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SPECIES DIVERSITY AND POPULATION DENSITY OF BIRDS BREEDING ON A PERIPHERY OF A LARGE CITY IN THE SILESIAN LOWLAND, SW POLAND

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Видове різноманіття та густота населення птахів, які гніздяться на периферії великого міста на Сілезькій низовині, Південно-Західна Польща. - Г. Копій. - Беркут. 34 (2). 2025. - У 2025 р. в передмісті Вроцлава зареєстровано 78 гніздових видів. Для більшості з них були проведені повні обліки на площі 16 км^2. Дуже поширені види (> 50 гніздових пар або > 3 пар/100 га): *Passer domesticus*, *P. montanus*, *Sturnus vulgaris*, *Acrocephalus palustris*, *Delichon urbica*, *Parus major*, *Cyanistes caerulea*, *Columba livia*, *Apus apus, Streptopelia decaocto, Columba palumbus, Sylvia atricapilla, Turdus merula, Pica pica*, *Phylloscopus collybita*. Поширені види (1,00–2,99 пар/100 га): *Phoenicurus ochruros, Erithacus rubecula, Alauda arvensis, Fringilla coelebs, Serinus serinus, Emberiza citrinella, Currcuca communis, Chloris chloris, Corvus monedula, Luscinia megarhynchos, Dendrocpos major, Carduelis cannabina, Turdus philomelos*. До групи досить поширених входять інші 13 видів (20–50 пар). Багато видів (22) були рідкісними в районі досліджень (1–2 пари). Є помітні відмінності в угрупованнях гніздових птахів внутрішньої й зовнішньої частин міста, як за видовим багатством, так і за густотою населення. Більш численними у внутрішній частині були *Phoenicurus ochruros, Chloris chloris, Corvus monedula, Hippolais icterina*.

Ключові слова: міська орнітологія, обліки, видове багатство, густота населення.

Abstract. In 2025, 78 breeding bird species were recorded in suburbs of Wrocław city. For most of them, total counts were conducted in the whole study area (16 km^2). Very common species (> 50 breeding pairs or > 3 pairs/100 ha) were represented by *Passer domesticus*, *P. montanus*, *Sturnus vulgaris*, *Acrocephalus palustris*, *Delichon urbica*, *Parus major*, *Cyanistes caerulea*, *Columba livia*, *Apus apus, Streptopelia decaocto, Columba palumbus, Sylvia atricapilla, Turdus merula, Pica pica*, and *Phylloscopus collybita*. The group of common species (1.00–2.99 pairs/100 ha) included *Phoenicurus ochruros, Erithacus rubecula, Alauda arvensis, Fringilla coelebs, Serinus serinus, Emberiza citrinella, Currcuca communis, Chloris chloris, Corvus monedula, Luscinia megarhynchos, Dendrocpos major, Carduelis cannabina,* and *Turdus philomelos*. The group of fairly common (20–50 pairs, i.e. 1.00–2.99 pairs/100 ha) was represented by another 13 species. However, most species (n = 22) were rare (1–2 pairs) in the study area. There are marked differences in breeding bird assemblages between inner and outer parts of city, both in regard to the species richness, as well as to their population densities. Significantly more common in the inner than in the outer part were the following species: *Phoenicurus ochruros, Chloris chloris, Corvus monedula,* and *Hippolais icterina*.

Key words: urban ornithology, censuses, species richness, population density.

Introduction

Wrocław is the largest city in Silesian Lowland and the third largest one in Poland. It has a surface area of 282 km^2 within its administrative boundaries, and according to the Municipality a population of 893.5 thousands in 2023. The city is divided into 5 districts: Stare Miasto, Śródmieście, Krzyki, Fabryczna and Psie Pole. Each district is further subdivided into settlements.

