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POPULATION DENSITY, NESTING SITES AND BREEDING SUCCESS IN BARN SWALLOWS IN URBAN HABITATS, SW POLAND

Justyna Niżyńska-Bubel, Grzegorz Kopij

Abstract. Studies were carried in the city of Wrocław, SW Poland, out during the years 2005–2006. Breeding densities increase along urban gradient: it does not breed in the city centre at all, it varies from 0.0 to 0.1 pairs/10 ha in old densely built-up areas in the inner parts, from 0.1 to 1.0 pairs/10 ha in built up areas in outer parts, and from 4.0 to 28 pairs per 10 ha in villages around the city. Barn Swallows nested in all kind of farm buildings such as stables (25.4 %), human houses (25.0 %), pigsties (14.4 %), sheds (11.0 %), poultry-houses (9.0 %) and other (12.5 %) (n = 201 nests). Nests were usually attached to an angle formed by the wall squared with the ceiling (56.0 %) or to a log under the roof (31.5 %) (n = 184). Out of 135 nests, which were aged, 17.8 % were one-year old, 8.1 % two-year old and 74.1 % were more than two-year old. The overall mean clutch size in all sites was 4.78 (n = 184 nests), being slightly higher for the first clutches (x = 4.80; n = 132) than for the second clutches (x = 4.73; n = 52). For the first clutches, hatching success was 76.5 %, while fledgling success – 89.3 %. For the second clutches these parameters were higher: 83.3 % and 93.2 % respectively. In comparison with rural populations, the mean clutch size and overall breeding success in urban population are, in general, similar, although breeding density is much higher in the rural than in the urban population. However, breeding success in the second clutches tend to be higher in urban than in rural population.

Key words: Barn Swallow, *Hirundo rustica*, Poland, ecology, synurbanisation, clutch size, breeding success.

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Плотность населения, места гнездования и успешность размножения деревенской ласточки в городских местообитаниях на юго-западе Польши. - Ю. Нижиньска-Бубель, Г. Копий. - Беркут. 16 (2). 2007. - Исследования проводились в г. Вроцлав в 2005–2006 гг. Плотность гнездования ласточек увеличивалась вдоль градиента урбанизации: они вообще не гнездились в центре города, во внутренних участках старой плотной застройки плотность составляла от 0,0 до 0,1 пар/10 га, во внешних участках застройки – 0,1–1,0 пар/10 га и от 4,0 до 28 пар/10 га в селах вокруг города. 25,4 % гнезд найдено в конюшнях, 25,0 % – в домах, 14,4 % – в свинарниках, 11,0 % – в навесах, 9,0 % – в птичниках, 12,5 % – в других местах (n = 201 гнездо). Гнезда обычно прикреплялись к углу, образованному стеной и потолком (56,0 %), или к бревну под крышей (31,5 %) (n = 184). Из 135 гнезд, возраст которых был известен, 17,8 % были однолетними, 8,1 % – двухлетними, 74,1 % – более старыми. Средний размер кладки – 4,78 (n = 184). Первые кладки (x = 4.80; n = 132) были несколько больше, чем вторые (x = 4.73; n = 52). Для первых кладок успешность вылупления составляла 76,5 %, успешность выкармливания – 89,3 %. Для вторых эти показатели были несколько выше – 83,3 % и 93,2 % соответственно. По сравнению с сельскими популяциями ласточек, в городской средний размер кладки и общая успешность размножения были сходными, но во вторых выводках успешность размножения была несколько выше.

