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Maciej LUNIAK

**The birds of the park habitats in Warsaw**

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Nr 7

Wojciech KANIA

**The autumn migration of the chaffinch *Fringilla coelebs*  
over the Baltic coast in Poland**

WARSZAWA 1981 WROCŁAW

P A Ń S T W O W E W Y D A W N I C T W O N A U K O W E

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Maciej LUNIAK

**The birds of the park habitats in Warsaw**

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The paper contains quantitative data from open and wooded parks, and municipal cemeteries. A total of 39 areas were observed in the breeding season and 37 in winter. 66 breeding species were recorded and 42 wintering species. In the plot with the most abundant avifauna 29 breeding species were found, and a density of 104 pairs/10 ha. The poorest breeding avifauna (or its complete absence) was recorded for open areas. In small mid-town areas a very high density of birds-visitors was found during the breeding season (up to 570 ind. per 10 ha), and of winter avifauna (up to 709 ind. and 192 kg of biomass per 10 ha). The main factor affecting both the diversity of species and density of avifauna was: the degree of woodland in the area, age of tree stand, number of breeding sites for hole nesters. The size of the area, abundance of undergrowth and presence of safe refuges increased primarily the diversity of the avifauna, while the presence of buildings, bodies of water and abundance of anthropogenic food — mainly the level of its numbers. During the last 20 years, 10 species have settled or clearly increased their numbers in the parks. Several other species showed a tendency to disappear.

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**Птицы парков Варшавы**

В работе содержатся данные по количественному учету птиц из открытых и обсаженных деревьями парков, а также городских кладбищ. В гнездовом периоде исследовано 39 пробных площадок, а зимой — 37. Констатировано 66 гнездящихся видов и 42 зимующих. На площадке с самой богатой авифауной встречалось 29 гнездящихся видов, плотность которых составила 104 пары/10 га. Наиболее бедная авифауна либо полное отсутствие птиц наблюдалось на небольших открытых территориях. На небольших пространствах в центре города отмечалась очень высокая плотность

птиц, залетающих в период гнездования (до 570 особей на 10 га) и зимующей авифауны (до 709 особей и 192 кг биомассы на 10 га). Главными факторами, обуславливающими как разнообразие видового состава, так и плотность авифауны, были: степень обсаженности деревьями, возраст древостоя, обилие мест гнездования для дуплогнездников. Величина территории, обилие подлеска и наличие спокойных участков, где птицы не были бы тревожены, увеличивали в основном разнообразие авифауны, в то время, как близкое соседство застройки, водоемы и обилие антропогенного корма — на ее количественный уровень. На протяжении последних 20 лет 10 видов сделалось оседлыми либо значительно повысилась их численность в парках. Несколько других проявляет тенденцию к исчезновению.

## INTRODUCTION

The investigations on which this paper is based were carried out, mainly in the years 1971–1976, at 39 census plots within the urban area of Warsaw. Their objective was to establish the composition of the avifauna and the factors on which it depended. The term “park habitats”, as used in this paper, includes small green patches in housing estates and along streets, municipal cemeteries with verdure, as well as the parks.

In the literature of the past (TACZANOWSKI 1882, SUMIŃSKI and TENENBAUM 1921, SUMIŃSKI 1922) only a few references to the avifauna of Warsaw parks can be found. In the post-war time 3 papers have been published dealing with the avifauna of the parks: Łazienkowski (PIEŁOWSKI 1957), Skaryszewski (PAWŁOWSKI 1963), and the park near the streets Reja and Wawelska (KOEHLER 1972), but these papers are not based on the standard quantitative methods. Some data can also be found in the papers by LUNIAK (1969, 1970, 1972) and LUNIAK *et al.* (1964). Recently quantitative investigations have been carried out on the avifauna of 3 areas: in the Zoological Garden (A. GARDAWSKA), — in the Łazienkowski Park (W. KALBARCZYK) and in the cemetery of Bródno (K. SIERAKOWSKI). The results from these investigations, not published before, have been used in the present paper, by agreement of the authors, to whom I wish to express my thanks.

The avifauna of the allotments in Warsaw, and of the Las Bielański — a large forest park on the outskirts of the city — are the subject of other papers (LUNIAK 1980, in press).

## STUDY AREAS

The distribution within the city area of the 39 plots, and of the 3 areas investigated by the authors mentioned in the Introduction, have been presented in Figure 1. The abbreviations of their names, used hereafter, have been explained in the Appendix, where also data can be found concerning their location. Tables 1-6 contain the description of the census plots arranged in the order of growing area of the open (Tables 1, 2) and wooded habitats (Tables 3-6).

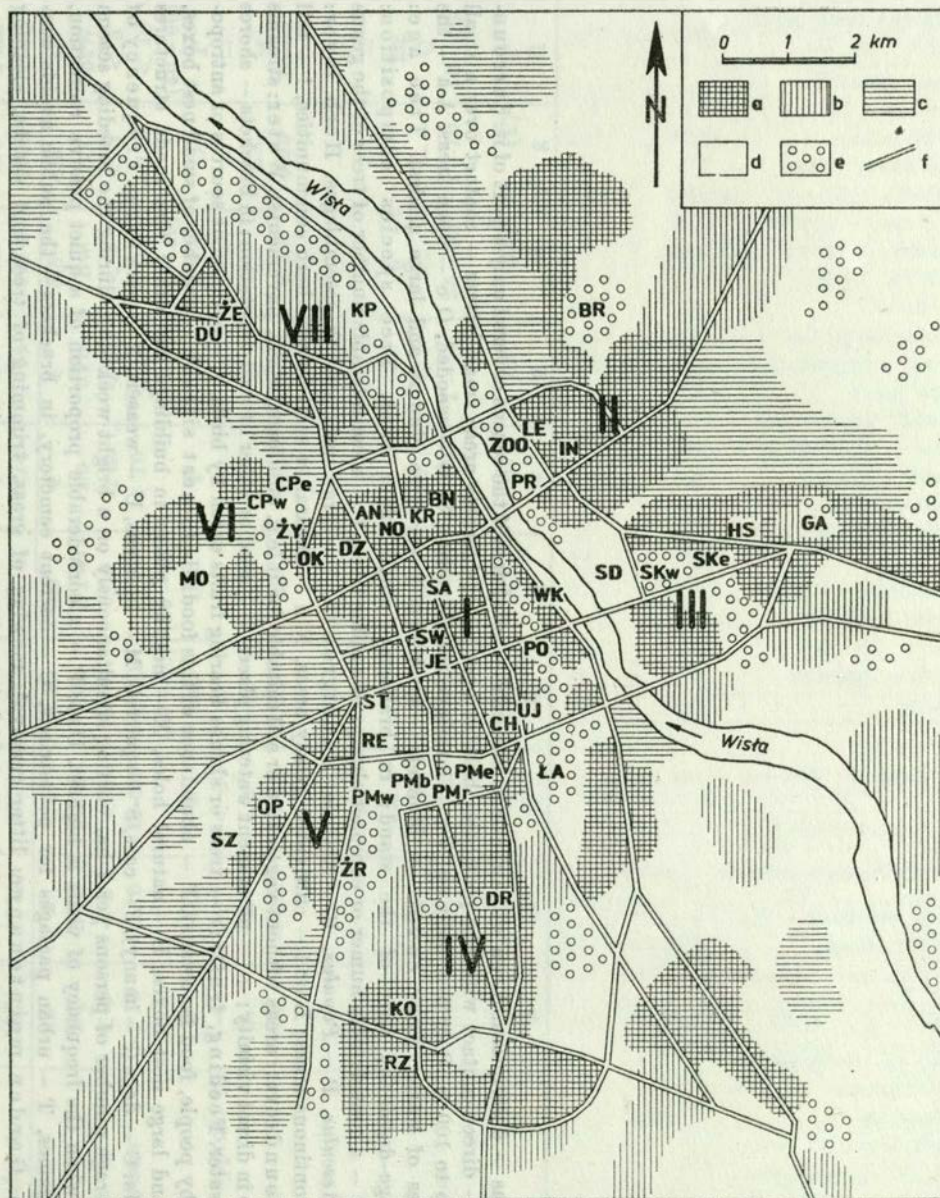


Fig. 1. Distribution of study areas. Abbreviations of study area names are explained in the Appendix. Habitats: a – built-up areas of the city, b – loosely built-up areas with verdure, c – loosely built-up areas poor in verdure, d – open green areas, also agricultural lands, e – wooded areas, f – main town transport roads. Numerals I-VI denote town districts.



Table 1. Small open areas — description. Area censused: in brackets — total area if the census covered only a part of it. Surroundings: capital letters — direct contact with the particular habitat over a considerable area; small letters — contact over a small area or the distance up to 100 m. B or b — built up, T t — intensive traffic routes, W w — wooded, O o — open areas, A a — the Vistula and large bodies of water. Tree cover: in brackets — ununiform cover (tree clumps and large glades). Tree age: determined for the age-dominant part of the stand; in brackets — single older trees. Tree species composition: D — deciduous stand, C — a considerable number or compact clumps of conifer trees, T — a considerable number of trees of the genus *Tilia*, A — *Acer*, E — *Aesculus*, P — *Populus*, R — *Robinia*. Undergrowth: ! — large undergrowth assemblages. Herb layer: capital letters — large continuous areas; L or l — cultivated grassy areas, N n — natural or semi natural herb communities, ! — tall herb clumps. „Dead” ground cover: areas without vegetation or soil suitable for it (e.g. buildings, roads, pavements). Water: streams and bodies of water, also in direct vicinity; + — permanent watering places, ! — reed or other littoral vegetation; in brackets — shores with difficult access to water. Feeding, fruits: r — trees or shrubs bearing fruits eaten by birds, f — permanent sources of antropogenic food (e.g. feeding by people, food for swans), F — abundance of this food. Hole nest sites: b — number of small nest boxes, B — of medium sized and large nest boxes, H — natural holes, X — nesting places in buildings and other man-made structures ! — abundance. Animals: C — dogs (! — many), F — cats, S — squirrels, M — martens, U — weasels, Y — park swans. Frequency of visits by public: average number of persons per 1 ha, visiting simultaneously on a bright week-day, during the breeding season at the time of the day when the frequency of visits is highest. Use: P — a considerable proportion of a quiet passive recreation, S — sports and noisy games, T — urban passages for pedestrians, C — current cemetery, in brackets — the public avoids considerable parts of area. Garden maintenance: litter removal, mowing of grass, trimming of trees and shrubs, cleaning and filling of tree holes, G — high intensity, g — low intensity.

Area symbol	DZ	RZ	BN	AN	OK	DU	ZE	GA	KO	PMe
Years the data refer to	1974	1974	1974	1974	1974	1974	1974	1974	1974	1976
Area censused - ha	2	2	2.5	3.5	3.5	4	4	5.5	5.5	10
Surrounding	BT	BT <sub>o</sub>	BT <sub>w</sub>	Bt	BT <sub>w</sub>	Bo	bT <sub>o</sub>	B <sub>w</sub>	BT	bt <sub>w</sub>
Tree cover - approx. %	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5	< 5
Tree age - approx. years	< 10	< 10	10-20	< 10	< 10	< 10	< 10	< 10	< 10	< 10
				(40-60)	(20-40)		(20-40)	(20-40)		(40-60)
Tree sp. composition	T	D	D	TA	A	T	R	ETA	D	P
Undergrowth cover - approx. %	-	-	< 5	-	-	-	-	< 5	-	-
Herb layer	L	L	LN	L	LN	L	N	L	LN	L
"Dead" ground cover - approx. %	50	5-25	25-50	50	50	25-50	5-25	5-25	5-25	25-50
Water - ha	-	-	-	-	-	-	-	-	-	-
Feeding, fruits	F	-	Fr	F	f	f	-	f	-	-
Hole nest sites	-	-	x	-	-	-	-	h	-	2b
Animals	C!	C	C!F	C!	C!	C!	C	C!	-	C
Frequency of people - approx.	25-50	10-25	10-25	25-50	25-50	10-25	1-10	25-50	1-10	10-25
Use	ST	T	ST	STP	ST	SP	SP	STP	(T)	P
Garden maintenance	G	G	G	G	g	G	g	G	g	G

Table 2. Broad open areas - description. For explanations see Table 1.