The city is located in Odra River Valley and is well-endowed with green and blue spaces, which results in relatively high biodiversity. One of the most important and most intensively investigated component of this biodiversity are birds. Their distribution and abundance is especially well known in the inner part, i.e. in Stare Miasto (Kopij, 2006, 2007), Śródmieście (Kopij, 2004, 2005), most part of Krzyki (Orłowski et al., 2006; Kopij, 2012, 2014, 2016b, 2017b), in the north-western part of Fabryczna (Lontkowski et al., 1988; Lontkowski, 1989; Kopij, 2008, 2010), and in some parts of Psie Pole (Orłowski, Górka, 2010; Tomiałojć, 2017). The distribution and abundance of selected uncommon species was also studied in the whole city, i.e. raptors (Kopij et al., 2009), owls (Rachel et al., 2002; Turzańska, Turowicz, 2014), woodpeckers (Kopij, Hołga, 2008; Kopij 2017a), wetland and meadow species (Kopij, 2018, 2020), forest species (Kopij, 2019), as well as the White Stork (*Ciconia ciconia*) (Kopij, 2017c), Rook (*Corvus frugilegus*) (Kopij, Wawrzyniak, 2015), Magpie (*Pica pica*) (Orłowski et al., 2002), Hooded Crow (*Corvus cornix*) (Udolf, 2004), Redstart (*Phoenicurus phoenicurus*) (Orłowski et al., 2004), and few others (Kopij, 2016b). However, peripheries of this city, have been neglected in most of these studies, and/or population densities for selected bird species originated from these areas were underestimated.

The purpose of this study was to investigate species composition and population density of most bird species breeding in northern periphery of the city, and to compare it with the that in the inner part of the city. In this way, it will be known which species are well-adapted to urban environment, and which avoid it.

Study area

The study area comprised few settlements in Psie Pole (Hundsfeld) district of Wrocław city, SW Poland, situated beyond the river Widawa. The area lays in a distance between 5.8 km and 11.4 km from the city hall (Rink).

Three zones were distinguished: **A:** Zgorzelisko and Psie Pole settlements, **B:** Zakrzów settlement, and **C:** Pawłowice and Kłokoczyce settlements (Table 1). A and B zones are more urbanized than C. The B zone is more industrialized than the A zone. The C zone still retain basically a rural character, with larger plots of forest, meadow and arable fields.

The total surface of the whole area is c. 16 km^2, including 4.4 km^2 in Pawłowice settlement. Excluded is the Widawa river valley contained within the dikes. The population in the study area was c. 32 thousands in 2024, including 2418 in Pawłowice and c. 20 thousands in Psie Pole and Zgorzelisko.

The largest wooded area comprises the Pawłowice Forest. Four smaller wooded plots are situated along Widawa, and 4 plots amidst arable grounds. Their total surface area is c.

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Table 1

Number of breeding pairs of birds in particular city settlements of Psie Pole city district (16 km²) in the year 2025.
Кількість гніздових пар птахів в окремих міських поселеннях району Psie Pole (16 км²) у 2025 р.