The Barn Swallow (*Hirundo rustica*) is a common and almost cosmopolitan bird species strictly associated with human settlements since the Pleistocene (Weiner, 1967; Cramp, 1988). In Europe, it prefers farmlands, with arable fields, meadows and pastures grazed by cattle, sheep and horses, around farm buildings (barns, stables, cowsheds, pig-sheds etc.), where it nests (Cramp, 1988). In and around larger towns, such habitats are often transformed into townships, industry areas and suburb settlements, becoming no longer suitable for Barn Swallows. It should be, however, stressed that in the Middle East and in North Africa Barn Swallows are equally common in rural and urban areas (Turner, 1994; Sakraoui et al., 2005). In most larger towns in Europe, especially in those which rapidly expand, breeding population of the Barn Swallow are usually in decline (Dyrcz et al., 1991; Kuźniak, 2000), although they sometimes develop special adaptations for nesting is such places as bridges, viaducts (Dyrcz et al., 1991; Stawarczyk, Tomiałojć, 2003), gates of old build-

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ings, industry halls or store-houses (Kuźniak, 2000).

There is a substantial body of literature devoted to the breeding ecology of Barn Swallows (Vietinghoff-Riesch, 1955; Kuźniak, 1967; Grzybowski, 1979; Glutz von Blotzheim, 1985; Cramp, 1988; Lorek, 1992; Turner, 1994; Abramciów, Kopij, 1997; Bańbura, Zieliński, 1998), but the literature refers to their main habitats in farmlands around villages and small towns. Much less is known about breeding ecology of this species inhabiting larger towns and cities. To date such studies were only conducted on populations breeding in Baghdad, Iraq (Al-Rawy, George, 1966) and Annaba, Algeria (Sakraoui et al., 2005).

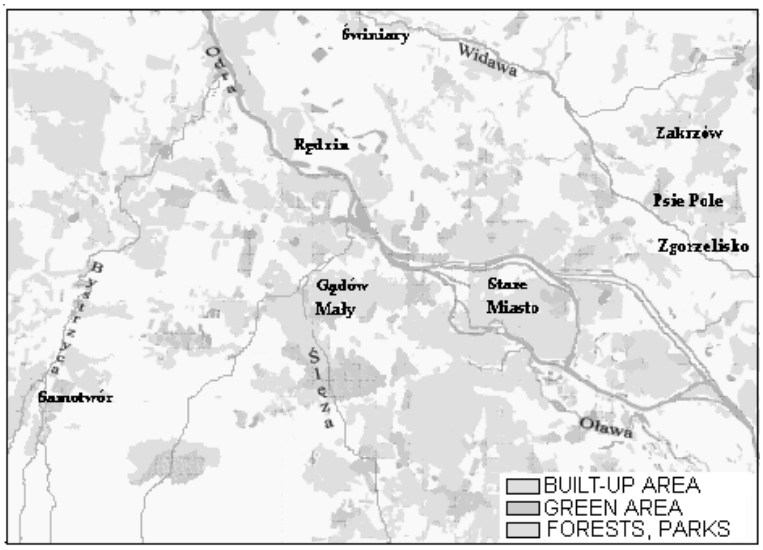

Fig. 1. The map of the city of Wrocław with eight study plots.
Рис. 1. Карта Вроцлава с 8 пробными участками.

The aim of this study is to investigate breeding densities, nesting sites, clutch size and breeding success in the Barn Swallows along an urban gradient in a large Central European city. Special attention was paid to the comparison of these parameters between the first and the second clutches and along an urban gradient: from the city centre towards its periphery.

STUDY AREA

Studies were conducted in the following districts of the city of Wrocław: Rędzin, Świniary, Stare Miasto, Psie Pole, Zgorzelisko, Zakrzów, Osobowice, Gądów Mały and in the nearby village Samotwór (Fig. 1).

