100% (95–99%) of the total biomass.

The results obtained in Warsaw are quite similar to those from similar built-up urban areas in other Polish towns and cities (LUNIAK, GŁĄZEWSKA 1987). The Feral Pigeon is more frequent and considerably more numerous in Warsaw than has been shown for the other cities, and therefore bird communities in Warsaw housing estates were also in general more abundant. This may however be the result of differences in the way in which pigeon populations were counted as well as of the tendency for several authors to ignore this species. The Woodpigeon *Columba palumbus* is often reported in the breeding avifauna of housing estates in Wrocław, but this species is in general considerably less widespread in Warsaw. The Swift and Black Redstart are also more frequent in other cities than in the housing estates of Warsaw. Blackbirds also occur in new housing estates in Germany (KRÜGER 1973, OTTO, RECKER 1976, PLATH 1985), in Slovakia (CHUDINOVA, BRTEK 1982) and in Western Poland. In comparison with the housing estate in Vilnius (IDZELIS 1992), characteristic differences were the absence of Blackbirds, the permanent presence of the Pied Wagtail *Motacilla alba* and a lower general abundance (total 57 pairs/10 ha) of avifauna. The last difference could have resulted from the greater area (43 ha) included in the count. There are few data concerning the winter avifauna of housing estates in other towns and cities, but Collared Dove, Starling and Blackbird are distinctly commoner in Wrocław and Poznań than in Warsaw. This is due to the milder climate of those cities.

#### FORMATION OF THE AVIFAUNA

Data in Tables 2 and 3 illustrate several stages in the formation of the avifauna of housing estates:

**Construction.** Data on the start point of the changes of the avifauna discussed (i. e. the composition prior to the construction of a housing estate) were provided by observations on three plots in undeveloped areas, directly adjacent to the studied housing estates of Marymont-Potok and Chomiczówka (Tab. 1). The comparison of avifaunas there and those on the two plots representing the stage of construction work shows a decline in the number of breeding species from 9–20 to 2 (or to 7 where the construction site retains remnants of the former greenery). The number of wintering species was halved and the total number of breeding birds declined at least fourfold. The formation of the avifauna of an emerging housing estate is therefore preceded by the extermination of the avifauna existing earlier in the area affected for construction. This “bird desert” is the result of the destruction of the main elements of the habitat in which the previous bird community existed. The newly-emerging biotope created by excavation work, stores for building materials and construction of buildings, is unattractive to birds in terms of food, and its instability makes breeding difficult. Only two species (Wheatear and Black Redstart) preferred construction sites, other birds usually avoided them in both the period of breeding (Tab. 2) and in winter (Tab. 3). Apart from the species mentioned in these tables, Sand

Martins *Riparia riparia* have been reported to nest in some Warsaw construction sites (though not in any of the housing estates studied). These were founding breeding colonies in the faces of excavations or heaps of excavated earth.

**The first year.** The first permanent elements of the typical avifauna of housing estates appeared as inhabitants moved into the newly built blocks. Construction work was still in progress in the vicinity and greenery was not yet established. The number of breeding and wintering species increased slightly over that found in the period of construction (Starlings and Pigeons colonized, but not in great numbers). A two-three fold increase in the number of birds was mainly due to the appearance of large numbers of House Sparrows and, in winter, Rooks.

**2 – 5 years after completion.** Although the avifauna of study plots at this stage was only slightly more species-rich (with Jackdaws and Swifts coming in), there was a further considerable increase in populations. Numbers of House Sparrows were already reaching maximum, and the population of pigeons increased. It was at this stage that the complement of species connected with buildings was more or less filled. In contrast, the community connected with greenery was still a very poor one. The Black Redstart – the species characteristic of the construction stage – was becoming rarer and rarer.

**5 – 23 years.** This stage was represented by the Wawrzyszew and Brzeziny-Wrzeciono housing estates (Tab. 1). The estates themselves were fully developed, but the vegetation was not. The number of species had not increased much, but there was a further considerable increase in the populations of certain species (mainly Pigeons, and wintering Rooks, whose presence in large numbers was favoured by the grassy ground cover which was already well-developed).