Area symbol Years the data refer to	SKe	KP	MO	PMw		SD	SZ
	1974	1974	1974	1972	1976	1974	1974
Area censused (total) - ha	14	17	23	23	26	28	20(34)
Surroundings	BTW	bWO	BTO	TWO	TWO	TW	WO
Tree cover - approx. %	(5-25)	(5-25)	(5-25)	(5-25)	(5-25)	(5-25)	<5
Tree age - approx years.	<10 (20-40)	10-20	10-20	20-40	20-40	20-40	10-20
Tree sp. composition	A	PS	TA	AD	AD	TD	PA
Undergrowth cover - approx. %	<5!	<5!	<5!	<5!	-	<5!	<5!
Herb layer	LN	Ln	L	N!	L	L	LN
„Dead” ground cover - approx. %	<5	<5	5-25	<5	5-25	25-50	5-25
Water - ha	0,5	2	2	-	(2)	-	5!
Feeding, fruits	f	-	r	-	-	-	-
Holenest sites	-	X	X	X	X	X	X
Animals	C	CU	C!	-	C	-	C
Frequency of people - approx.	10-25	1-10	10-25	1-10	1-10	10-25	1-10
Use	(PS)	PS	PS	(PT)	PTS	(S)	PS
Garden maintenance	Gg	G	G	-	G	G	G

Table 3. Wooded areas below 3 ha - description. For explanations see Table 1.

Area symbol Years the data refer to	NO	CH	IN	ST	LE	HS	DR	OP
	1974	1975	1975	1972-1975	1974	1975	1972	1975
Area censused - ha	1	1	1	1.5	2	2.5	2.5	2.5
Surroundings	BTw	Bw	BT	Btw	Btwo	BT	BTw	B
Tree cover - approx. %	25-50	50-75	50-75	50-75	25-50	50-75	50-75	50-75
Free age - approx. years	20-40	60-80	20-40 (40-60)	20-40 (60-80)	10-20 (20-40)	20-40 (40-60)	40-60	20-40
Tree sp. composition	TA	AP	TA	PTC	A	PD	APC	PD
Undergrowth cover - approx. %	5-20!	-	<5	<5!	<5	5-20!	5-20	<5
Herb layer	1	1	1	L	1	1	1	1
„Dead” ground cover - approx. %	25-50	25-50	25-50	25-50	>50	>50	25-50	25-50
Water - ha	-	(+)	-	+	-	-	-	-
Feeding, fruits	fr	F	F	F	F	f	f	F
Hole nest sites	-	H	X	1BH	2B	8b 8B	2BH	2b
Animals	C!F	C!F	C!	C!	C!	C!	C!F	C!F
Frequency of people - approx.	50-80	25-50	80-110	80-110	80-110	50-80	50-80	50-80
Use	P	PS	PT	P	PT	PS	PT	PT
Garden maintenance	G	G	G	G	G	G	G	G



Table 4. Wooded areas 3-6 ha – description. For explanations see Table 1.

Area symbol	PMr		ŚW		JE	RE
	1972	1976	1967-1971	1972-1974	1967-1972	1975
Area censused – ha	3	3	3.5	3.5	4	5.5
Surroundings	BT	bTo	BT	BT	BT	BTo
Tree cover – approx. %	>75	>75	(50-75)	(50-75)	(25-50)	(50-75)
Tree age – approx. years	20-40	20-40	20-40	20-40	20-40	20-40
Tree sp. composition	P	P	TD	TD	TD	TPC
Undergrowth cover – approx. %	5-20!	<5	5-20!	<5!	<5!	<5!
Herb layer	n	l	L	L	l	L
„Dead” ground cover – approx. %	<5	5-25	25-50	25-50	>50	25-50
Water – ha	–	–	(+)	(+)	(+)	–
Feeding, fruits	–	f	Fr	F	Fr	F
Hole nest sites *1972 only	X	1B X	X!	X! 5B	X 4B*	11b13BX
Animals	OF	C	C!	C!	C!	C!
Frequency of people – approx.	1-10	10-25	80-110	80-110	80-110	10-25
Use	(P)	P	PT	PT	PT	P
Garden maintenance	–	G	G	G	G	G

Table 5. Wooded areas 6-16 ha – description. For explanations see Table 1.

Area symbol	UJ	WK	KR	Pmb		SA
	1975	1975	1972-1974	1972	1976	1968-1974
Area censused – ha	6	7	10	14	16	15
Surroundings	BTW	BTa	BTw	bTO	BTO	BT
Tree cover – approx. %	50-75	25-50	50-75	>75	>75	50-75
Tree age – approx. years	20-40	20-40	20-40	20-40	20-40	20-40
	>80		>80	(40-60)	(40-60)	>80
Tree sp. composition	ATD	TP	EATD	AD	AD	ETD
Undergrowth cover – approx. %	<5!	<5!	5-20!	5-20!	–	<5
Herb layer	l	L	L	N!	l	L
„Dead” ground cover	>50	25-50	25-50	–	5-25	>50
Water – ha	0,5	Vistula	<0,3	–	–	0,5
Feeding, fruits	F	f	F	r	fr	F
Hole nest sites	2b XH	X	X H!	–	X	X H!
Animals	C!SY	C	C!S	COF	C!	C!SY
Frequency of people – approx.	50-80	25-50	50-80	1-10	10-25	50-80
Use	P	PS	P	(P)	P	PT
Garden maintenance	G	G	G	–	G	G

Table 6. The largest wooded areas — description. For explanations see Table 1.

Area symbol Years the data refer to	ŻR	PR	CP		ŻY	PO	SKw
	1971	1975	CPe	CPw	1971	1975	1975
Area censused (total) — ha	18	19	12 (43)	13	13 (35)	14 (35)	21(50)
Surroundings	bTWa	bTWa	bW	W	bTW	BTw	bTWAo
Tree cover — approx. %	(25-50)	50-75	>75	50-75	>75	>75	50-75
		20-40	>80	20-40		20-40	
Tree age — approx. years	20-40	>80		40-60	20-40	>80	60-80
Tree sp. composition	TCD	ATPC	AED	AD	AR	PAD	PAC
Undergrowth cover — approx. %	5-20!	5-20!	<5	<5	>20!	5-20	5-20!
Herb layer	L	L	—	—	N!	l	L
„Dead” ground cover — approx. %	25-50	25-50	>50	>50	5-25	25-50	5-25
Water — ha	—	+	+	+	—	(0.3)	4
Feeding, fruits	r	F	f	—	—	F	F
Hole nest sites	X	26b 7B	2B X H	X	X	2b 2B	16b 21B
		X H				X H	X H
Animals	C	CS	SMF	M	MO	C!	CSY
Frequency of people — approx.	10-25	50-80	1-10	1-10	<1	25-50	10-25
Use	(P)	PT	C	C	(C)	PT	(P)
Garden maintenance	G	G	G	G	—	G	G

## AVIFAUNA OF THE BREEDING SEASON

## Material and methods

The assessment of the state of the avifauna was based on the mapping method according to the principles of the international standard (PINOWSKI and WILLIAMSON 1974). Between the end of March and the middle of June birds were counted at each of the plots 7-9 times, and evening checking was done from time to time. The results concern territories maintained, conventionally identified with breeding pairs. Taken into account during the census were also birds which did not breed at a sample plot, but visited it. In this case the term “visitors” was adopted, and only those of them were considered which were present throughout the breeding season, whereas those whose presence was evidently connected with migration were omitted. Because of the difficulty to discover them, the census of *Passer domesticus* visitors was based mainly on the data obtained in the period preceding the appearance of leaves on the trees. Ignored among the visiting species was *Micropus apus*, often observed in the study areas, but little connected with them ecologically. Data on the biomass of the particular species have been taken from the handbook edited by FERENS (1967, 1971).

Tables 7–12 contain data concerning the breeding season avifauna. As regards their arrangement, these tables are a continuation of Tables 1–6.

Table 7. Small open areas — breeding season avifauna. Numbers — density of breeding pairs (p/10 ha); p — number of breeding pairs; v — density of bird-visitors (ind./census 10 ha); + — density below 0.5/10 ha. Hole nesters — species breeding in holes and semiholes; High nesters — species breeding in open nests above *ca* 1.5 m; Low nesters — species breeding on ground and in shrub below *ca* 1.5 m; Biomass — breeding pairs and visitors. Bold type — density of species-dominants (over 10%).

Area symbol	DZ	RZ	BN	AN	OK	DU	ZE	GA	KO	PMe
Years of investigations	1974	1974	1974	1974	1974	1974	1974	1974	1974	1976
Area in ha	2	2	2.5	3.5	3.5	4	4	5.5	5.5	10
<i>Perdix perdix</i>										
<i>Columba domestica</i>	<b>150v</b>	5v	<b>30v</b>	<b>41v</b>	<b>29v</b>	<b>15v</b>	<b>11v</b>	<b>14v</b>	1v	+v
<i>Galerida cristata</i>				+v			1p		1p	1
<i>Motacilla flava</i>			3v		2v		1p			1p
<i>Motacilla alba</i>								+v	2v	
<i>Sturnus vulgaris</i>	<b>30v</b>	<b>28v</b>	<b>18v</b>	8v	8v	2v	6v	<b>20v</b>	<b>15v</b>	<b>8v</b>
<i>Corvus monedula</i>	8v	7v	8v	<b>16v</b>	4v	4v	<b>16v</b>	<b>24v</b>	7v	+v
<i>Pica pica</i>									3v	4v
<i>Passer domesticus</i>	<b>77v</b>	<b>56v</b>	<b>42v</b>	<b>43v</b>	<b>49v</b>	<b>22v</b>	<b>16v</b>	<b>78v</b>	<b>20v</b>	<b>23v</b>
<i>Passer montanus</i>			1p							
<i>Carduelis chloris</i>	2v		1p	3v		1v		1p		
Breeding species — number			2				2	3	3	3
diversity index H'			1.0				1.0	1.6	1.6	1.0
p/10 ha			8				5	5	5	4
Visitors — ind./10 ha	267v	96v	101v	111v	92v	46v	49v	136v	48v	16v
Biomass — kg/10 ha	52	7	14	18	12	6	8	14	5	2
Hole nesters — p/10 ha			4					2		2
High nesters — p/10 ha			4					2		
Low nesters — p/10 ha							5		4	2

### Composition of avifauna

In the study areas, 57 breeding species were found and 6 species regularly visiting them in the breeding season (Tables 7–12). The results of W. KALBARCZYK's study (*in litt.*) carried out at Łazienki, and of K. SIERAKOWSKI's study (*in litt.*) at the cemetery of Bródno increase the list of the breeding species found in the 70-ies by another 9 species: *Athene noctua*, *Columba domestica*, *Dendrocopos medius*, *D. minor*, *Jynx torquilla*, *Micropus apus*, *Phoenicurus ochruros*, *Carduelis spinus* — a pair nesting at BR cemetery, and in the past also found by PIELOWSKI (1957) at Łazienki, *Emberiza citrinella* — at BR cemetery during 3 years 1–2 pairs per 20 ha.

Table 8. Broad open areas — breeding season avifauna. In brackets — data concerning total area when the census plot covered only a part of it. Bold type — species-dominants (over 5%). For other explanations see Table 7.