The surface of built-up area of the Rędzin district is 22.1 ha. It is typical rural settlement, with old farm buildings. The farming activities include cultivations of agricultural plants and breeding the pigs, goats, horses and poultry (no cattle and sheep). The Świniary district is a mixture of farm and suburb buildings. The surface of built-up area is c. 30 ha. Farming activity is low and includes breeding the poultry and two cows only. There is also a stud on the outskirt of this settlement. A part of the Osobowice district, 22.4 ha in surface, was designed for the purpose of this study. This is a built-up area, with mostly old tenement-houses. The area borders with a forest to the west, polders to the north and the Oder River to the south. The Psie Pole (38.6 ha) and Zgorzelisko (68.4 ha) districts are situated in the Widawa River valley. The built-up area consists of both old and new houses as well as low and high block buildings. The Zakrzów district, c. 200 ha in surface, is surrounded by industry area on one side and by arable fields on the other side. The built-up area consists mainly old and new houses and two high block-buildings (10-stories). The Gądów Mały district is 148.5 ha in surface. The built-up area is dominated by block-buildings (both 4- and 10-stories). The densely built-up area of the Stare Miasto district (147.5 ha) consists a poor natural environment, with mostly old tenement-

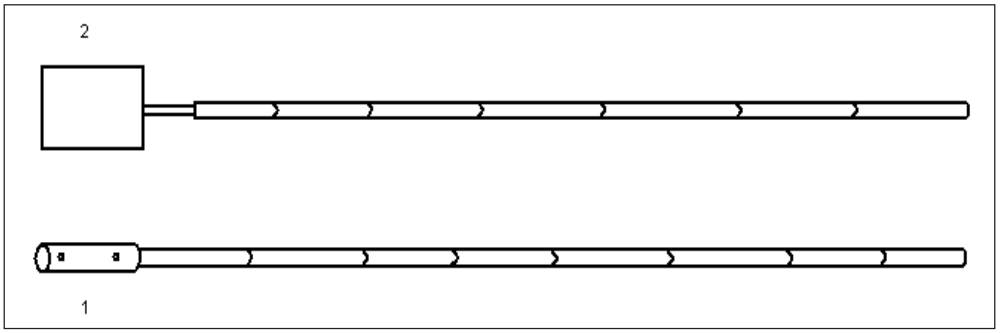

Fig. 2. A tool used to check nest contents. 1 – bamboo stick with a metal bonding bar; 2 – bamboo stick with a trowel with a fixed mirror.
Рис. 2. Инструмент, использовавшийся для проверки содержимого гнезд. 1 – бамбуковый прут с металлической соединительной планкой; 2 – бамбуковый прут с укрепленным зеркалом.

houses. The Samotwór is a village with c. 240 inhabitants situated in the Bystrzyca River valley. The built-up area, 7 ha in surface, is surrounded by arable fields, meadows and forests. The farming activity in the village is very low and confined to breeding the poultry.

METHODS

Studies were carried out during the years 2005–2006. Nests were checked on a two-week basis beginning from their arrival from Africa to hatching, and on a weekly basis after hatching.

For the estimation of population density, all occupied nests were located, i.e. those which were renewed, at which birds performed breeding activities, and all nests containing eggs and chicks. The number of occupied nests located in inaccessible places was estimated counting singing males around those places and birds flying out/into the places.

The clutch was assumed to be full if the number of eggs laid did not change in two following surveys and when eggs were incubated. To determine breeding losses, farmers were interviewed.

Breeding success has been defined as the percentage of fledglings to eggs laid. Hatching success – the percentage of hatchlings to eggs laid; fledgling success – the percentage of fledglings to hatchlings; nesting success – the percentage of nests with fledglings to nests with eggs.

Each nest was classified as occupied or unoccupied. Unoccupied was the nest, which was not used by birds in a given breeding season. Cases of an adoption by Barn Swallow nests by other bird species were also recorded. If nest was accessible its content was checked. For each nest found the following parameters were determined: character and approximate age of building; kind of animals bred in these buildings if any; nesting site, its exposition and height above the ground; wall material to which the nest was attached; a distance from the neighboring nest and the colony size. Distances were measured to the nearest 0.5 m.

The colony was assumed to be formed by nests within a given village or other human settlement, while the sub-colony was to be formed by nests located in buildings within one farmstead. Nest content was usually checked using a 12 x 18 cm mirror fixed to a 1.37 m bamboo pole (Fig. 2).