**17 – 50 years.** Of the housing estates studied, the three oldest were Wierzbno, Muranów and WSM Żoliborz (Tab. 1). These differed considerably from each other in terms of location and layout, but all had avifaunas that were distinctly richer than those of any of the younger estates. It is only at this stage that there is an increase in the importance of the group of species connected with green space (six new species breed). In contrast, the increase in the total population of birds was no longer large, and was connected mainly with the further increase in the population of pigeons.

Data from other areas confirm the findings from Warsaw regarding the pattern in the way in which the avifauna of housing estates is built up. GÓRSKI (1982) studied the 38 ha of the Zatorze housing estate, which was under construction in Słupsk. Fragments of the former green space were preserved there and 12 breeding species were reported – at a density of 52 pairs/10 ha. After four years, the estate had been built and the land managed. The number of breeding species had fallen to eight, but the total population had doubled (to 108 pairs/10 ha). Analogous transformations of the avifauna have also been noted in an area of the newly-emerging town of Columbia (GEIS 1974). There, construction work led to a impoverishment of the avifauna in comparison with that found in the original biotopes before work began. The number of species fell to 40% of the original and the total number of birds to 20–70%. In the first years after the erection of this housing estate, the areas of high-rise construction had as few species as had been present in the construction period, but seven times as many birds. Similar changes were noted after building work, in the avifauna of semi-desert areas of southern California (GUTHRIE 1974). Studies by IDZELIS (1992)

on a newly-erected housing estate in Vilnius showed that, as in Warsaw, the breeding fauna was poor in the construction period (five species, eight pairs/10 ha) and in the first year after habitation (eight species, 15 pairs/10 ha). It then developed over the next 16 years to include 21 species and 57 pairs/10 ha. The total number of birds stabilized there (at 53–58 pairs/10 ha) after only 10 years. This is earlier than in Warsaw, and at a considerably lower level. Housing estates in both Warsaw and Vilnius were colonized by particular species in a similar order. The results of other research cited in the introduction have demonstrated a similar regularity in the development of the avifauna of new housing estates. Everywhere areas in the construction stage have extremely poor avifaunas. Numbers increase rapidly in the course of the first few years, and a richer species composition develops only after between 10 and 20 years. The diversity of breeding species in housing estates is everywhere considerably lower than that of the avifauna of urban green areas.

#### THE INFLUENCE OF OTHER FACTORS

**Situation.** The locations of the studied housing estates along a gradient from the centre of the city to the periphery coincided to a considerable extent with their ages (Tab. 1). This made it difficult to separate out the influence of the factor under discussion. In spite of this, data from the three oldest housing estates (Tab. 1) show that location in the centre (Muranów), or within built-up areas on the edges of the city centre (Wierzbno and Żoliborz), did not have a major influence on the composition of the avifauna, in comparison to that of the peripheral location. In particular it did not limit species diversity. The only difference was a greater population of Feral Pigeons. On the contrary – the only distinctive effect of location in the direct proximity of areas outside the city (Chomiczówka) was the presence of Tree Sparrows, and possibly also of Crested Larks in winter. Neither the remaining permanent components of the avifauna of the housing estates studied, nor the general features of it, were shown to be conditioned distinctly by either the location of an estate in the city or by the character of directly adjoining areas.

The avifauna of the housing estates studied had a very local character in the breeding period. A considerable majority of species, including the dominant ones, had ranges of individual penetration that were generally less than 100 m radius. Only Swifts flew beyond the housing estate, while Jackdaws, Magpies and Hooded Crows often remained mainly within the area.

**Height of the buildings.** 59 buildings of up to five storeys were compared with 16 buildings of 6–11 storeys, in relation to the mean number of pairs of Jackdaw and House Sparrow which nested there. Neither species was found to have a significant preference for low or high blocks. Other species nesting in buildings did not exhibit any dependence on the height of construction either – although data on Swifts was lacking. In his aforementioned studies IDZELIS (1992) did not record House Martins and Starlings nesting below the third, or above the ninth storeys. It may be presumed that tall buildings which are also long (more than 100 m) constitute an undesirable obstacle for a number of species (e. g. tits). Such buildings did occur in the studied housing estates of Chomiczówka and Wawrzyszew.