Area symbol Years of investigations Area censused (total) — ha	SKe	KP	MO	PMw		SD	SZ	
	1974	1974	1974	1972	1976	1974	1972	1974
	14	17	23	23	26	28	20 (34)	20 (34)
<i>Anas platyrhynchos</i>	<b>2v</b>						(+v)	(1v)
<i>Perdix perdix</i>	1			1		1	+v	(1p)
<i>Fulica atra</i>								
<i>Charadrius dubius</i>		1					(1p)	
<i>Actitis hypoleucos</i>		+v						(+v)
<i>Larus ridibundus</i>	1v	1v			+v	+v	(+v)	(+v)
<i>Sterna hirundo</i>		+v					(+v)	(+v)
<i>Columba domestica</i>	<b>2v</b>	1v	1v		2v	1v		
<i>Columba palumbus</i>				1v	1v			
<i>Cuculus canorus</i>				+				
<i>Hirundo rustica</i>	+v	+v		+				+v
<i>Delichon urbica</i>	5v	2v	1v		1v			
<i>Alauda arvensis</i>	1	+					1	1
<i>Galerida cristata</i>		1	1	1	+	1	2	2
<i>Motacilla alba</i>	1	1	+				(1p)	1
<i>Motacilla flava</i>	3	2	+	1	1	+	3	2
<i>Oriolus oriolus</i>				+	+			
<i>Sturnus vulgaris</i>	<b>24v</b>	<b>14v</b>	+	+	<b>3v</b>	+	<b>10v</b>	<b>20v</b>
<i>Corvus monedula</i>	<b>9v</b>	<b>15v</b>	<b>6v</b>	<b>10v</b>	<b>3v</b>	<b>9v</b>	<b>4v</b>	<b>3v</b>
<i>Corvus corone cornix</i>	1v	1v	6v	2v	3v	3v		
				1v	1v			

<i>Corvus frugilegus</i>					lv				
<i>Pica pica</i>		lv	1	lv	lv	+	1		
<i>Acrocephalus arundinaceus</i>								(1p)	(2p)
<i>Acrocephalus palustris</i>					4				
<i>Hippolais icterina</i>					1	+		1	
<i>Sylvia curruca</i>					1		+		
<i>Sylvia communis</i>					2			1	1
<i>Saxicola rubetra</i>					1			+	
<i>Oenanthe oenanthe</i>					1				
<i>Luscinia luscinia</i>							+		
<i>Turdus merula</i>				1	1			1	
<i>Parus major</i>		lv				+		+	
<i>Passer domesticus</i>		34v	28v	1	1	2	2	1	1
				31v	6v	4v	15v	18v	14v
<i>Passer montanus</i>		+v	1 4v	1	1	+ 2v	1 1v	1v	1
<i>Acanthis cannabina</i>		1		+v			1		1
<i>Carduelis chloris</i>			1	+	1	1	1	1	1
<i>Carduelis carduelis</i>		1			+	+			1
Breeding species — number		6	8	8	18	9	13	8	10
Breeding species — diversity index H'		2.3	2.5	2.9	3.9	3.1	3.4	(11)	(12)
Breeding species — p/10 ha		6	6	5	19	6	10	9	9
Visitors — ind./10 ha		80v	67v	47v	22v	18v	29v	33v	38v
Biomass (breeding pairs + visitors) — kg/10 ha		8	6	4	3	3	3	2	3
Hole and semi-hole nesters — p/10 ha		1	1	3	4	2	4	1	2
Species breeding in open nests above ca 1.5 m — p/10 ha		1	1	1	4	2	3	2	1
Ground and shrub (below ca 1.5 m) nesters — p/10 ha		4	4	1	10	1	3	7	6

Table 9. Wooded areas below 3 ha — breeding season avifauna. For explanations see Table 7.

Area symbol Years of investigations Area in ha	NO		CH	IN	ST		LE	HS	DR	OP
	1972	1974	1975	1975	1972	1975	1974	1975	1972	1975
	1	1	1	1	1.5	1.5	2	2.5	2.5	2.5
<i>Columba domestica</i>	10v	36v	412v	134v	60v	175v	105v	24v	54v	114v
<i>Streptopelia decaocto</i>				1p	1p	1p		2p	1p	1p
<i>Delichon urbica</i>							+v			3v
<i>Sturnus vulgaris</i>	3v	5v	2p 33v	2p	2p	2p	2p	2p	3p	19v
<i>Pica pica</i>					1p	1p				
<i>Corvus monedula</i>	3v	5v	22v	4v	11v	3v	5v			3v
<i>Corvus corone cornix</i>			4v			3v	5v			
<i>Hippolais icterina</i>	1p	1p	1p	1p		1p		1p	1p	1p
<i>Sylvia curruca</i>	1p				1p	1p		1p		
<i>Turdus merula</i>	1p	1p	7v	1p	1p	2p		1p	2p	1p
<i>Parus major</i>					2v	1p				
<i>Parus caeruleus</i>					2v			1p		
<i>Passer domesticus</i>	105v	95v	1p 103v	1p 222v	102v	105v	1p 106v	9p >80v	77v	2p 116v
<i>Passer montanus</i>			1p		1p	1p		1p		
<i>Carduelis chloris</i>	1p	1p	1p	1p	1p	1p	1p	1p	2p	2p
<i>Serinus serinus</i>									1p	
Breeding species — number	4	3	5	6	7	9	3	9	6	5
— diversity index H'	2.0	1.6	2.2	2.5	2.7	3.1	1.5	2.5	2.4	2.3
— p/10 ha	40	30	60	70	53	73	20	76	40	25
Visitors — ind./10 ha	121v	141v	581v	360v	177v	286v	221v	>100v	131v	255v
Biomass (breeding pairs + visitors) — kg/10 ha	10	10	130	60	36	77	38	15	23	42
Hole and semi-hole nesters — p/10 ha			40	30	20	27	15	52	12	7
Species breeding in open nests above ca 1.5 m — p/10 ha	30	30	20	40	20	33	5	20	28	14
Ground and shrub (below ca 1.5 m) nesters — p/10 ha	10				7	7		4		

The lowest diversity of breeding avifauna, as expressed by the number of species and the value of SHANNON'S WEAVER'S index (ERDELEN 1977), was found at small open sites (Table 7). Over the total area of 25.5 ha of all plots of up to 5 ha only 5 species were found to nest, the average being 1.6 per 10 ha. At some of the plots no birds nested. The highest, relative to the area, number of breeding species was found in wooded sites of 10–21 ha in area (Tables 11 and 12).

In large, sometimes considerably diversified park complexes the following numbers of breeding species were found: a new park PM (ca 65 ha) in 1977 – 17 species, ŁA park (ca 70 ha) for 3 years – 39 breeding species + 8 probable breeding species (KALBARCZYK *in litt.*), cemeteries CP + ŻY (ca 80 ha) – 44 species, SK + SD complex (ca 90 ha) – 34 species, BR cemetery (113 ha) – in different years – 28–33 species (SIERAKOWSKI *in litt.*).

At most plots the number of species found to be regular visitors was limited to several, but they often occurred in considerable numbers. Apart from these, at the beginning of the breeding season over a dozen passing migrant species were seen. Most common among these were: *Motacilla flava*, *Muscicapa striata*, *Lanius collurio*, *Ficedula hypoleuca*, *Phylloscopus trochilus*, *Ph. sibilatrix*, *Ph. collybita*, *Erithacus rubecula*, *Phoenicurus phoenicurus*, *Turdus philomelos*, *Pyrhula pyrrhula*.

The main proportion of the breeding season avifauna consisted of between ten and twenty species present in most parks, although the differences in habitat conditions were considerable. Taking as a measure of frequency of occurrence the ratio of the total area and study years in which a species was found to occur to the number of plots and all study years, the highest frequency of occurrence has been found for:

– on sites of all types – *Passer domesticus* and *Sturnus vulgaris* (100 % frequency as breeders or visitors) and *Columba domestica*, *Corvus monedula* and *Carduelis chloris* (a frequency of over 75 %);

– on open sites the following showed a frequency of over 66 %: *Galerida cristata*, *Pica pica*, *Motacilla flava* and *Passer montanus*;

– in larger wooded areas a frequency of over 66 % was found for: *Strix aluco*, *Muscicapa striata*, *Hippolais icterina*, *Corvus corone cornix*, *Sylvia atricapilla*, *Turdus merula*, *Parus major*, *P. caeruleus*, *Passer montanus*, *Fringilla coelebs*.

As regards their ecological origin, the most numerous (about 40) was the group of wood species and their density was sometimes considerable. There were about 10 species of open habitats and of meadow-field shrubs – these were occurred in small numbers. Only 4 breeder and 6 visitor waterfowl species were found, whereas the number of species characteristic of built-up areas was 7.

Table 10. Wooded areas 3-6 ha — breeding season avifauna. Bold type — density of species-dominants (over 5%). v! — visitors of high abundance. For other explanations see Table 7.

Area symbol Years of investigations Area in ha	PMr		Św				JE			RE
	1972	1976	1967	1971	1972	1974	1967	1971	1972	1975
	3		3.5				4			5.5
<i>Columba domestica</i>		+v	<b>32v</b>	<b>57v</b>	<b>51v</b>	<b>83 v</b>	<b>144v</b>	<b>173v</b>	<b>127v</b>	<b>14v</b>
<i>Streptopelia decaocto</i>				1p	1p	1p				2p
<i>Delichon urbica</i>				+v	2v					
<i>Oriolus oriolus</i>	1p									
<i>Sturnus vulgaris</i>	8v	2v	<b>13v</b>	<b>14v</b>	<b>3p</b>	<b>2p</b>	<b>15v</b>	<b>14v</b>	2p	<b>4p</b>
					ca 10v	ca 10v			ca 10v	
<i>Pica pica</i>	1p	1p								1p
<i>Corvus monedula</i>			4v	1v	2v	1v	5v	7v	12v	
<i>Corvus corone cornix</i>										1p
<i>Hippolais icterina</i>	<b>2p</b>	1p	<b>3p</b>	<b>4p</b>	<b>3p</b>	1p	1p	2p	2p	<b>2p</b>
<i>Sylvia curruca</i>	1p	1p	1p	1p	1p	1p	2p	1p	1p	2p
<i>Sylvia atricapilla</i>	1p	1p	2p	1p	1p				:	
<i>Phylloscopus sibilatrix</i>	1p									
<i>Luscinia luscinia</i>	1p		1p	1p			1p	1p		
<i>Turdus merula</i>	1p	1p	1p	<b>4p</b>	<b>5p</b>	<b>5p</b>			2p	<b>3p</b>
<i>Parus major</i>	<b>2p</b>	1p			1p	1p		1p	1p	1p
<i>Parus caeruleus</i>	1p	1p				1p				



<i>Muscicapa striata</i>		1p			1p				1p	+v
<i>Passer domesticus</i>	30v	1p	24p	19p	21p	17p	6p	6p	4p	7p
		18v	v!	v!	v!	v!	v!	v!	v!	v!
<i>Passer montanus</i>	1p	1p	1p			1p				12p
<i>Carduelis chloris</i>	2p	1p	2p	2p	2p	3p	1p	1p	1p	2p
<i>Fringilla coelebs</i>		1p				1p				1p
Breeding species — number	12	12	8	9	11	11	4	6	8	12
— diversity index H'	3.5	3.6	1.7	2.1	2.4	2.5	1.4	2.3	3.1	3.5
— p/10 ha	50	40	100	97	114	97	28	30	35	69
Visitors — ind./10ha	38v	20v	v!	v!	v!	v!	v!	v!	v!	v!
Biomass (breeding pairs + visitors) — kg/10 ha	5	4	17	25	25	33	49	59	46	15
Hole and semi-hole nesters — p/ha	13	17	71	57	77	63	15	18	20	44
Species breeding in open nests above ca 1.5 m — p/10 ha	20	17	17	31	31	31	5	8	12	22
Ground and shrub (below ca 1.5 m) nesters — p/10 ha	14	7	11	9	5	3	8	5	2	4

Table 11. Wooded areas 6-16 ha – breeding season avifauna. Bold type – density of species-dominants (over 5%).\* *Anas platyrhynchos* not considered. For other explanations see Tables 7 and 10.