RESULTS

Breeding densities were estimated for the year 2006 only: Rędzin – 28 pairs/10 ha, Świniary – c. 9 pairs/10 ha, Samotwór – 47 pairs/10 ha, Osobowice – 4 pairs/10 ha, Psie Pole –

1 pair/10 ha and no pairs in Stare Miasto, Zgorzelisko and Gądów Mały. In village areas the overall density was 20.5 pairs/10 ha, while in suburb areas it was only 0.2 pairs/10 ha. A total of 201 nests were found in the study areas, i.e. 88 nests in Rędzin, 44 nests in Świniary, 14 nests in Osobowice and 18 nests in Psie Pole. No nests were found in the densely built-up area of Stare Miasto (city centre) and in the suburbs of Gądów Mały and Zgorzelisko (block-buildings). For Rędzin and Świniary the numbers have been estimated, while in other settlement the absolute numbers are given.

Table 1

Distances between Barn Swallow nests in various areas in the city of Wrocław (m)
Расстояния между гнездами деревенской ласточки в различных участках Вроцлава (м)

Area	Mean	SD	Range	% of connected nests	Number of nests
Świniary	1.6	2.5	0 – 5	6.1	33
Rędzin	1.7	2.5	0 – 15	6.1	82
Samotwór	4.8	3.7	0 – 10	5.4	37
Psie Pole	2.1	1.4	0 – 5	11.2	18
Osobowice	3.3	2.7	0 – 10	14.3	14
Total	2.1	2.4	0 – 15	7.1	184

In all study plots, eight colonies were located. They ranged in size from 4 to 62. The average colony size was 16.6 nests. The distance between a colony and the nearest water ranged from 180 to 918 m; on average 460.2 m. The distance between nests ranged form 0 to 15 m and nests attached to each other comprised 5–14 % of all nests in particular colony (Table 1).

The nest height above the ground varied from 1.5 to 10 m ($\bar{x}$ = 2.4 ± 2.3 m; n = 184); for nests in village areas $\bar{x}$ = 4.5 m (± 2.4 m; n = 152; range 1.5–10 m), while for nests in suburb areas $\bar{x}$ = 4.7 m (± 2.2 m; n = 32; range 2–8 m).

Barn Swallows nested in all kind of farm buildings such as stables (25.4 %), human houses (25.0 %), pigsties (14.4 %), sheds (11.0 %), poultry-houses (9.0 %), ware-houses (4.5 %), cow-sheds (4.0 %), garages (3.0 %), goat-houses (1.0 %), disused school (1.0 %), barns (0.5 %) (n = 201 nests).

Nests were usually attached to an angle formed by the wall squared with the ceiling (56.0 %) or to a log under the roof (31.5 %); 4.3 % placed nests around the lamp, 3.3 % were supported by a metal abutment specially constructed by farmers, and 2.7 % in switch board (n = 184 nests). Most nests were attached to the concrete plaster (49.0 %) and to the woody surface (36.0 %) while the remaining to metal surface (9.7 %), bricks (2.7 %), plastic surface (2.6 %) (n = 184 nests).

Out of 135 nests, which were aged, 17.8 % were one-year old, 8.1 % two-year old and 74.1 % were more than two-year old. Most nests were exposed to the north (29 %) or south

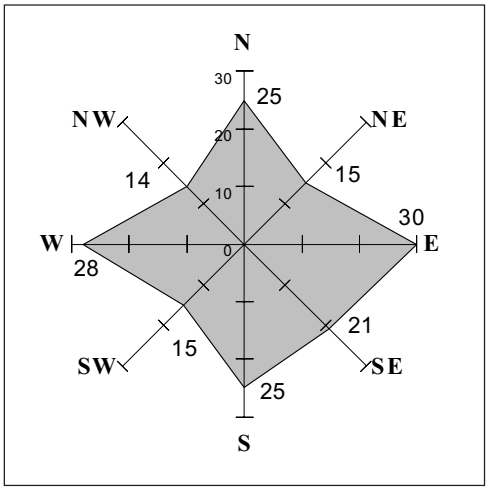

Fig. 3. The exposition of Barn Swallow nests (n = 184 nests). 11 open nests are excluded as they had no clear exposition.
Рис. 4. Экспозиция гнезд деревенской ласточки.