**Nest sites in buildings.** This was the element conditioning the occurrence of all numerically- and ecologically-dominant components of the breeding avifauna of the housing estates under study. In young housing estates (up to 20 years old) with poorly-developed greenery, species connected with buildings made up either the entire breeding avifauna, or at least 2/3 of the number of species and 95–98% of the total population. Even in the three oldest housing estates with the best developed greenery, this group amounted to at least 1/3 of the species (5–6) and 91–95% of the number of birds. This group also constituted 90% of the total number of birds in the housing estate in Vilnius studied by IDZELIS (1992). In addition, breeding places in buildings were often used by a number of species depending mainly on greenery (e. g. Tree Sparrows and tits). In the conditions of the housing estates under study, the four dominant species differed quite considerably in their preferences regarding the kind of nesting sites utilized (Tab. 4). A relatively high density of each of these species attests to the fact that competition between them was not a significant limiting factor. It would seem that the species least likely to find appropriate nest sites were starlings, which almost entirely used nest-boxes, and jackdaws, which require quite deep holes with entrance of appropriate size. On the other hand, neither Feral Pigeons nor (in all probability) House Sparrows were greatly limited in this respect. This was in part because these species showed very great flexibility in adapting to various nesting places. For instance, Feral Pigeons nested both in the interiors of lofts and in the spaces under roofs, as well as on open balconies. The wide range of adaptative possibilities of House Sparrows to various kinds of breeding place is also known (INDYKIEWICZ 1991, OTTO, RECKNER 1976).

Table 4. Use of nest sites in buildings. (o) – small boxes and other nest sites with narrow opening, O – medium sized ones, OO – large. Underlines – nest sites most commonly or less frequently used.

Nest sites	<i>Passer domesticus</i>	<i>Sturnus vulgaris</i>	<i>Apus apus</i>	<i>Corvus monedula</i>	<i>Columba livia d.</i>	<i>Delichon</i>
Holes and crevices	<u>(o)</u>	-- O --	-- O --			
Nest boxes	-- (o) --	<u>O</u>	-- O --			
Under-roof spaces	<u>(o)</u>	-- O --	-- O --	<u>OO</u>	-- OO --	
Ventilation ducts				<u>OO</u>		
Lofts					<u>OO</u>	
Balconies and ledges					<u>OO</u>	
Overhanging cornices						---

**Greenery.** In general, greenery was created anew in all the studied areas in a period of one-two years after the construction of the housing estate. During construction the old vegetation of the ground cover and shrub layers was destroyed totally,

and only a few trees were retained. New greenery consisted mainly of lawns and trees among the blocks, small green areas around schools and kindergartens and small greens/squares in housing estates. These areas covered quite a large part of a housing estate (c. 25%), but their vegetation was generally poor, particularly in the lower layers. The only more luxuriant areas of low vegetation were a large square in the Żoliborz WSM housing estate and two rows of house gardens in Wierzbno. Newly-created green spaces in housing estates up to 20 years old were so poor that Magpies, Collared Doves and tits were only present in the breeding avifauna on account of the preservation of a few already established trees. It was only in older housing estates (over 20 years old) that greenery had developed sufficiently to allow a larger group of species to colonize (Tab. 2). The nesting places for the majority of these were the crowns of trees aged at least 30, or in buildings. On the other hand, birds were rarely able to nest in the low greenery of the housing estates under study. IDZELIS (1992) found that a considerable increase in the group of birds nesting in greenery had occurred in the Vilnius housing estate after only 10 years. However, as in Warsaw, these birds were not numerous there.

#### CONCLUSIONS

1. To a great degree, the avifauna of the housing estates under study displayed features characteristic of the zoocoenoses of urbanized areas: In the breeding period there were relatively few species (total 18) but large populations and biomass (124–241 pairs and 18–95 kg per 10 ha), as well as a highly uneven numerical structure: Feral Pigeon and House Sparrow constituting 63–91% of the total number of birds and 68–97% of the biomass. Compared to the breeding period, the number of species in winter (17) and the number of birds (85–558 individuals/10 ha) were not smaller and the biomass (at 17–168 kg per ha) was actually higher – a feature specific to the fauna of towns and cities. The numerical disparity was even greater than in the breeding period (with 84–94% of birds – 92–98% of biomass – being Feral Pigeons, Rooks and House Sparrows).