Area symbol Years of investigations Area in ha	UJ	WK	KR		PMb		SA			
	1975	1975	1972	1974	1972	1976	1968	1971	1972	1974
	6	7	10		14	16	15			
<i>Anas platyrhynchos</i>	<b>10 30v</b>							9v	1 11v	17v
<i>Perdix perdix</i>					1					
<i>Columba domestica</i>	<b>68v</b>	<b>9v</b>	<b>16v</b>	<b>14v</b>	+v	2v	<b>31v</b>	<b>38v</b>	<b>42v</b>	<b>77v</b>
<i>Columba palumbus</i>						1				
<i>Streptopelia decaocto</i>	2	3	1	1				1	+v	1
<i>Strix aluco</i>	+v		1	1			1	1	1	1
<i>Delichon urbica</i>	2v						4v	2v	4v	3v
<i>Motacilla alba</i>	2	2v				1				
<i>Oriolus oriolus</i>	2				1	1				
<i>Sturnus vulgaris</i>	<b>20</b>	3 2v	<b>13</b>	<b>17</b>	<b>4v</b>	2v	<b>21</b>	<b>27</b>	<b>23</b>	<b>19</b>
<i>Pica pica</i>		<b>3</b>	+v		1	1				
<i>Corvus corone cornix</i>	1v		1	1	1	1	1	+v	1	1
<i>Corvus monedula</i>	3	1v	6	8	1v		<b>13</b>	<b>12</b>	<b>15</b>	<b>17</b>
<i>Acrocephalus palustris</i>					1					
<i>Hippolais icterina</i>	3	1	5	3	4	2	5	5	3	4
<i>Sylvia borin</i>					1					
<i>Sylvia atricapilla</i>			1	1	<b>3</b>			1	1	
<i>Sylvia curruca</i>		1	2	2	1		1	1		

<i>Phylloscopus sibilatrix</i>					1					
<i>Muscicapa striata</i>					1			1	1	1
<i>Luscinia luscinia</i>					1					
<i>Turdus merula</i>	7	4	4	6	3	2	3	5	6	8
<i>Parus major</i>	5	1	4	4	1	1	3	3	3	5
<i>Parus caeruleus</i>	2	2v	2	3	1	1	1	2	1	2
<i>Passer domesticus</i>	3 50v	41v	2 43v	3 25v	15v	1 26v	4 v!	3 v!	5 v!	3 v!
<i>Passer montanus</i>	10	1v		1	5v	1	1	1	1	
<i>Fringilla coelebs</i>	3	1	1	2	1	1	1	1	1	2
<i>Serinus serinus</i>	2		1				1		1	1
<i>Carduelis chloris</i>	2	4	2	3	2	1	1	1	2	3
<i>Carduelis carduelis</i>			1	1	1	1				
Breeding species — number	15	9	18	17	16	14	15	15	16	14
— diversity index H'	3.5	3.0	3.6	3.5	3.8	3.7	2.8	2.8	3.0	3.0
— p/10 ha	77	21	49	58	21	13	57	65	65	67
Visitors — ind./10 ha	151v	58v	59v	39v	25v	30v	v!	v!	v!	v!
Biomass (breeding pairs + visitors) — kg/10 ha	81	8	15	15	4	3	24	35	39	56
Hole and semi-hole nesters — p/10 ha	45*	4	29	38	2	4	44	51	50*	47
Species breeding in open nests above ca 1.5 m — p/10 ha	22*	16	16	17	13	9	11	12	14*	19
Ground and shrub (below ca 1.5 m) nes- ters — p/10 ha	*)	1	4	3	6		1	2	1*	

Table 12. The largest wooded areas — breeding season avifauna. In brackets — data concerning total area when the census plot covered only a part of it. Bold type — species dominants (over 5%). For other explanations see Tables 7 and 10.

Area symbol	ŽR	PR	CPe	CPw	ŽY	PO	SKw
Years of investigations	1971	1975	1975		1971	1975	1975
Area censused (total) in ha	18	19	12	(43) 13	13 (35)	14 (ca 40)	21 (ca 50)
<i>Anas platyrhynchos</i>					(+v)	1	1 (8p)
<i>Perdix perdix</i>	1						
<i>Phasianus colchicus</i>	+v				1 (2-3p)		
<i>Larus ridibundus</i>							(+v)
<i>Columba domestica</i>		10v				14v	3v
<i>Columba palumbus</i>	1	1			1		1
<i>Streptopelia decaocto</i>	1	2	1			1	
<i>Cuculus canorus</i>	+		+	+	+	+	+
<i>Strix aluco</i>	+v		+	(1-2p) +	(+)	(+)	1
<i>Picus viridis</i>			+	(1p) +	(+)		(1p)
<i>Dendrocopos major</i>			1	(1p)			1
<i>Lanius collurio</i>	1						
<i>Oriolus oriolus</i>	1		1	+v	1		1
<i>Sturnus vulgaris</i>	3v	14	18	5	+v (+)	16	24
<i>Garrulus glandarius</i>	+v		+v	+v	(1p)		
<i>Pica pica</i>	1	1		+v	2		1
<i>Corvus corone cornix</i>		1	4	2	1	1	2
<i>Corvus monedula</i>	4v	12	(ca 10p)			6	1
<i>Corvus frugilegus</i>			(16p)				
<i>Troglodytes troglodytes</i>					1		
<i>Prunella modularis</i>					1		
<i>Acrocephalus palustris</i>	1				(+)		
<i>Hippolais icterina</i>	1	2	3	5	2	3	3
<i>Sylvia borin</i>	1				1		(1p)
<i>Sylvia atricapilla</i>	1	2	1		4	2	3
<i>Sylvia corruca</i>	1	1		1	1	1	2

<i>Sylvia communis</i>	1				(+)		
<i>Phylloscopus trochilus</i>	1						
<i>Phylloscopus collybita</i>					2	(1p)	1
<i>Phylloscopus sibilatrix</i>					4		1
<i>Ficedula hypoleuca</i>			1				
<i>Muscicapa striata</i>			4	2	1	1	3
<i>Phoenicurus phoenicurus</i>			6	4	4	1	
<i>Erithacus rubecula</i>					5	(1p)	1
<i>Luscinia megarhynchos</i>					(1p)		
<i>Luscinia luscinia</i>	1				1		1
<i>Turdus merula</i>	3	6	7	8	4	9	8
<i>Turdus philomelos</i>					(2p)		
<i>Parus major</i>	2	7	7	8	5	5	8
<i>Parus caeruleus</i>	1	4	6	5	3	4	6
<i>Parus palustris</i>					1		1
<i>Sitta europaea</i>			2				
<i>Certhia brachydactyla</i>			1				1
<i>Passer domesticus</i>	3 22v	8 v!	4 ca 10v	3v	6v (+)	7 v!	2 ca 15v
<i>Passer montanus</i>	2 3v	11	11	4		6	22
<i>Fringilla coelebs</i>	1	3	7	7	3	5	5
<i>Serinus serinus</i>		1	3	2	1	1	
<i>Carduelis chloris</i>	2	2	3	8		4	4
<i>Carduelis carduelis</i>			1	2		2	1
<i>Acanthis cannabina</i>	1						
<i>Coccothraustes coccothraustes</i>					1		1
Breeding species — number	23	18	24 (28)	18	25 (32)	20 (23)	28 (30)
— diversity index H'	4.1	3.4	3.9	3.6	4.5	3.6	3.6
— p/10 ha	23	75	91	65	46	74	104
Visitors — ind./10 ha	32v	v!	ca 10v	5v	6v	v!	ca 20v
Biomass (breeding pairs + visitors) kg/10 ha	4	22	10	5	7	13	14
Hole and semi-hole nesters — p/10 ha	8	56	59	29	13	46	69
Species breeding in open nests above ca 1.5 m — p/10	9	17	30	3	13	25	26
Ground and shrub (below 1.5 m) nesters — p/10 ha	6	2	1	1	20	3	8

## Numbers

The density of the breeding population on open sites was only several, or between ten and twenty pairs/10 ha. In wooded areas — from about 20 to 100 pairs/10 ha.

The abundance of the breeding avifauna was determined by the percentage of hollow nesters, the number of which in the respective areas came up to 50-70 pairs/10 ha. Species that build open nests in tree crowns and in tall shrubs attained an overall density of 30-40 pairs/ha. The least important numerically was the group of species nesting on the ground and in lower parts of shrubs — they did not usually exceed a density of several pairs per 10 ha, but at some open sites they were found to be the only breeders. Visitors represented a considerably important group numerically. This group appeared to be the dominant component of the avifauna of open sites and of small wooded areas (Tables 7-9). In some small areas the density of the birds of this group came up to 250-570 ind./10 ha.

As regards its biomass the avifauna (breeders + visitors) of the areas under study showed considerable differences (2-130 kg/10 ha), depending mainly on the contribution of visitor birds — especially *Columba domestica* and *Anas platyrhynchos*. The proportion of the breeding population alone on open sites as a rule did not exceed 1 kg/10 ha, and in wooded areas — several kg/10 ha.

## WINTER AVIFAUNA

### Material and method

The census was carried out in morning and afternoon hours, from mid-December to the end of February. Wooded areas were surveyed at a speed of 10-15 ha/hour, and the open sites — at a faster speed. In small areas, the counting was in most cases repeated 3 times, in large ones — usually twice during the season. The winters during which the census was conducted were relatively mild and with little snow, but counting was usually done in periods when there was at least a partial snow cover, but hardly ever of a considerable thickness.

The representativeness of the data from 2-3 winter countings could be estimated on the basis of the following comparisons: during the 5 times repeated counting done by A. GARDAWSKA (*in litt.*) at the ZOO in the winter of 1973/74 (28 Nov.-14 Febr.) a total of 25 species were found, the number of species recorded in single countings being 15-17, and in 2-3 countings — 19-23. The results from single countings differed from the mean of 5 countings on part A (24 ha) by  $\pm 13-20\%$  ( $\bar{x}$  16%), with 613 individuals registered, whereas on part B (16 ha) by  $\pm 3-14\%$  ( $\bar{x}$  8%), with 258 individuals. KOEHLER (1972) who conti-

Table 13. Small open areas – winter avifauna. Numbers – density (individuals per census per 10 ha), + – density below 0.5, bold type – density of species-dominants (over 10%), W:B – density ratio of winter (W) and breeding (B) populations.

Area symbol	DZ	RZ	BN	AN	OK	DU	ZE	GA	KO	PMo
Years of investigations	1974/ 1975	1974/ 1975	1974/ 1975	1974/ 1975	1974/ 1975	1975/ 1976	1975/ 1976	1975/ 1976	1974/ 1975	1976/ 1977
Area in ha	2	2	2.5	3.5	3.5	4	4	5,5	5.5	10
<i>Columba domestica</i>	<b>79</b>		<b>67</b>	25	<b>54</b>	<b>13</b>				
<i>Galerida cristata</i>				2	4	8	2	2	2	1
<i>Corvus monedula</i>	7	<b>33</b>	28	<b>35</b>	<b>24</b>	<b>13</b>		<b>53</b>	4	<b>3</b>
<i>Corvus frugilegus</i>	<b>157</b>	<b>60</b>	<b>141</b>	<b>162</b>	<b>104</b>	<b>44</b>	<b>52</b>	<b>89</b>	<b>71</b>	<b>18</b>
<i>Bombycilla garrulus</i>			<b>57</b>	<b>45</b>				5		
<i>Turdus pilaris</i>										1
<i>Parus major</i>				2					1	
<i>Passer domesticus</i>	<b>33</b>	<b>19</b>	24	18	<b>29</b>	<b>18</b>	5	<b>18</b>	<b>60</b>	1
<i>Passer montanus</i>			35							
<i>Carduelis carduelis</i>									3	
Species	4	3	6	7	5	5	3	5	6	4
Density – ind./10 ha	276	112	370	289	215	96	59	167	141	24
Biomass – kg/10 ha	89	29	82	77	60	23	19	45	28	8
W:B ratio			23				6	17	14	3

Table 14. Broad open areas – winter avifauna. In brackets – data concerning total area when the census plot covered only a part of it. For other explanations see Table 13.