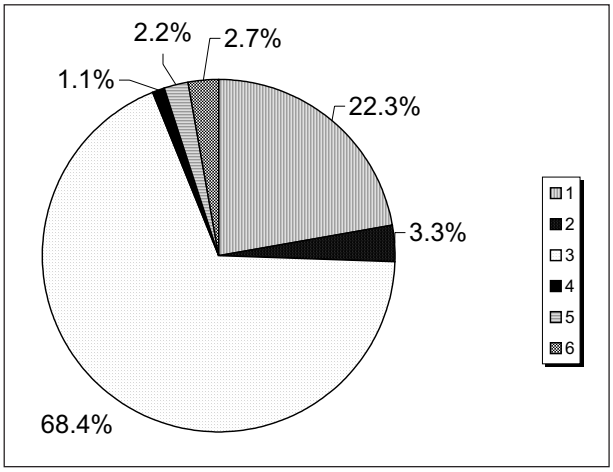

Fig. 4. Manners of nest occupation (n = 184 nests) in 2006. 1 – not occupied, 2 – occupied for one brood only, 3 – occupied for two broods, 4 – occupied by other bird species, 5 – destroyed by man, 6 – ruptured.
Рис. 4. Способы занятия гнезд в 2006 г.

(34 %), less to the east (16 %) and west (15 %) (Fig. 3).

In village areas, 21.1 % of nests were not occupied by swallows; in 44.7 % of them one brood was recorded, while two broods were recorded in 34.2 % of these nests (n = 152 nests). In suburb areas, 62.5 % of nests were not used and no nests with two broods was recorded (n = 32 nests). Two nests in village areas were adopted by the Black Redstart (*Phoenicurus ochruros*) (Fig. 4)

Clutch size varied from 1 to 8 and the most frequent clutches comprised five eggs (Fig. 5). The overall mean clutch size in all sites was 4.78 (n = 184 nests), being slightly higher for the first clutches ($\bar{x}$ = 4.80; n = 132) than for the second clutches ($\bar{x}$ = 4.73; n = 52). The mean of the size of first clutches varied markedly from 4.00 to 5.85 between sites, while for the second clutches the mean value varied only slightly from 4.55 to 4.76 (Tables 2 and 3).

For the first clutches, hatching success was 76.5 %, while fledgling success – 89.3 %. For the second clutches these parameters were higher: 83.3 % and 93.2 % respectively. In particular colonies hatching success ranged from 68.1 % in Świniary to 82.9 % in Rędzin; while fledgling success ranged from 86.7 % in Psie Pole to 96.2% in Osobowice. Nesting success ranged from 87.5% (Osobowice) to 100 % (Psie Pole). Overall reproductive success was the lowest in Świniary and Psie Pole (63.4 % and 65.0 % respectively) and the highest in Osobowice (78.1 %) (Tables 2 and 3).

The average number of hatchlings per occupied nest was 3.7 for the first brood and 3.9 for the second brood (altogether 3.7) in all study plots (n = 132 nests). The average number of fledglings per occupied nest was 3.3 for the first brood and 3.7 for the second brood (altogether 3.4) in all study plots (n = 132 nests) (Tables 2 and 3).

