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Diet variability of Syrian Woodpecker *Dendrocopos syriacus* nestlings in the rural landscape of SE Poland

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Abstract. The Syrian Woodpecker has expanded in Central Europe in the 20th century. The knowledge about nestling diet may allow better understanding on the colonisation process of anthropogenic tree stands by this species. In 2003-2006, we studied the nestlings' diet composition and feeding frequency of 11 Syrian Woodpecker broods in SE Poland. The time nestlings spent in the nest was divided into six five-day intervals (pentads). Two four-hour observations were conducted during each pentad, and then the average number of feedings per one nestling in a clutch in 1 hour was calculated. Nestlings received food of animal origin more often - 1.70 feedings/1 nestling/1 hour, than of plant origin - 0.52 plant feedings/1 nestling/1 hour (proportion of 76.6 % and 23.4 % respectively). The birds fed their nestlings mainly *Lepidoptera* butterfly caterpillars, then the larvae of *Coleoptera* beetles, Cockchafers *Melolontha melolontha* and other arthropods (average of 0.70, 0.28, 0.15 and 0.57 feedings/1 nestling/1 hour, respectively). Between the first and sixth pentad of nestling life, the proportion of plant food in the diet increased from 1.6 % to 33.3 %. This most often consisted of walnuts *Juglans regia* and cherry *Prunus avium* or sour cherry *Prunus cerasus* fruits (average of 0.34 and 0.17 feedings/1 nestling/1 hour respectively). Individual broods were fed various foods and the diet varied according to the nestling growth. Dietary opportunism allows the Syrian Woodpeckers to produce broods in anthropogenic woodlots in Central Europe.

Key words: broods feeding, dietary opportunism, primary hole nesters, afforestations

Introduction

The Syrian Woodpecker *Dendrocopos syriacus* has colonized much of Europe in the 20th century (Cramp 1985). The colonization of new area is actually proceeding dynamically on the east part of Europe, mainly on Russia territory (Zavialov et al. 2008, Michalczuk 2014). In the last three decades, it has also populated and expanded to south-east Poland (Tomiałojć & Stawarczyk 2003), becoming a moderately numerous breeding species in the region (Michalczuk & Michalczuk 2006, Michalczuk 2014, 2015). This species avoids dense forests, preferring anthropogenic tree stands (Glutz von Blotzheim & Bauer 1980, Cramp 1985, Aghanajafizadeh et al. 2011, Michalczuk & Michalczuk 2011, Fröhlich & Ciach 2013, Michalczuk & Michalczuk 2016c, 2016d, 2016e). Probably Syrian Woodpecker can inhabit afforestations because its foraging behavior and diet which are highly variable (Glutz von Blotzheim & Bauer 1980, Cramp 1985). Diet opportunism, which is characteristic for many birds species colonizing new habitats and areas (e.g. Skórka et al. 2005, Neubauer et al. 2006, Skórka & Wójcik 2008, Lill & Hales 2015), may determine the success of Syrian Woodpecker in the colonization of anthropogenic habitats. This species feed mainly on items of animal origin, such as insects, for example, *Melolontha melolontha* beetles, *Lepidoptera* butterfly caterpillars and arachnids *Arachnida* (Szlivka 1962, Ruge 1969, Marisova & Butenko 1976). The birds also feed on food of plant origin. Often these are fruits, such as walnuts *Juglans regia*, the fruits and seeds of cherry *Prunus avium*, sour cherry *Cerasus* sp. and plum *Prunus* species, which are eaten mainly in autumn and winter (Stevanović 1960, Szlivka 1962, Winkler 1973, Marisova 1965). Syrian Woodpeckers also feed their nestlings plant items (Szlivka 1962, Winkler 1972, Mitjaj 1986), which distinguishes this species from other European woodpeckers that feed their young only animal food (Glutz von Blotzheim & Bauer 1980, Cramp 1985).

The aim of this study was to define the composition and seasonal variability of Syrian Woodpecker nestlings' diet in rural landscape of SE Poland.