2. The composition of the avifauna was clearly dependent on the course of changes in the environment resulting from the initial construction of the housing estate, and its subsequent ageing. The construction work creating the housing estate caused an extreme impoverishment of the original avifauna of areas formerly undeveloped. The number of species and total density of the bird community fell by 2/3 to 3/4. Construction sites are unattractive to birds because they are a barren, unstable habitat. During the first 10–20 years in the existence of the housing estate the avifauna is species-poor (with 4–10 breeding), but the number of birds increases rapidly. This process is mainly the result of the possibilities for the species nesting in buildings (particularly Feral Pigeon and House Sparrow) to colonize, increase in numbers and adapt to local conditions. It is only after 20–50 years that a significant enrichment of the species composition took place. This is the time taken for the development of vegetation (particularly trees) which allowed a number of species connected with greenery to colonize.

3. Nesting sites in buildings were a factor decisive in the occurrence of a numerically dominant (89–100%) fraction of the breeding avifauna of the housing estates studied. The great abundance of this group of species was made possible by their diverse requirements in terms of the kind of places used for nesting.

4. Greenery was the main factor leading to species enrichment of the avifauna. Connected with the greenery of newly-created housing estates was a group of as few as two-four species, which made up only 2% of the total number of birds. 10 species of bird (2/3 of the total number) occurred as a consequence of the development of greenery in older housing estates (20–50 years old). However, such birds made up only 1/10 of the total population.

## REFERENCES

- GEIS A. D. 1974. Effects of urbanization and types of urban development on bird populations. Proc. Symp. Wildlife in an urbanizing environment. Sprigfield, Mass. pp 97–105.
- GÓRSKI W. 1981. Lęgowa awifauna śródmieścia Pescu (Południowe Węgry) w roku 1978. Not. orn., **22**: 19–35.
- GUTHRIE D. A. 1974. Suburban bird population in southern California. Amer Midland Nat., **92**: 461–466.
- IDZELIS R. F. 1981. Ornitofauna nowych zilych raynov Litvy i puti eyo preobrazovaniya. X Pribalt. Orn. Konf., T. 1, Riga, pp. 33–36.
- IDZELIS R. 1992. On the development of avifauna in a new residential district of Vilnius. Acta orn. lituanica, **5/6**: 72–77.
- INDYKIEWICZ P. 1991. Nest and nest-sites of the House Sparrow *Passer domesticus* (Linnaeus 1758) in urban, suburban and rural environments. Acta zool. cracov., **34**: 475–495.
- KRÜGER S. 1973. Siedlungsdichteuntersuchungen am Brutvogelbestand von Hoyerswerda-Neustadt im Jahr 1971. Mitt. I. G. Avifauna DDR, **6**: 89–100.
- LENZ M. 1971. zum Problem der Erfassung von Brutvogelbeständen in Stadtbiotopen. Vogelwelt, **92**: 41–52.
- LUNIAK M. 1990. Zasiadlanie przez ptaki nowych osiedli mieszkaniowych w Warszawie. In: H. ZIMNY (ed.). Problemy ochrony i kształtowania środowiska przyrodniczego na obszarach zurbanizowanych. Cz. II. Wyd. SGGW-AR, Warszawa. pp. 156–169.
- LUNIAK M., GLAZEWSKA E. 1987. Ptaki terenów zabudowy miejskiej w Polsce – przegląd badań. Not. orn., **28**: 3–15.
- MIZERA T. 1988. Badania ekologiczne synantropijnej awifauny dzielnicy Sołacz w Poznaniu w latach 1975–1984. Acta zool. cracov. **31**: 3–64.
- OTTO W., RECKER W. 1976. Zum Einfluss nistökologischer Faktoren auf die Abundanz des Hausperlings in Berliner Neubauwohnvierteln. Falke, **23**: 330–337.
- PINOWSKI J., WILLIAMSON K. 1974. Inductory information of the Fourth Meeting of the International Bird Census Committee. Acta orn., **14**: 152–164.
- PLATH L. 1985. Besiedlung eines Neubauwohngebietes durch Voegel – Ergebnisse 13-jähriger Bestandserhebung. Falke. **32**: 335–342.
- SAEMANN D. 1973. Untersuchungen zur Siedlungsdichte der Vogel in verschiedenen Grosstadthabitaten. Mitt. I. G. Avifauna DDR, **6**: 3–24.
- TOMIAŁOJC L. 1970. Badania ilościowe synantropijnej awifauny Legnicy i powiatu legnickiego. Acta orn., **12**: 293–392.

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