DISCUSSION

In the centre of Polish cities breeding densities of Barn Swallows fall usually below 1

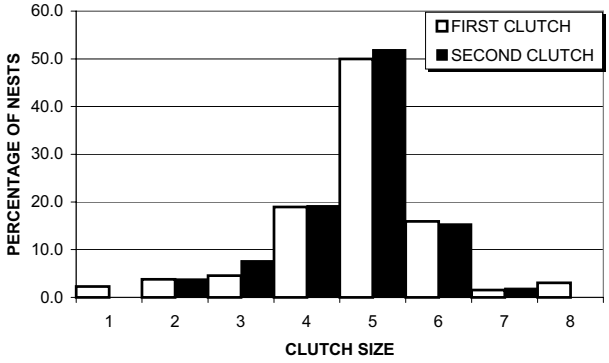

Fig. 5. First (n = 132) and second (n = 52) clutches in the Barn Swallow.
Рис. 5. Первая (n = 132) и вторая (n = 52) кладки у деревенской ласточки.

pair per 10 ha of built-up area, e.g. Warsaw: 0.02–0.03 pair/10 ha (Nowicki, 2001), Wrocław: 0.07 pair/10 ha (Kopij, 2005), Gliwice: 0.6 pair/10 ha (Dyrcz et al., 1991), Leszno: 0.8–0.9 pair/10 ha (Kuźniak, 1996), Nysa: 1.5 pairs/10 ha (Kopij, 2006b). A general tendency is evident that the larger the city the lower is breeding density of the Barn Swallow in its centre. In cities of other European countries the breeding densities are similarly low (Turner, 1994). For the contrast, breeding densities in Polish villages are usually very high, often exceeding 100 pairs/ha of built up area (Dyrcz et al., 1991; Abramciów, Kopij, 1995; Bednorz et al., 2000; Tomiałojć, Stawarczyk, 2003). Moreover, the Barn Swallow is dominant bird species in most villages studied so far (Kopij, 2004).

In the city of Wrocław, breeding densities of Barn Swallows increase along urban gradient: it does not breed in the city centre at all (Kopij, 2006a, 2007 and this study), the density varies from 0.0 to 0.1 pairs/10 ha in old densely built-up areas in the inner part (Kopij, 2005, 2007; this study), and it varies from 0.1 to 1.0 pairs/10 ha in built up areas in outer parts of the city (Kopij, 2004a, 2004b; this study) and from 4.0 to 28 pairs/10 ha in villages around the city (this study). Similar tendency has been evidenced in Warsaw (Luniak et al., 2001). The decrease of breeding densities of the Barn Swallow towards city centers is probably caused by scarcity of suitable nesting sites rather than deteriorating food resources. The related House Martin (*Delichon urbica*), which prey on similar insects, is often a common breeder in inner parts of large cities, where it can easily adopt block-buildings as nesting sites (Kopij, 2004b, 2005, 2007; Niżyńska-Bubel, Kopij, in press).

Both in urban and rural areas, Barn Swallows show a clear tendency to locate nests inside farm buildings, especially pigsties, and cowsheds (Kuźniak, 1967; Lorek, 1992; Abramciów, Kopij, 1997). However, in the urban area due to the scarcity of such buildings Barn Swallows adopt as nesting sites more frequently houses, garages, sheds and similar constructions.

Table 2

Number of eggs, hatchlings and fledglings of Barn Swallows in various areas in the city of Wrocław
Количество яиц, вылупившихся птенцов и слетков у деревенских ласточек в различных участках Вроцлава

Parameters	First clutch	Second clutch	Total
Rędzin			
Number of eggs laid	286	100	386
Number of hatchlings	237	90	327
Number of fledglings	199	83	282
Number of nests	64	22	
Świniary			
Number of eggs laid	152	61	213
Number of hatchlings	96	49	145
Number of fledglings	88	47	135
Number of nests	26	13	
Samotwór			
Number of eggs laid	143	81	224
Number of hatchlings	110	66	176
Number of fledglings	107	61	168
Number of nests	30	17	
Osobowice			
Number of eggs laid	32	0	32
Number of hatchlings	26	0	26
Number of fledglings	25	0	25
Number of nests	8	0	
Psie Pole			
Number of eggs laid	20	0	20
Number of hatchlings	15	0	15
Number of fledglings	13	0	13
Number of nests	4	0	
Total			
Number of eggs laid	633	246	879
Number of hatchlings	484	205	689
Number of fledglings	432	191	623
Number of nests	132	52	184