Area symbol	SKe	KP	MO	PMw	SD	SZ
Years of investigations	1974/ 1975	1974/ 1975	1974/ 1975	1974/ 1975	1974/ 1977	1974/ 1975
Area in ha	14	17	23	26	28	20 (34)
<i>Perdix perdix</i>	1				+	
<i>Larus ridibundus</i>	4	7			2	(10)
<i>Columba domestica</i>					1	
<i>Galerida cristata</i>			1		+	1
<i>Sturnus vulgaris</i>			1			
<i>Pica pica</i>		+		1	1	+
<i>Corvus monedula</i>	2	4	4		2	10
<i>Corvus corone cornix</i>	3	2	2	+	+	+
<i>Corvus frugilegus</i>	50	24	29	21	27	23
<i>Bombycilla garrulus</i>					2	
<i>Turdus pilaris</i>	+	+		2		+
<i>Turdus merula</i>			1	+	1	
<i>Parus major</i>	2		2		1	1
<i>Passer domesticus</i>	7	+	13	1		+
<i>Passer montanus</i>				6		
<i>Carduelis chloris</i>	1		+		+	
<i>Carduelis carduelis</i>	2					
<i>Acanthis flavirostris</i>			6			
<i>Pyrrhula pyrrhula</i>	+				1	1
<i>Emberiza citrinella</i>						(3)
Species	11	7	10	7	13	9 (11)
Density – ind./10 ha	72	37	59	31	38	36
Biomass – kg/10 ha	21	12	12	8	11	11
W : B ratio	6.0	3.1	5.9	2.6	1.9	2.0

nued during several years daily observation in the park at Reja St. (RE) recorded there 20 species in winter, but 11 of these he described as very rare. By comparison with these data the result of a census repeated 3 times in one winter season (Table 15), when 11 species were found, seems to be sufficiently representative.

The material concerning the avifauna of the winter season has been summarized in Tables 13-17.

### Composition of avifauna

The data in tables 13-17 show a total of 36 species. Researches carried out at the ZOO (A. GARDAWSKA *in litt.*), Łazienki (W. KALBARCZYK *in litt.*) and the Bródno cemetery (K. SIERAKOWSKI *in litt.*) add 6 more species found in the 70-ies as rare species. In these three areas *Carduelis spinus* and *Erithacus rubecula* were found to winter, at BR – *Buteo buteo*, *Accipiter gentilis* and *Turdus viscivorus*, and in the ŁA park – *Carduelis flammea*.

A least diversified species composition was found, as in the breeding season,



Table 15. Wooded areas below 6 ha — winter avifauna. For explanations see Table 13.

Area symbol	CH	IN	ST	LE	HS	DR	OP	PMr	SW	RE
Years of investigations	1975/ 1976	1975/ 1976	1975/ 1976	1974/ 1975	1975/ 1976	1974/ 1975	1975/ 1976	1976/ 1977	1974/ 1975	1975/ 1976
Area in ha	1	1	1.5	2	2.5	2.5	2.5	3	3.5	5.5
<i>Larus ridibundus</i>					8					
<i>Columba domestica</i>	78	105	200	67	9	124	86	7	152	7
<i>Streptopelia decaocto</i>		15	3			4			1	
<i>Sturnus vulgaris</i>					3					2
<i>Corvus monedula</i>	56		20		19	8	7		9	
<i>Corvus corone</i>				2						2
<i>Corvus frugilegus</i>	150	325	343	175	238	134	186	75	92	84
<i>Pica pica</i>								3		1
<i>Turdus pilaris</i>							4		1	
<i>Turdus merula</i>					6		4		4	4
<i>Parus major</i>	7	30	10	2	21	28	11	8	3	8
<i>Parus caeruleus</i>					4					1
<i>Passer domesticus</i>	89	190	133	160	116	122	146	8	138	57
<i>Passer montanus</i>	20				47	2	11	10	3	19
<i>Carduelis chloris</i>				3					3	3
<i>Pyrrhula pyrrhula</i>	10				9				1	
<i>Coccothraustes coccothraustes</i>								2		
Species	7	5	6	6	11	7	8	7	11	11
Density — ind./10 ha	410	665	709	409	480	422	455	113	407	188
Biomass — kg/10 ha	93	156	192	89	100	92	96	33	85	36
W:B ratio	3.1	4.8	5.6	10.2	3.2	5.9	9.1	1.4	2.1	1.4

Table 16. Wooded areas 6–16 ha – winter avifauna. For explanations see Table 13.

Area symbol	UJ	WK	KR	SA	PMb
Years of investigations	1975/ 1976	1975/ 1976	1975/ 1976	1974/ 1975	1976/ 1977
Area in ha	6	7	10	15	16
<i>Anas platyrhynchos</i>	90			61	
<i>Columba domestica</i>	94		23	67	
<i>Streptopelia decaocto</i>				+	
<i>Strix aluco</i>				+	
<i>Sturnus vulgaris</i>			5		
<i>Pica pica</i>				+	2
<i>Corvus monedula</i>			8	26	
<i>Corvus corone</i>	2			+	+
<i>Corvus frugilegus</i>	41	82	95	79	44
<i>Bombycilla garrulus</i>				33	6
<i>Turdus pilaris</i>		11	1		6
<i>Turdus merula</i>	1	2	2	1	2
<i>Parus major</i>	13	11	17	9	2
<i>Parus caeruleus</i>	2		4	2	+
<i>Passer domesticus</i>	57	24	24	26	6
<i>Passer montanus</i>	40		2	1	1
<i>Carduelis chloris</i>	+	+			7
<i>Pyrrhula pyrrhula</i>	1		2		1
<i>Coccothraustes coccothraustes</i>		1			
<i>Fringilla montifringilla</i>					1
Species	11	7	11	14	13
Density – ind./10 ha	341	131	189	306	78
Biomass – kg/10 ha	140	32	44	119	17
W : B ratio	2.2	2.8	1.6	2.3	3.0

at small open sites (Table 13). Over their joint area of 43 ha a total of only 10 species were found, that is to say, fewer by 4-6 than over a similar joint area of large open sites (Table 14). Over a total area of 25 ha of small wooded parks (Table 15) 17 species were found, that is, much more than at small and large open sites of similar area, but without any clear difference relative to large wooded areas (Tables 16, 17), where a similar number of species was found, proportionately to the area. In large park complexes the following numbers of species were found: PR + ZOO (ca 60 ha) – 25 species; PM complex (ca 65 ha) – 17; Łazienki (ca 70 ha) – 26 species (W. KALBARCZYK *in litt.*); CP : ŻY cemeteries (ca 80 ha) – 19; SK + SD parks (ca 90 ha) – 22; BR cemetery (113 ha) – 18 species each year, in 2 winters – 19 (K. SIERAKOWSKI *in litt.*).

The frequency of occurrence, calculated as for the breeding period, amounted, at the habitats of all types, to 100 % for *Corvus frugilegus* and 95 % for *Passer domesticus*. At open areas (Tables 13, 14) frequencies above 66 % were recorded for *Galerida cristata* and *Corvus monedula*, and at wooded sites (Tables 15–17) – *Columba domestica*, *Parus major* and *Passer montanus*.

Table 17. The largest wooded areas — winter avifauna. For explanations see Tables 13 and 14.

Area symbol	ŽR	PR	CP	ŽY	PO	SKw
Years of investigations	1974/1975	1975/1976	1975/1976	1975/1976	1975/1976	1975/1976
Area censused (total) in ha	18	19	25 (43)	13 (30)	14 (ca40)	22 (ca50)
<i>Anas platyrhynchos</i>						(15)
<i>Perdix perdix</i>	2	3				
<i>Phasianus colchicus</i>				4		
<i>Larus ridibundus</i>						(+)
<i>Columba domestica</i>	2	6			18	3
<i>Dendrocoptes major</i>	+		1	+		
<i>Dendrocoptes minor</i>				+		
<i>Sturnus vulgaris</i>			+			
<i>Garrulus glandarius</i>	+					
<i>Pica pica</i>	3	2	2	1		
<i>Corvus monedula</i>				2		+
<i>Corvus corone cornix</i>		2	2		1	5
<i>Corvus frugilegus</i>	43	61	18	5	52	35
<i>Troglodytes troglodytes</i>						+
<i>Turdus pilaris</i>	3					1
<i>Turdus merula</i>	6				+	1
<i>Parus major</i>	6	18	24	15	9	20
<i>Parus caeruleus</i>	1	3	6	4	4	7
<i>Parus palustris</i>			2	1	+	+
<i>Sitta europaea</i>			2	1		
<i>Certhia familiaris</i>			+			
<i>Certhia brachydactyla</i>		+	+			1
<i>Passer domesticus</i>	1	15	+		10	4
<i>Passer montanus</i>		10	2		3	16
<i>Fringilla coelebs</i>				+		+
<i>Fringilla montifringilla</i>	+			(+)		+
<i>Pyrrhula pyrrhula</i>	1	5	11	3	5	4
<i>Carduelis chloris</i>	1		1		1	+
Species	14	11	15	12 (13)	11	17 (19)
Density — ind./10 ha	70	125	73	37	103	99
Biomass — kg/10 ha	17	28	9	8	25	19
W:B ratio	1.5	0.8	0.5	0.4	0.7	0.5

## Numbers

The level of numbers of the winter avifauna varied considerably. Densities were recorded ranging from 31 (PMw) to 665 (IN) and 709 ind./10 ha (ST). In the managed part of the ZOO (part A — 24 ha) A. GARDAWSKA (*in litt.*) found 255 ind./10 ha, and in the undeveloped part (part B — 16 ha) — 133 ind./10 ha. At open sites the level of numbers was about a half lower relative to that found for wooded sites of similar size.

Only in the largest wooded areas (Table 17) was the density of the winter avifauna (W) lower than that of a breeding (B) population (W : B ratio 0.4-0.8). At all the other sites the numerical predominance of the winter avifauna was very considerable — on the whole several-fold, and in cases of a particularly poor breeding avifauna — over 10-fold (Table 15). The numerical predominance of the winter avifauna was in most cases considerable even when compared with the entire population of the breeding period — that is to say, the total number of nesting individuals and visitors.

The level of numbers of the winter avifauna at each site depended on the presence of several species occurring in large numbers — *Columba domestica*, *Corvus frugilegus* and *Passer domesticus*, and sometimes *Anas platyrhynchos* and *Bombycilla garrulus*. More marked still was this in respect of the biomass, because most of the dominants were species of large individual weights. Where they occurred in large numbers the biomass amounted to several dozen, and over a hundred kg/10 ha.

The most numerous species, at almost all sites, was *Corvus frugilegus*, the percentage of which in the total numbers was not as a rule lower than 30-50%. Similarly high was the joint percentage of two most synanthropic species — *Columba domestica* and *Passer domesticus*, but only in the vicinity of buildings. After subtracting these 3 species and concentrations of *Anas platyrhynchos* at places of feeding — the numbers of the remainder of species in open parks, and in small wooded parks (Tables 13-15), attained the level of only several to between ten and twenty ind./10 ha. In large wooded parks the contribution of this group attained 30-50% of the total abundance, coming up to 30-50 ind./10 ha, but this was very little, if the biomass is considered.

## IMPACT OF THE ENVIROMENTAL FACTORS

## Area size

The data contained in Tables 7-17, arranged in ascending order of area size, show a considerable dependence of the diversity of the specific composition of the avifauna on this factor. The minimum space required for the settling of a community of open site species (*Motacilla flava*, *Galerida cristata*, *Perdix perdix*) was 5 ha (Table 7). The communities of open habitats birds found in larger,

even over 20 ha, areas of open habitats in managed parks were not clearly richer (Table 8 — without PMw 1972).