Species	A	B	C	n	d	Species	A	B	C	n	d
Sylvia atricapilla	19	28	77	124	6.89	*Fulica atra*	0	0	5	5	0.28
Streptopelia decaocto	33	40	47	120	6.67	*Curruca nisoria*	2	0	3	5	0.28
Turdus merula	14	18	60	92	5.11	*Gallinula chloropus*	0	0	5	5	0.28
Columba palumbus	36	19	28	83	4.61	*Falco tinnunculus*	0	4	0	4	0.22
Phylloscopus collybita	10	17	41	68	3.78	*Garrulus glandarius*	1	1	2	4	0.22
Pica pica	19	35	12	66	3.67	*Certhia brachydactyla*	0	0	4	4	0.22
Phoenicurus ochruros	8	17	20	45	2.50	*Aegithalos caudatus*	0	1	3	4	0.22
Erithacus rubecula	2	6	29	37	2.06	*Muscicapa striata*	0	0	4	4	0.22
Alauda arvensis	8	13	14	35	1.94	*Schoeniclus schoeniclus*	2	2	0	4	0.22
Fringilla coelebs	4	5	25	34	1.89	*Certhia familiaris*	2	0	2	4	0.22
Serinus serinus	4	5	25	34	1.89	*Circus aeruginosus*	1	1	1	3	0.17
Emberiza citrinella	2	4	27	33	1.83	*Troglodytes troglodytes*	1	0	2	3	0.17
Currcuca communis	19	8	5	32	1.78	*Corvus corax*	0.5	1	1	2.5	0.14
Chloris chloris	10	11	8	29	1.61	*Buteo buteo*	0	0	2	2	0.11
Corvus monedula	17	8	0	25	1.39	*Accipiter nisus*	0	0	2	2	0.11
Luscinia megarhynchos	6	5	11	22	1.22	*Dryocopus martius*	0	1	1	2	0.11
Dendrocopos major	3	4	15	22	1.22	*Picus canus*	0	0	2	2	0.11
Carduelis cannabina	2	4	13	19	1.06	*Motacilla cinerea*	0	0	2	2	0.11
Turdus philomelos	3	1	16	20	1.11	*Coccothraustes coccothraustes*	0	0	2	2	0.11
Curruca curruca	9	1	3	13	0.72						
Phasianus colchicus	6	5	6	17	0.94	*Cygnus olor*	0	0	1	1	0.06
Oriolus oriolus	6	2	9	17	0.94	*Accipiter gentilis*	0	0	1	1	0.06
Emberiza calandra	5	7	4	16	0.89	*Alcedo atthis*	0	0	1	1	0.06
Sitta europaea	0	0	16	16	0.89	*Dendrocoptes medius*	0	0	1	1	0.06
Carduelis carduelis	5	5	4	14	0.78	*Jynx torquilla*	0	0	1	1	0.06
Picus viridis	6	2	6	14	0.78	*Coturnix coturnix*	0	0	1	1	0.06
Lanius collurio	1	3	8	12	0.67	*Phylloscopus trochilus*	1	0	0	1	0.06
Anas platyrhynchos	0	0	10	10	0.56	*Rhadina sibilatrix*	0	0	1	1	0.06
Motacilla alba	4	1	5	10	0.56	*Acrocephalus arundinaceus*	1	0	0	1	0.06
Cuculus canorus	4	1	3	8	0.44	*Hippolais icterina*	0	0	1	1	0.06
Hirundo rustica	5	2	1	8	0.44	*Carpodacus erythrinus*	1	0	0	1	0.06
Locustella naevia	7	0	1	8	0.44	*Regulus regulus*	0	0	1	1	0.06
Saxicola torquata	5	1	1	7	0.39	*Prunella modularis*	0	0	1	1	0.06
Phoenicurus phoenicurus	1	2	3	6	0.33	*Parus palustris*	0	0	1	1	0.06
Motacilla flava	3	3	0	6	0.33	**Total**	**307**	**309**	**621**	**1196**	**66.64**

Explanations. A = Zgorzelisko i Psie Pole, **B** = Zakrzów, **C** = Pawłowice i Kłokoczyce; **n** – number of breeding pairs, **d** – population density (breeding pairs/100 ha).
Species excluded from counts: *Passer domesticus*, *P. montanus*, *Sturnus vulgaris*, *Acrocephalus palustris*, *Delichon urbica*, *Parus major*, *Cyanistes caerulea*, *Columba livia*, and *Apus apus*.

200 ha. Several allotment gardens occupy total area of c. 200 ha and are situated in each zone. A small river, Dobra flows through the middle of the study area from the south to the north, separating the A and B from the C zone. Meadows are situated on the right bank of this river.

Methods

A simplified mapping method has been employed in the study (Bibby et al., 2012). Birds were counted four times in the whole study area: the first survey in April, the second survey in May, the third survey in June and fourth survey in July. Since the study area was relatively large, 4–5 counts (mornings) were conducted in each of this month. Counts were conducted under sunny and calm weather conditions. For further detailed see Kopij (2007, 2016a, 2022).

All potentially breeding birds were counted, except for the most common ones, i.e.: *Passer domesticus*, *P. montanus*, *Sturnus vulgaris*, *Acrocephalus palustris*, *Delichon urbica*, *Parus major*, *Cyanistes caerulea*, *Columba livia*, and *Apus apus*.

Table 2

Comparison of species abundance in the inner part (Kopij, 2005, 2007) and the outer part (this study) of the city.
Порівняння численності видів у внутрішній (Kopij, 2005, 2007) та зовнішній (це дослідження) частинах міста.