Table 3

Clutch size and breeding success in the Barn Swallow in various areas of the city of Wrocław
Размер кладки и успешность размножения у деревенских ласточек в различных участках Вроцлава

Parameters	First clutch	Second clutch	Total
Rędzin			
Hatching success	82.9	90.0	84.7
Fledgling success	84.0	92.2	86.2
Reproductive success	69.6	83.0	73.1
Nesting success	95.3	100.0	96.5
Świniary			
Hatching success	63.2	80.3	64.7
Fledgling success	91.7	95.9	93.1
Reproductive success	57.9	77.0	63.4
Nesting success	92.3	100.0	94.9
Samotwór			
Hatching success	76.9	81.5	78.6
Fledgling success	97.3	92.4	95.5
Reproductive success	74.8	75.3	75.0
Nesting success	93.3	100.0	95.7
Osobowice			
Hatching success	81.2	0.0	81.2
Fledgling success	96.1	0.0	96.1
Reproductive success	78.1	0.0	78.1
Nesting success	87.5	0.0	87.5
Psie Pole			
Hatching success	75.0	0.0	75.0
Fledgling success	86.7	0.0	86.7
Reproductive success	65.0	0.0	65.0
Nesting success	100.0	0.0	100.0
Total			
Hatching success	76.5	83.3	78.4
Fledgling success	89.2	93.2	90.4
Reproductive success	68.2	77.6	70.8
Nesting success	93.9	100.0	95.7

In Polish villages, the mean size of first clutches (4.7–4.9) in the Barn Swallow (Nitecki, 1964; Lorek, 1992; Bańbura, Zieliński, 1998) does not differ from that recorded in the city of Wrocław (4.8; this study). Also the mean size of second clutches varies slightly from 4.5 to 4.7 (Nitecki, 1964; Lorek 1992; Bańbura, Zieliński, 1998 and this study) in all these sites. In the southern Palearctic Region, the mean size of first clutches was similar to that recorded in Poland (Al-Rawy, Georg, 1966; De Lope, 1983; Sakraoui et al., 2005), but the mean value for the second clutch appears to be lower (3.2–4.6). Moreover, the mean value of the first clutches in comparison with that of the second clutches is statistically higher in the southern Palearctic Region, while in the city of Wrocław these means don't differ significantly.

The average number of hatchlings per occupied nest is slightly lower in the city (3.7; this study) than in villages (3.9–4.4; Nitecki, 1964; Lorek, 1992). On the other hand the average number of fledglings per occupied nest is not so much dependent on habitat type (Lorek, 1992; Nitecki, 1992; Abramciów, Kopij, 1997; this study), as it depends probably more on prevailing weather conditions (Nitecki, 1964). Under same weather conditions the average number of fledglings per breeding pair is probably higher in villages than in urban habitats, but this has not been evidenced so far.

In the urban population of the Barn Swallow in Wrocław, hatchling and fledgling success were higher for the second clutches than for the first clutches. However, in rural populations the reverse was true (Nitecki, 1964; Lorek, 1992; Bańbura, Zieliński, 1998). In rural area of Canada the same trend was shown (Safran, 2006). Even in an urban population in a large city of Annaba, Algeria, all the parameters of breeding success were higher for the first than in the second clutches (Sakraoui et al., 2005). Since mean clutch size is slightly higher in first than in second clutches, feeding conditions are probably better for the second than for first brood in the city of Wrocław. How-

ever, the feeding conditions may deteriorate with the advance of summer in the southern Palearctic Region, probably as a result of decrease in humidity (Sakraoui et al., 2005).

In conclusion, it should be pointed out that in Poland the mean clutch size and overall breeding success in urban population of the Barn Swallow are, in general, similar to these in rural population, although breeding density is much higher in the rural than in the urban population. However, breeding success in the second clutches tend to be higher in urban than for rural population.

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