No such „zero threshold” of space determining the settling of a community of birds connected with wooded habitats has been revealed at the wooded sites studied, because a number of such species use distant feeding grounds and penetrate areas among buildings. A similar minimum of green space has, however, been found for breeding of several species (Tables 9-12): ca 3 ha for *Parus major*, *P. caeruleus*, *Sylvia atricapilla* and *Luscinia luscinia*; ca 5 ha for *Fringilla coelebs*; ca 10 ha for *Strix aluco* and *Carduelis carduelis*; verdure complexes, consisting of several dozen hectares each, conditioned the occurrence of *Cuculus canorus*, *Picus viridis*, *Dendrocopos major*, *Columba palumbus*.

Winter avifauna did not show such marked conditioning by minimum park space, but in winter, too, some species preferred larger park complexes. For example *Picidae*, *Certia sp.*, *Parus palustris*, *Sitta europaea* were only found at areas CP, LA, BR and ZOO.

The size of a park conditioned also the number of visiting *Columba domestica* and *Passer domesticus* — see page 24 and 27.

#### Location in relation to the city centre

Only in some cases was it possible to separate the effect of this factor from the effect of the direct neighbourhood of buildings, usually connected with a mid-town location. Areas were compared which were contrasted with

Table 18. Comparison between some avifauna elements in areas of central (C) and peripheral (P) situation. B — breeding season, W — winter season.

Areas compared		Avifauna elements compared		
Central situation (C)	Peripheral situation (P)		$\bar{x}$ ind./10 ha	
			C	P
CH, ST 1975, ŚW 1974, JE 1972	LE, IN, HS, OP	<i>Columba domestica</i> — B	302	94
		— W	143	67
AN, BN, DZ	RZ, DU, GA, KO	— B	64	9
		— W	57	3
PO	CP (BR)	<i>Corvus frugilegus</i> — W	153	66
		— W	52	18

regard to their location relative to the axis mid-town — outskirts (see Fig. 1), but comparable in other respects — especially the bordering on built-up areas. For the majority of species, including the two *Passer* species, this comparison does not show any marked relationship of occurrence. The few differences found include the more abundant occurrence of *Columba domestica* and wintering

*Corvus frugilegus* (Table 18) in mid-town areas, absence of *Oriolus oriolus* from parks of between ten and twenty hectares in the city centre, and the nesting of *Emberiza citrinella* only on the outskirts (BR cemetery).

#### Vicinity of built-up areas

A comparison of small and medium-sized areas, where the effect of the factor considered was intense, with areas, few in number, of similar sizes, to small extent bordering on built-up areas (ZE, PMe, PMe 1976, PMb 1976), and with the largest areas (Tables 2, 6) shows that the nearness of built-up areas increases several, or over ten times the number of visiting *Columba domestica* and *Passer domesticus* in both the breeding season and winter, due to which the total densities of the avifauna are increased. *Passer domesticus* was found to nest in large numbers on wooded habitats only at a distance of up to several dozen metres from built-up areas. Only at 2 areas (PMe and SD) was this species found to nest at a distance of over 250 m from built-up area. Nothing seemed to indicate that the nearness of a built-up area limited the occurrence of other species.

#### Proximity of streets

The effect of this factor was studied at two plots with the most uniform structure of woodland and other elements affecting the avifauna. In the PO park a plot was selected located at the foot of a viaduct carrying one of the busiest and noisiest roads of the city (3 Maja Ave.). In the PMb 1972 park, the part selected for observation was situated in the vicinity of a transport route with tramway and car traffic — one of the main roads in the city (Niepodległości Ave.). In the two areas the composition of the breeding avifauna was compared over strips at a distance of 0-100 m (3.5 and 3 ha), and 100-200 m (3 ha each) from the road, and in the PMb park also 200-400 m (8.5 ha). This comparison has not revealed any clear differences in the relative number of species, total density of breeding pairs, or density of species building open nests, depending on the distance from the transport route.

The composition of the avifauna of areas completely or almost completely cut-off by main roads with heavy traffic (WK, ŚW, JE) indicates that the factor considered did not have a noticeable limiting effect on the numbers of visiting *Passer domesticus*, *Sturnus vulgaris*, *Corvus monedula*, arriving from nearby areas. Flights across the transport routes have been found for nesting *Oriolus oriolus* (PMr), *Galerida cristata* (ŽE, KO), *Turdus merula* (NO), *Passer montanus* (SKe, SD).

#### Degree of wooding and tree stand age

Sites with a tree stand cover of up 25 % (Tables 1, 2) were found to have a poorer specific composition and a lower density of breeding and winter avifauna.

na, relative to wooded areas to a larger extent. Only in those areas could a community be found of species typical of open habitats, whereas species of wooded areas did not generally nest there.

Areas included in the category with 25-50% tree stand cover (NO, LE, JE, WK, ŻR) were found to already have a specific composition of the avifauna typical of wooded parks, but the abundance level of the breeding avifauna was markedly lower there than at more wooded areas. Plots included in the two top categories of wooding (50-75% and over 75%) did not appreciably differ in the composition of their avifauna in relationship to the degree of wooding.

The avifauna found in stands up to 10 years old was that typical of open areas. The presence of single older trees (OK, ŻE, PMe) was of no great importance if they did not provide nesting places for hole nesters.

At a stand age of 10-20 years species of wooded areas began to settle: *Carduelis chloris* and *Pica pica*, rarely *Turdus merula*, *Hippolais icterina*, *Parus major*, *Carduelis carduelis*. The overall density of the group of species building open nests high above the ground was slight (1-3 pairs/10 ha), and the nesting of hole nesters depended only on the presence of artificial nesting places.

In stands 20-40 years old, a numerous community could already be found of tree nesting species, its permanent components being: *Pica pica*, *Hippolais icterina*, *Sylvia curruca*, *S. atricapilla*, *Luscinia luscinia*, *Turdus merula*, *Streptopelia decaocto*, *Parus major*, *P. caeruleus*. This was also the initial stage of colonization by *Columba palumbus*, *Oriolus oriolus*, *Corvus corone cornix*, *Muscicapa striata*, *Fringilla coelebs* - this could be seen in the consecutive study years on areas ŚW and PMr. The presence of single old trees favours the nesting of *Corvus corone cornix* (Pmb, RE). The number of high nesting species (ca 20 pairs/10 ha) attained there a level similar to that found in old stands. The breeding of hole nesters was still dependent almost entirely on the presence of artificial nesting place.

In 40-60 years old stands (DR, CP w) *Sturnus vulgaris* already found a small number of nesting places in tree holes, *Corvus corone cornix* continued to occur in small numbers, as can be seen when sites CPw and CPe are compared, the two sites only differing by the age of the tree stand.

In areas with a stand 60-89 years old (SKw, BR) *Corvus corone cornix*, and species using small and medium-size tree hollows (e.g. *Sturnus vulgaris*), already attained a high level of numbers. There already were a few nesting places for species requiring large tree holes: *Corvus monedula*, *Anas platyrhynchos*, *Strix aluco*.

Stands aged above 80 years (SA, UJ, KR, PR, CPe, PO, ŁA) provided the conditions for the highest frequency of occurrence and abundance (up to between ten and twenty pairs/10 ha) of species utilizing large tree holes. The composition and numbers of the group of species nesting high above the ground did not show any differences relative to the stands of the preceding age category.

### The undergrowth

The relationship between the composition of the avifauna and the amount of undergrowth can be illustrated by a comparison of the data from plots ŚW, PMr, PMb, PMw in different years, when a drastic change affected particularly this factor — the shrubs were cut down, which eliminated, or considerably limited the occurrence of *Luscinia luscinia*, *Sylvia borin*, *S. communis*, *S. curruca*, *S. atricapilla*, *Phylloscopus sibilatrix*. On areas with a rich undergrowth the group of species including ground and shrub nesters came up to 10 species and between ten and twenty pairs/10 ha, while in areas with a poor undergrowth it did not occur at all, or consisted of up to 3 species nesting at a minimum density.

### The ground vegetation, „dead” cover

The occurrence of *Alauda arvensis* was connected with the minimum „dead” cover (roads, buildings, pavements). It settled at grassy sites not intensely mown (KP, SZ), and at ones with a natural ground vegetation (SKe). If it occurred in grassy areas (PMe, SD), *Motacilla flava* stuck to clumps, even small ones, of uncut grass, or tall weeds. In open parks with a considerable degree of dead cover the number of *Corvus monedula* and *Strunus vulgaris* gathering food was not noticeably lower relative to areas with a larger proportion of grassy sites. Also in wooded parks a high proportion of dead cover (CP, SA, UJ) was without a lowering effect on the numbers of *Turdus merula*, although in its breeding period this species feeds primarily on the fauna of the soil and ground vegetation. The occurrence of *Erithacus rubecula* was clearly connected with the plots (ŻY, PMb 1972), or even small parts of them (in parks SKw, PO), from which litter was not removed.

### Water

Small open water reservoirs (garden barrels, fountain pools) attracted a number of species as places of watering and bathing. However, access to water was often difficult. Cases were recorded of drowning of *Parus major* (CP) and *Turdus merula* (CH) in such water reservoirs.

Ponds of an area up to 0.3 ha were sometimes the places of stay of *Anas platyrhynchos* (SKe, KR from 1975), sometimes very numerous (SA). If there were convenient tree holes near by, single ducks nested (PO, SA) and succeeded in bringing up offspring even on such small bodies of water, if people supplied food to the birds.

Bodies of water of 0.3-1.0 ha, combined with the presence of nesting places (tree holes, inaccessible islands) and of anthropogenic food made possible a successful nesting of several mallards (UJ, ZOO) and a considerable concentration of non-breeding and wintering individuals — on the ponds in the UJ park and in the ZOO 100-200 individuals gathered.



On larger bodies of water or their complexes (SKw, ŁA) there were considerable numbers of *Anas platyrhynchos*: on several large ponds in the ŁA park in the 70-ies over 35-40 ducks nested every year, and during the post-breeding period and in winter over 300 individuals gathered there (W. KALBARCZYK *in litt.*). Bodies of water, even if they were large, were not inhabited by *Anas platyrhynchos* if there was no supplementary feeding and no nesting places (KP, MO, SZ, PMw), and even the number of visiting ducks there was small. Such bodies of water were, however, visited by *Larus ridibundus*.

#### Anthropogenic food and fruits

The importance of this factor to *Anas platyrhynchos* has been discussed in the preceding subsection. A comparison of the composition of the avifauna of these areas, where birds were fed by the public or food remains were available, with areas where the factor in question was of low intensity indicates that it did not exert an important effect on the diversity of the specific composition. But in the breeding season and in winter, this factor considerably raised the level of numbers of the avifauna by attracting few, but abundantly occurring, species that were dominant, especially with regard to biomass (see Table 19).

Table 19. Comparison between some avifauna elements in areas of abundant (+) and scarce (-) anthropogenic food. B - breeding season, W - winter season.

Avifauna elements	Areas					
	small open		immediate wooded		large wooded	
	+ DZ BN AN	- RZ ŻE KO	+ UJ KR SA	- WK PMb	+ PO PR SKw	- ŻY CP ŻY
	+	-	+	-	+	-
<i>Columba domestica</i> ind./10 ha - B	74	4	42	6	9	0
"    "    - W	57	0	61	0	19	1
<i>Corvus frugilegus</i> ind./10 ha - W	153	69	72	63	50	32
<i>Corvus monedula</i> ind./10 ha - W	35	13	17	0	0	0
<i>Passer domesticus</i> ind./10 ha - W	25	21	36	15	10	1
Total biomass kg/10 ha - B	28	6	38	6	16	7
"    "    - W	83	20	148	25	24	11

Data gathered during the winter of 1973/74 by A. GARDAWSKA (*in litt.*) at the ZOO, where the supply of anthropogenic food is particularly rich, have confirmed the results obtained for the parks: In the rearing part (A), where there was plenty of food, the total density was 325 ind. and 89 kg of biomass/10 ha, whereas in the part poorer in food supplies (B) - 133 ind. and 27 kg/10 ha. As in the parks, the differences mainly concerned *Columba domestica*, *Streptopelia decaocto*, *Corvus frugilegus*, *C. monedula*, *C. corone cornix* and *Passer domesticus*.