Species	Outer part c. 16 km²		Inner part 15.3 km²		% of difference	χ^2-test
	n	d	n	d		
Sylvia atricapilla	124	8.10	45	2.81	36	36.93**
Streptopelia decaocto	120	7.84	152	9.50	127	3.76
Turdus merula	92	6.01	47	2.94	51	14.57**
Columba palumbus	83	5.42	86	5.38	104	0.05
Phylloscopus collybita	68	4.44	19	1.19	28	27.60**
Pica pica	66	4.31	74	4.63	112	0.46
Phoenicurus ochruros	37	2.42	90	5.63	243	22.12**
Erithacus rubecula	35	2.29	2	0.13	6	29.43**
Alauda arvensis	34	2.22	0	0.00	0	34.00**
Fringilla coelebs	34	2.22	49	3.06	144	2.71
Serinus serinus	33	2.16	37	2.31	112	0.23
Emberiza citrinella	32	2.09	0	0.00	0	32.00**
Currcuca communis	29	1.90	23	1.44	79	0.69
Chloris chloris	25	1.63	47	2.94	188	6.72*
Corvus monedula	22	1.44	58	3.63	264	16.20**
Luscinia megarhynchos	22	1.44	10	0.63	45	4.50*
Carduelis cannabina	20	1.31	0	0.00	0	20.00**
Dendrocopos major	19	1.24	0	0.00	0	19.00**
Curruca curruca	17	1.11	24	1.50	141	1.20
Phasianus colchicus	17	1.11	5	0.31	29	6.55*
Oriolus oriolus	16	1.05	1	0.06	6	13.24**
Emberiza calandra	16	1.05	0	0.00	0	16.00**
Carduelis carduelis	14	0.92	18	1.13	129	0.50
Sitta europaea	14	0.92	5	0.31	36	4.26*
Turdus philomelos	13	0.85	2	0.13	15	8.07**
Picus viridis	12	0.78	2	0.13	17	7.14**
Anas platyrhynchos	10	0.65	18	1.13	180	2.29
Lanius collurio	10	0.65	0	0.00	0	10.00**
Hirundo rustica	8	0.52	6	0.38	75	0.29
Motacilla alba	8	0.52	2	0.13	25	3.60
Phoenicurus phoenicurus	6	0.39	9	0.56	150	0.60
Falco tinnunculus	4	0.26	8	0.50	200	1.33
Muscicapa striata	4	0.26	8	0.50	200	1.33
Hippolais icterina	1	0.07	10	0.63	1000	7.36**

Explanations. n – number of breeding pairs, **d** – density (pairs/100 ha);
% difference indicates by how many percentage the numbers of breeding pairs of given species recorded in the inner part differ from these recorded in the outer part;
for **χ^2-test**: ** $p < 0.01$, * $p < 0.05$.

The Sørensen index was used to investigate similarities between avian communities: **$S = 2c/(a + b)$**, where **c** is the number of species common for two compared communities, **a** – number of species in the community «a», **b** – number of species in the community «b». The index changes from 0 (absolute dissimilarity between communities) to 1 (identical communities).

Results and discussion

In total, 78 breeding bird species were recorded in the study area in 2025, including nine species which abundance was not assessed. They were however recorded as breeding in each three parts distinguished in the study area. In overall, they were common breeding residents. Each of these species was represented by at least 50 breeding pairs in the whole study area (Fig. 1, 2).

Very common species (> 50 breeding pairs or > 3 pairs/100 ha) were also represented by *Streptopelia decaocto*, *Columba palumbus*, *Sylvia atricapilla*, *Turdus merula*, *Pica pica*, and *Phylloscopus collybita*. The group of common species (1.00–2.99 pairs/100 ha) included *Phoenicurus ochruros*, *Erithacus rubecula*, *Alauda arvensis*, *Fringilla coelebs*, *Serinus serinus*, *Emberiza citrinella*, *Curruca communis*, *Chloris chloris*, *Corvus monedula*, *Luscinia megarhynchos*, *Dendrocopos major*, *Carduelis cannabina*, and *Turdus philomelos*. The group of fairly common (20–50 pairs, i.e. 1.00–2.99 pairs/100 ha) was represented by another 13 species. Most species (n = 22) were, however, rare (1–2 pairs) in the study area.

The following species, usually fairly common in habitats similar to those in the study area, were not recorded at all, viz. *Tachybaptus ruficollis*, *Perdix perdix*, *Streptopelia turtur*, *Emberiza hortulana*, *Saxicola rubetra*, *Galerida cristata*, *Parus ater*, *P. cristatus*, and *P. montanus*.

In comparison with breeding avifauna of the inner part of the city (Stare Miasto and the western part of Śródmieście city districts, with a total surface area of 15.3 km²), the species richness was higher in the outer zone (78 vs. 53 spp., χ^2-test = 4.77; $p < 0.05$). There were 46 species common for these two areas compared, 7 species were recorded only in the inner part, whereas as many as 32 species were recorded only in the outer part. Only in the outer part: *Dendrocopos major*, *Alauda arvensis*, *Carduelis cannabina*, *Emberiza hortulana*, *E. calandra*, *Lanius collurio*, *Saxicola torquata*, *Motacilla flava*, *Fulica atra*, *Cygnus olor*, *Gallinula chloropus*, *Curruca nisoria*, *Aegithalos caudatus*, *Certhia familiaris*,

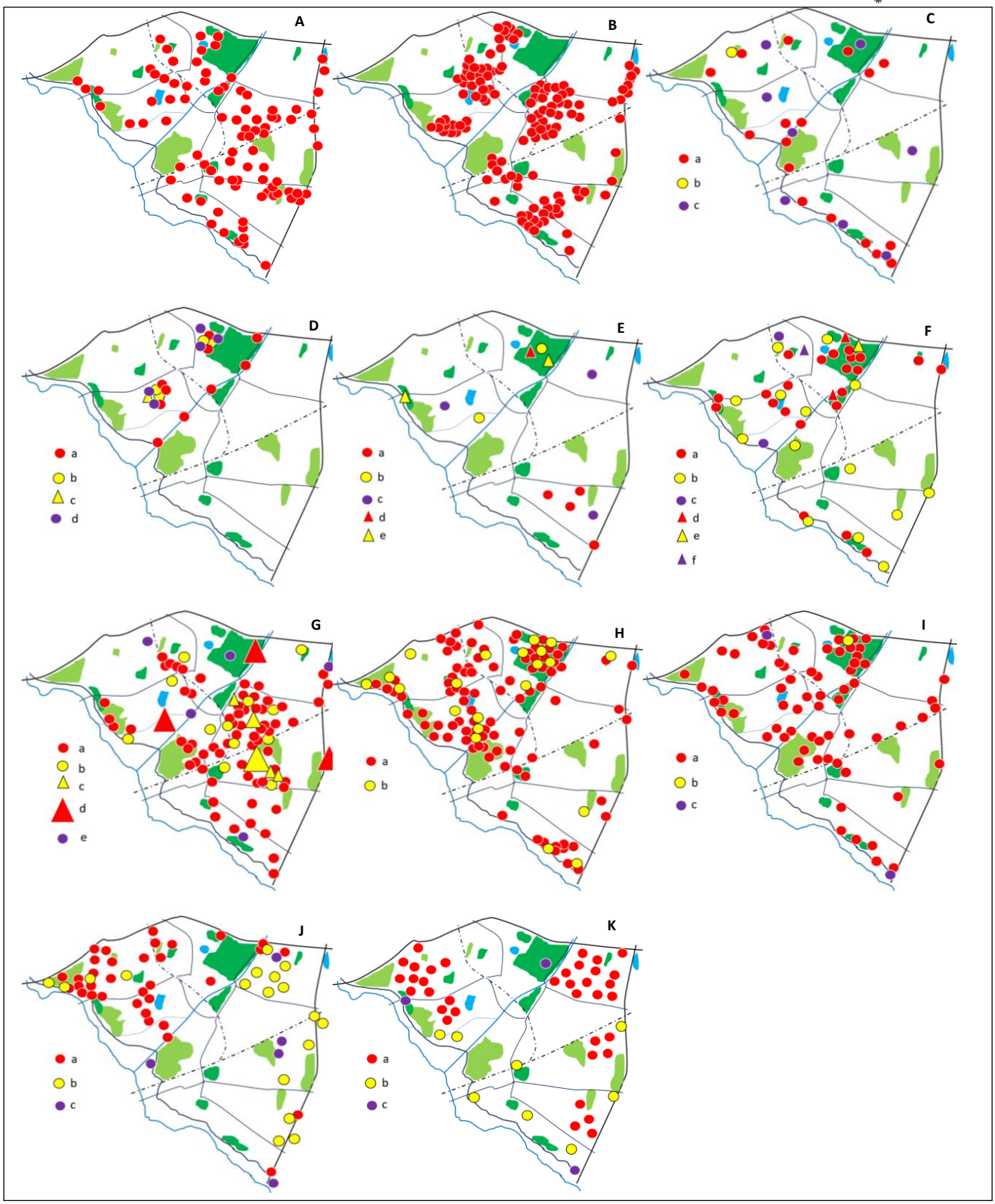

Fig. 1. Distribution of breeding pairs.