At some areas birds of the following species were observed to actively approach the people feeding them: *Parus major*, *P. caeruleus*, *P. palustris*, *Sitta europaea* would alight on the hand, shoulder or head of the person feeding them; *Passer domesticus*, *Columba domestica*, *Anas platyrhynchos*, *Fringilla coelebs* would approach at a distance less than 1 m; *Corvus frugilegus*, *C. monedula*, *Streptopelia decaocto*, *Passer montanus* — at a distance of several metres.

The observations from Warsaw confirm the known role of trees and bushes bearing edible fruits, especially for *Bombycilla garrulus*, *Turdus merula*, *T. pilaris*, *Sturnus vulgaris* — even though the small number of occurrences has not made it visible in the results from quantitative samples. Among the trees and shrubs most frequent in Warsaw parks the following are most readily visited by these birds: *Sambucus*, *Elaeagnus*, *Malus*, *Sorbus*, *Vitis*.

#### Nesting places of hole nesters

This was one of the main factors determining the quantitative level of the breeding avifauna. Where there were plenty of nesting sites, the total numbers of hole nesters came up to 60–70 pairs/10 ha, representing over 2/3 of the whole breeding population. This factor made possible the nesting on the study areas of 15 bird species, excluding the woodpeckers. On plots with a full variety of covered nesting places (e.g. SA, SKw, OP, KR) there were 8–13 species using them, representing about a half of the total number of breeding species.

Nesting places of the largest size could only be found in natural tree holes, the number of which was in general insufficient even in old stands. The nesting of *Corvus monedula*, *Strix aluco*, and in most cases of *Anas platyrhynchos*, depended on the presence of these tree holes.

In addition to natural tree holes, nest boxes played a considerable role as medium-size nesting places. They conditioned the nesting of *Sturnus vulgaris* on sites of all types, but the number of birds of this species was much smaller than the number of suitable boxes (e.g. on sites HS, ŚW, JE, RE). In such cases the boxes were occupied by *Passer domesticus* and *P. montanus*.

Small-bodied species used as nesting places both natural tree holes and nest boxes, recesses, and nooks in buildings. If located at a height of above 3 m, such places were used mainly by *Passer domesticus* and *P. montanus*. They often nested in holes lamp posts and in lamp-shades. The nesting places probably were the main factor controlling the numbers of these species — *Passer domesticus* nesting in the vicinity of buildings, *Passer montanus* in larger green areas. *Parus major* and *P. caeruleus* distinctly retreated as a result of the competition with both the *Passer* species for high nesting places, but owing to their greater tolerance as regards the height at which the nesting place is situated and the size of the latter — they were able to nest on sites where the competition from sparrows was strong (e.g. HS, ŚW), and even in areas where sparrows found no possibilities for nesting (e.g. WK, PMr, PMb). *Phoenicurus phoenicurus*

was found to occur in considerably larger numbers only on cemeteries. In two cases nests were found in the recesses of low tombs — structures of this type probably made it possible for the species to avoid the competition of the sparrows.

### The presence of people and animals

Swan breeding created favourable food conditions for *Anas platyrhynchos* (see subsection „Water”).

The composition of the avifauna of the parks where squirrels (SA, KR, UJ, SKw, CPw, ŁA) and martens (CP, ŻY, ŁA) occurred permanently, when compared with the areas where these animals were not found, does not show any differences in the total numbers of the group of species breeding in open nests high above the ground (without *Carduelis chloris* and *Hippolais icterina*) including *Sturnus vulgaris*, *Corvus monedula* and *Anas platyrhynchos*.

When considering the effect of the presence of people, it is necessary to take into account both the intensity and distribution of the presence of the public and of the dogs brought in, as well as the conditions of the shelter that the birds can use.

Among open parks, areas little visited (ŻE, KO, SZ) were found to have, in comparison with the corresponding areas with large numbers of people (AN, OK, GA, PMe, MO), a noticeably richer avifauna of species nesting low, i.e., typical of open habitats.

Among wooded parks with a poor undergrowth, a comparison of little-visited areas (WK, PMb 1976, PMr 1976, CP) with areas with many visitors (UJ, SA, PR, PO) indicates that, within the limits considered, the number of people visiting was of no importance as regards the occurrence of low nesters, because this group was extremely poor everywhere. In these parks, the factor considered did not have any effect on the variety of the species composition, or on the level of numbers of the whole breeding avifauna. The number of visiting *Columba domestica* and *Passer domesticus* in areas with a high rate of visits by people was noticeably higher, this being connected with the additional feeding (see subsection “Food”).

If a shelter was provided by brushwood, or by a space avoided by people, in open areas (e.g. SD, SKe), even in time of a high rate visiting to the whole area, the community of ground nesters was markedly richer than in the above-enumerated intensely visited open areas without shelter. Similarly, in wooded areas (KR, ŚW 1967-72, JE 1972) a good shrub shelter made possible the occurrence of a markedly richer community of species of the group discussed, even if the frequency of visits was very high. In the centre of the city in green squares ŚW and JE, clumps of thorny shrubs made possible the nesting of *Luscinia luscinia* amidst a flowing crowd of passers-by. In intensely visited parks, corners inaccessible to people and dogs: fenced back space of the summer cinema (PO) and tennis-court (SKw), islets separated with a several-metre

strip of water (UJ, SKw), and the ŁA park where walking on the grass and bringing in dogs are strictly forbidden, made possible the nesting of *Phylloscopus sibilatrix*, *Ph. collybita*, *Erithacus rubecula*, *Luscinia luscinia*, *Turdus philomelos* (ŁA), not found in other areas with a high rate of visits.

In the unmanaged areas of the ŻY cemetery and the PM complex, at the lowest frequency of visits and best shelter, in 1972, the percentage of ground and shrub nesters was very high for urban conditions. It represented about 1/3 of both the breeding species and total density (up to between ten and twenty pairs per 10 ha). The development of the PM complex (1976) was followed by a considerable impoverishment of the avifauna. There the decisive role was visible of the shelter, because this factor was subject to the greatest change — in place of the brushwood and herbs smooth lawns were established, while the frequency of visits did not increase much and remained lower than that found in most parks.

The composition of the avifauna in wooded areas from which the presence of dogs was completely eliminated (CP, ŻY, BR cemeteries, ŁA park) does not indicate that this factor alone would have an effect different from that combined with the presence of people. The presence of *Phasianus colchicus* and *Perdix perdix* was the only feature showing a relationship to the absence of dogs, or a limited penetration by them.

Areas of a lower frequency of visits by the public, or with good shelter were the only, or the most frequent nesting sites of species which only begin to form urbanized populations (see section "Changes"), in Warsaw, or those which avoid urban areas (e.g. *Emberiza citrinella*, *Alauda arvensis*, *Troglodytes troglodytes*).

#### CHANGES OF AVIFAUNA

In areas with environmental conditions changing little, where investigations were repeated for several years, the range of short-lived variations in the state of the avifauna was not great: for the SA park the value of RENKONEN'S index, describing the similarity of quantitative structure (ROMANISZYN 1972) for 6 season pairs (1968–1974), was 65–78% ( $\bar{x}$  73%), without any dependence on the time interval between the years compared; for the SZ and KR parks in the years 1972 and 1974 64% and 70%, respectively.

The present investigations and a comparison with data in the papers by LUNIAK (1969, 1970, 1972), LUNIAK *et al.* (1964), PAWŁOWSKI (1963), PIEŁOWSKI (1957) indicate that during the recent period of about twenty years there occurred clear changes in the occurrence of a number of species:

— Nesting of species previously not recorded as breeding in the parks of Warsaw, *Garrulus glandarius* (in ŻY cemetery, in ŻR park from 1972), *Turdus philomelos* (ŻY, from 1974 — ŁA), *Turdus pilaris* (ŻR from 1976, ŁA from 1977, for several years more and more numerous in parks in winter),

*Phasianus colchicus* (ŻY, vicinity of ŻR park), *Prunella modularis* (ŻY, in 1978 — SKw, also in Bielański Las).

— A considerable increase in the spreading of *Corvus corone cornix*, *Pica pica*, *Motacilla flava*, *Turdus merula* (a considerable increase in density is indicated by data from the SA, ŚW and JE areas, as recorded by W. KALBARCZYK *in litt.*) for the ŁA park, colonization of the BR cemetery (K. SIERAKOWSKI *in litt.*), *Anas platyrhynchos* (nesting in SA and PO parks, from 1975 — KR).

— Disappearance of *Jynx torquilla*, *Sylvia borin*, *Phoenicurus phoenicurus*, *Luscinia luscinia*, *L. megarhynchos* and several other species — mainly those belonging to the ground and shrub nester group. Less frequent visits by birds of prey.

Changes leading to an enrichment of the avifauna were mainly connected with a progressing adaptation of the populations of individual species to their living in the town — their urbanization. Losses to the avifauna were usually caused by the degradation of the park habitats, especially by the removal of litter, undergrowth and old trees. A general crisis of some species was also reflected there. In the period in question, the SKe + SKw complex lost at least 14 breeding species, or probable breeders, the ŁA park — at least several breeder species. The development of the PM complex caused a reduction in the number of breeding species in the PMw + PMb + PMr areas from 25 (1972) to 17 (1976), and in the area of the previous allotment garden — from 12 to 4 breeding species (LUNIAK 1980, *in press*).

#### CONCLUSIONS

The present study and the data reported by other authors have proved the occurrence of 66 breeding species and 42 wintering bird species over the last decade. Most numerous (above 40) among them were species typical of wooded areas.

Small open areas were found to have the poorest breeder avifauna, or were devoid of it. Abundant in those areas were visitor birds arriving there from built-up and wooded areas. In winter, too, the species composition in such areas was poor and the density was high. In large open areas a greater diversity of breeding avifauna was recorded, but a low density of the populations of breeding species and of the visitors arriving there in the breeding season, as well as of the wintering population.

Wooded parks, by comparison with the open ones, had a much richer avifauna, in respect of both the species composition diversity and numbers. In small areas, a smaller, relatively, number of breeding species was found, but, as in the small open areas, a high density of visiting and wintering birds. The density of the breeding avifauna depended primarily on the percentage of hole nesters. The proportion of ground and shrub nesters was usually very low.

Among the environmental factors considered the following have been found to be important for the abundance and diversity of the avifauna: the proportion of wood cover, increasing up to 75%; the age of the tree stand; number of natural and artificial nesting places for hole nesters. The species composition diversity was increased mainly by: an increase in the size of the area — this being particularly evident in the case of the breeding avifauna, the amount of undergrowth, the presence of refuges, even small ones, where birds are not disturbed. High quantitative level, mainly due to the presence of birds-visitors, were caused primarily by: the vicinity of built-up areas and a mid-town location usually connected with it; water bodies making possible the gathering of *Anas platyrhynchos*; presence of anthropogenic food, exerting some influence particularly in winter. The vicinity of busy streets had no evident effect on the breeding avifauna of wooded areas.

During recent years, about twenty, a number of directional changes in the avifauna could be observed: About 10 breeding species have settled in park areas, or clearly increased in numbers. This is mainly connected with the formation of urbanized populations, or an advanced urbanization. The greatest progress was found for *Turdus merula*, *Anas platyrhynchos*, *Turdus pilaris*, *Corvus corone cornix*. On the other hand, an intensified habitat degradation in many parks, and a general crisis of a number of species had an impoverishing effect on the avifauna. This was particularly evident in the case of ground and shrub nesters.

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## STRESZCZENIE

[Ptaki terenów parkowych w Warszawie]

Badania stanowiące podstawę pracy prowadzono głównie w latach 1971-76. Poza samymi parkami objęły one też skwery osiedlowe i uliczne oraz emmentarze miejskie.

Rozmieszczenie 39 terenów objętych badaniami, a także 3 terenów zbadanych przez innych autorów, których nie opublikowane wyniki wykorzystano w pracy — przedstawiono na ryc. 1. Używane w pracy skrótove symbole nazw terenów wyjaśniono w Appendix, gdzie podano też bliższe dane o lokalizacji terenów. Ich charakterystykę fizjograficzną zestawiono w tab. 1-6.