Рис. 1. Поширення гніздових пар.

A: *Columba palumbus*, **B:** *Streptopelia decaocto*, **C:** a) *Phasianus colchicus*, b) *Coturnix coturnix*, c) *Cuculus canorus*; **D:** a) *Anas platyrhynchos*, b) *Fulica atra*, c) *Gallinula chloropus*, d) *Cygnus olor*; **E:** a) *Falco tinnunculus*, b) *Buteo buteo*, c) *Circus aeruginosus*, d) *Accipiter gentilis*, e) *A. nisus*; **F:** a) *Dendrocopos major*, b) *Picus viridis*, c) *P. canus*, d) *Dryocopus martius*, e) *Dendrocoptes medius*, f) *Jynx torquilla*; **G:** a) *Pica pica*, b) *Corvus cornix*, c) *C. monedula* (1 pair, 7 pairs, 15 pairs), d) *C. corax*, e) *Garrulus glandarius*; **H:** a) *Turdus merula*, b) *T. philomelos*; **I:** a) *Phylloscopus collybita*, b) *Rhadina sibilatrix*, c) *Phylloscopus trochilus*; **J:** a) *Emberiza citrinella*, b) *E. calandra*, c) *Schoeniclus schoeniclus*; **K:** a) *Alauda arvensis*, b) *Hirundo rustica*, c) *Troglodytes troglodytes*.