Skład awifauny okresu lęgowego zestawiono w tabelach 7-12. Ocenę liczebności populacji lęgowej oparto na metodzie kartograficznej, uwzględniono też ptaki nie gnieźdzące się na badanych terenach, lecz zalatujące na nie w ciągu całego okresu lęgowego. Wykazano występowanie w ciągu ostatniego dziesięciolecia 66 gatunków lęgowych.

Skład awifauny zimowej przedstawiono w tabelach 13-17. Wykazano występowanie 42 gatunków. Stwierdzono, że obraz awifauny oparty na 2-3 liczeniach w ciągu sezonu jest dość reprezentatywny.

Wśród terenów odkrytych najmniejsze (po kilka ha) nie miały wcale awifauny lęgowej lub tylko skrajnie ubogą. Licznie (średnio *ca* 100 osobników i kilkanaście kg biomasy na 10 ha) występowały tam ptaki zalatujące z zabudowy i zadrzewień. Również zimą zestaw gatunków był tu ubogi, ale ogólne zagęszczenie awifauny — wysokie (średnio *ca* 200 osobników i *ca* 50 kg biomasy na 10 ha). Rozległe tereny odkryte miały większą różnorodność awifauny lęgowej (średnio po *ca* 10 gatunków), ale zagęszczenia były tu niskie — zarówno populacji lęgowej (do kilkunastu par na 10 ha) i zalatującej (średnio *ca* 40 osobników i kilka kg biomasy na 10 ha), jak też zimującej (średnio *ca* 40 osobników i kilkanaście kg na 10 ha).

Parki zadrzewione miały w porównaniu z odkrytymi awifaunę znacznie bogatszą. Liczba gatunków lęgowych wynosiła od 3-9 na terenach poniżej 3 ha do 18-29 na kilkunastohektarowych powierzchniach w dużych parkach i 30-40 w rozległych, kilkudziesięciohektarowych kompleksach. Zagęszczenia awifauny

łęgowej były zależne głównie od udziału dziuplaków. Udział grupy ptaków gnieźdzących się nisko był na ogół minimalny — kilka gatunków i ogółem kilka par na 10 ha. Tereny małe miały wysoką liczebność ptaków zalatujących (na ogół 100-200 osobników na 10 ha), duże — znacznie niższą. Zimowa awifauna na najmniejszych terenach składała się z 5-11 gatunków (najczęściej 250-500 osobników i 50-100 kg na 10 ha), na kilkunastohektarowych powierzchniach w dużych parkach z 11-15 gatunków (ca 100 osobników i kilkanaście kg na 10 ha), a w kilkudziesięciohektarowych kompleksach ogółem — 17-26 gatunków.

Spośród rozpatrywanych czynników istotny wpływ zarówno na różnorodność składu gatunkowego awifauny, jak i jej poziom ilościowy miały: stopień zadrzewienia terenu, wiek drzewostanu, obfitość miejsc łęgowych dla dziuplaków. Na samą różnorodność składu gatunkowego miały wpływ: wielkość terenu, obfitość podszycia, obecność zakątków, gdzie ptaki są bezpieczne przed płoszeniem. Napływ gatunków masowych, a przez to silny wzrost ogólnego zagęszczenia awifauny powodowały głównie: sąsiedztwo zabudowy, położenie w śródmieściu wiążące się z intensywnym zalatywaniem *Columba domestica* z terenów zabudowy w szerszym zasięgu, zbiorniki wodne umożliwiające gromadzenie się *Anas platyrhynchos*, obecność pokarmu antropogenicznego wywierająca szczególnie wpływ zimą. Sąsiedztwo ruchliwych tras komunikacyjnych nie wywierało widocznego wpływu na awifaunę łęgową terenów zadrzewionych.

Skład awifauny badanych terenów ulegał stosunkowo niedużym zmianom fluktuacyjnym, natomiast w ciągu ostatnich kilkunastu lat zaznaczyło się szereg zmian ukierunkowanych: nastąpiło osiedlenie się na terenach parkowych w Warszawie lub wzrost liczebny około 10 gatunków, które wytworzyły zurbanizowane populacje lub zwiększyły stopień zaawansowania urbanizacji. Największy postęp wykazały tu *Turdus merula*, *Anas platyrhynchos*, *Turdus pilaris*, *Corvus corone cornix*. W tym samym czasie tendencję zaniku wykazały *Jynx torquilla*, *Phoenicurus phoenicurus*, ptaki drapieżne oraz szereg gatunków z grupy gnieźdzących się nisko — szczególnie *Luscinia luscinia*. Wiąże się to zarówno z degradacją siedlisk w wielu parkach, jak i z ogólną sytuacją szeregu gatunków.

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## APPENDIX

### List of study areas

Abbreviations of area names are arranged in alphabetic order. The names which they stand for are distinguished by bold type. Roman numerals denote the districts marked on the map of the town (Fig. 1). The first of the numbers given against tables containing data concerning a particular area refers to table with area description, the second — with the breeding avifauna, the third — with the winter avifauna.

- AN (I, Tables 1, 7, 13) — a housing estate green square at **Anielewicza** st. between **Karmelicka**, **Lewartowskiego** and **Zamenhoffa** streets.
- BN (I, Tables 1, 7, 13) — a street grassy area delimited by **Bonifratska**, **Franciszkańska**, **Nowowiniarska** and **Długa** streets.
- BR (II) — the cemetery of **Bródno**. Established about 1920; 113 ha in area; wooded, but with open areas; no old trees. Investigated by K. SIERAKOWSKI (*in litt.*) in the years 1971-1973 — who carried out quantitative studies for 3 breeding seasons in a 20 ha plot, as well as winter studies.
- CH (I, Tables 3, 9, 15) — a green square at **Chopina** st.
- CP (IV, Tables 6, 12, 17) — the **Powązkowski Cemetery** representing part of a large complex of old cemeteries; established in 1790. Two areas have been marked out: CPe — (eastern) delimited by compartment lines 25-176 and 234-270 to lines of compartments 243-247 on the south.  
CPw — (western) in a new part of the cemetery; located along the CPe area to the line of compartments 251-237 on the south.
- DR (IV, Tables 3, 9, 15) — **Dreszera Park** (Mokotowski) between **Puławska** and **Kazimierzowska** streets.
- DU (VII, Tables 1, 7, 13) — a housing estate green square between **Duracza** and **Perzyskiego** streets.
- DZ (VI, Tables 1, 7, 13) — a housing estate green square between **Dzielną** and **Marchlewskiego** streets.
- GA (III, Tables 1, 7, 13) — housing estate green square delimited by **Garwolińska**, **Szaserów** and **Kobielska** streets.
- HS (III, Tables 3, 9, 15) — **Hanki Sawickiej Park**, established in 1953.
- IN (II, Tables 3, 9, 15) — a street verdure patch delimited by **Inżynierska**, **Ratuszowa** and **11 Listopada** streets.
- JE (I, Tables 4, 10, 15) — a green square in the centre of the town, delimited by **Jerozolimskie** av. **Marszałkowska** and **Em. Plater** streets; established in 1955; busy passage to the railway station.
- KO (IV, Tables 1, 7, 13) — grassed belt about 50 m broad; along **Komarowa** street, between **Woronicza** and **Marynarska** streets.
- KP (VII, Tables 2, 8, 14) — **Kępa Potocka** park, established in 1962.
- KR (I, Tables 5, 11, 16) — **Krasieńskich** Park — established in 1895.
- LE (II, Tables 3, 9, 15) — a housing estate green square at **Leńskiego** sq.
- ŁA (I) — **Łazienki** park representing part of a large complex of green areas. About 70 ha in area; an old tree stand and large ponds. Visited by many people, but contrary to other parks of Warsaw, the injunctions not to walk on the grass and to bring in dogs are observed. The area was investigated by **PIEŁOWSKI** (1957) and **W. KAL-**

BARCZYK (*in litt.*). The latter author carried out studies in this park in the years 1955-1975, as well as quantitative investigations at 2 plots, 10 ha each, for 2 breeding seasons in the years 1972-1974.

- MO (VI, Tables 2, 8, 14) — **Moczydło** park without its eastern part; established in the 60-ties on a municipal dumping ground.
- NO (I, Tables 3, 9, 15) — a green square delimited by **Nowotki** street (separating it from KR park) and Anielewicza and Nowolipki streets.
- OK (VI, Tables 1, 7, 13) — grassy area along **Okopowa** st. to Wolność st. on the south.
- OP (V, Tables 3, 9, 15) — a housing estate green square along **Opaczewska** st. between Szczęśliwicka and Grójecka streets.
- PM (I) — **Pole Mokotowskie**, a park complex established in 1975 in unmanaged green areas and allotment gardens. It has been divided into 4 neighbouring plots.
- PMw (Tables 2, 8, 14) — western, from Żwirki and Wigury ave.
- PMb (Tables 5, 11, 16) — from PMw along Batorego st. to Niepodległości ave.
- PMr (Tables 4, 10, 15) — from Niepodległości ave along Rychlińskiego st.
- PMe (Tables 1, 7, 13) — eastern, from PMr to Waryńskiego st., without the area of the previous allotment garden at Armii Ludowej ave.
- PO (I, Tables 6, 12, 17) — a park in **Powisłe**, established at the beginning of the 50-ties; representing part of a large complex of green areas. The census plot included the part between the upper edge of the escarp and Kruczkowskiego and Rozbrat streets from 3 Maja ave. to Prusa street.
- PR (II, Tables 6, 12, 17) — **Park Praski**; established in the years 1865-1871.
- RE (I, Tables 4, 10, 15) — a park delimited by **Reja**, Wawelska, Krzywickiego, Górnickiego, Dantyszka, Filtrowa and Łęczycka streets. Studied earlier by KOEHLER (1972).
- RZ (IV, Tables 1, 7, 13) — a complex of newly founded grassy area delimited by **Rzymowski**, Obrzeźna, Cybernetyki and Lotników streets.
- ŚW (I, Tables 4, 10, 15) — a green square, delimited by **Świętokrzyska**, Marszałkowska and Em. Plater streets. Established in 1955.
- SA (I, Tables 5, 11, 16) — **Ogród Saski** park, established in 19th c.
- SD (III, Tables 2, 8, 14) — green areas between the **Dziesięciolecia Stadium** and Zieleniecka st., established in 1955.
- SK (III) — **Skaryszewski Park** in which 2 plots were studied: SKe (Tables 2, 8, 14) — eastern; east of Grochowski canal between Washington st. and Stanisław August boulevard established in 1971.
- SKw (Tables 6, 12, 17) — western; delimited by Zieleniecka st. Washington ave. and park ponds. A park was established there in 1920.
- ST (I, Tables 3, 9, 15) — a green square in **Starynkiewicza** sq.
- SZ (V, Tables 2, 8, 14) — a park in **Szczęśliwice**, established in 1970 on a municipal dumping ground. The census plot included a part of the park west of the ponds.
- UJ (I, Tables 5, 11, 16) — **Ujazdowski Park**, established in 1893.
- WK (I, Tables 5, 11, 16) — a park belt up to 60 m in breadth, between the roadways of **Wybrzeże Kościuszkowskie** route. Extending from Karowa st. to the railway line.
- ZOO (II) — the **Zoological Garden**, established in 1928. Total area of 40 ha; numerous old trees and brushwood clumps. High frequency of public only in a part of the area. A. GARDAWSKA (*in litt.*) carried out a winter census over the whole area in the season of 1973/1974.
- ŻE (VII, Tables 1, 7, 13) — grassed area delimited by **Żeromskiego**, Kasprowicza and Marymoncka streets.
- ŻR (V, Tables 6, 12, 17) — **Żołnierzy Radzieckich Park-Cemetery**; established in 1950.
- ŻY (VI, Tables 6, 12, 17) — **Żydowski Cemetery**. The census plot included the central part of the cemetery, extending to its borders at Okopowa st. and Powązki Cemetery.