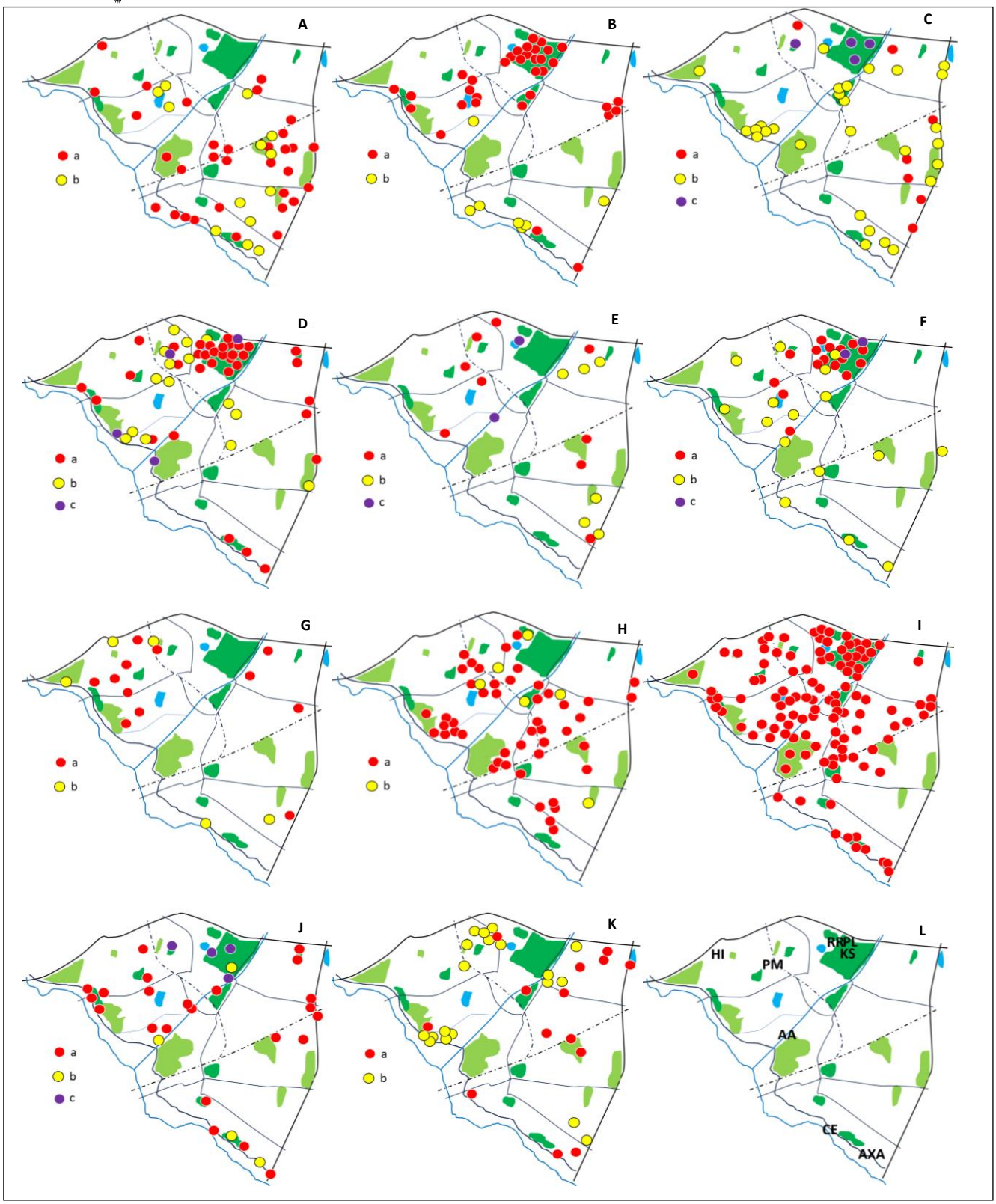

Fig. 2. Distribution of breeding pairs.

Рис. 2. Поширення гніздових пар.

A: a) *Curruca communis*, b) *C. curruca*; **B:** a) *Erithacus rubecula*, b) *Locustella naevia*; **C:** a) *Saxicola torquatus*, b) *Chloris chloris*, c) *Muscicapa striata*; **D:** a) *Fringilla coelebs*, b) *Serinus serinus*, c) *Aegithalos caudatus*; **E:** a) *Motacilla alba*, b) *M. flava*, c) *M. cinerea*; F: a) *Sitta europaea*, b) *Oriolus oriolus*, c) *Coccothraustes coccothraustes*; **G:** a) *Lanius collurio*, b) *Curruca nisoria*; **H:** a) *Phoenicurus ochruros*, b) *Ph. phoenicurus*; **I:** *Sylvia atricapilla*; **J:** a) *Luscinia megarhynchos*, b) *Certhia familiaris*, c) *C. brachydactyla*; **K:** a) *Carduelis carduelis*, b) *C. cannabina*; **L:** HI – *Hippolais icterina*, PM – *Prunella modularis*, AA – *Alcedo atthis*, RR – *Regulus regulus*, KS – *Rhadina sibilatrix*, PL – *Parus palustris*, CE – *Carpodacus erythrinus*, AXA – *Acrocephalus arundinaceus*.

Circus aeruginosus, *Troglodytes troglodytes*, *Corvus corax*, *Buteo buteo*, *Accipiter nisus*, *A. gentilis*, *Dryocopus martius*, *Motacilla cinerea*, *Coccothraustes coccothraustes*, *Alcedo atthis*, *Dendrocoptes medius*, *Jynx torquilla*, *Coturnix coturnix*, *Rhadina sibilatrix*, *Carpodacus erythrinus*, *Regulus regulus*, *Prunella modularis*, *Parus palustris*. Only in the inner part: *Riparia riparia*, *Acrocephalus scirpaceus*, *Actitis hypoleucos*, *Luscinia svecica*, *Oenanthe oenanthe*, *Turdus pilaris*, *Anthus campestris*. The Sørensen Similarity Index was 0.75.

Significantly more common in the inner than in the outer part were the following species: *Phoenicurus ochruros*, *Chloris chloris*, *Corvus monedula*, and *Hippolais icterina*. These species can be called city adopters/exploiters. However, far more species can be classified as city avoiders, viz. *Turdus philomelos*, *T. merula*, *Erithacus rubecula*, *Oriolus oriolus*, *Sitta europaea*, *Luscinia megarhynchos*, *Phasianus colchicus*, *Picus viridis*, *Phylloscopus collybita*, and *Sylvia atricapilla*, as these were more common in the outer than in the inner part of the city. Other species, such as *Streptopelia decaocto*, *Columba palumbus*, *Pica pica*, *Fringilla coelebs*, *Serinus serinus*, *Curruca communis*, and *C. curruca* were neither city avoiders, nor city exploiters, as their population densities were similar in both parts compared (Table 2).

In conclusion, it should be pointed out that there are marked differences in breeding bird assemblages between inner and outer parts of city, both in regard to the species richness, as well as to their population densities.

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