Material and methods

Study area

The study was conducted in the agricultural landscape of south-eastern Poland approximately 10 km west of the

border with Ukraine (50°28 'N, 23 °40'E). This area (approximately 305 km²) is characterized by gentle hills in the range of 195 to 263 m above sea level (Kondracki 2000). Crops (71%) and grassland (11%) prevail here, small forests represent 4% of the area and usually are of hornbeam complexes, with a substantial share of Common Hornbeam *Carpinus betulus* and Oak *Quercus* spp. or pine forests with a predominance of Scots Pine *Pinus sylvestris*. The tree cover of built-up areas occupies 14% of the total study area. These are comprised mostly of tree clumps, shaded avenues, hedgerows and parks, dominated by Willow *Salix* spp., Poplar *Populus* spp., Maple *Acer* spp. and Ash *Fraxinus* spp. as well as the fruit trees growing in preferred orchards: Apple *Malus domestica*, Sour Cherry *Prunus cerasus*, Plum *Prunus* spp. and Walnut *Juglans regia*. Conifers are rarely found in the built-up areas, represented by Spruce *Picea* spp., Larch *Larix* spp. or Pine *Pinus* spp. There were about 30-50 pairs of Syrian Woodpeckers breeding in the study area (Michalczuk & Michalczuk 2006, 2015, 2016c).

Observing the feedings of nestlings

The study was conducted from May to July in 2003-2006. The research was conducted on 11 nests (max. 3 nests per year). Observations were made of nestling feeding near the nest holes using 10x50 binoculars and a 30x50 spotting scope or photo and video cameras. Broods were observed while hiding, sometimes even only a few meters from the nest hole during the 6 pentads (five-day periods), which is equal to the time nestlings remain in the nest (about 26 days, Holzer & Holzer 1982, Al-Safadi 2004, Mersten-Katz et al. 2012, Michalczuk & Michalczuk 2016a, 2016b). Two cycles of observations lasting four hours each were conducted during each pentads. The scope of one observation included morning feedings from dawn (approximately 4:00) to about 8:00. The second observation included afternoon feedings, most often on a different day in a given pentad, from about 16:00 to the evening hours (around 20:00). Such a distribution of observations enabled us to capture the variation in the intensity of feedings associated with the time of day and the development of nestlings. In order to determine the number of nestlings in the broods we have checked study holes. For each brood feeding sample, the average number of feedings per one nestling in the clutch during one hour was calculated. For this purpose, the number of recorded feedings was divided by the four hours of observation and the number of nestlings in the clutch. The feeding rate was presented in the form of No. of feedings per hour and nestling were used to compare the feeding intensity for different categories of food in successive pentads of nestlings' life. Information was obtained for a total of 11 independent nests (from 2 up to 5 nestlings in a brood) on 4315 feedings, in a range of from 234 to 589 feedings per brood.

Analysis of nestlings' diet

In the course of observing the intensity of feedings, the type of food supplied to the nestlings was also recorded. First, plant and animal food was distinguished from the items brought by the adults. Animal food was further divided into 4 groups of clearly identifiable food items. Representing animal food were: larvae - mostly *Coleoptera* beetles, *Lepidoptera* butterfly caterpillars (larvae), Cockchafer beetles *Melolontha melolontha* and "other arthropods". The last group was comprised mainly of the adult forms of many insect species that were difficult to identify because they were shredded at an anvil or of small size, such as aphids. Plant food was divided into 3 groups: Walnut *Juglans regia*, Cherry *Prunus avium* or Sour Cherry *Prunus cerasus*, and "other", which included other plant items such as flower petals. In many cases, adult birds were observed at foraging areas, such as anvils or anthills, in order to identify the food brought to nestlings. It was easy to define because in many cases the foraging sites were located near the nest holes.

Statistical analysis

To assess the variability of nestling diet, the intensity of feeding of the particular components was evaluated in particular broods. The same approach was made while assessing the nestling growth. In this case, the intensity of feeding in the next pentads was assessed. In order to do this, we used Kruskall-Wallis or one-way ANOVA test (respectively with the Dunn and Tukey post hoc test). To compare the general feeding frequency of animal and plant foods or to compare within the particular broods the U Mann-Whitney test or Student's t-test was used. The parametric tests were used if data had normal distribution or non-parametric ones were used if data had not normal distribution. The statistical analysis was carried out using the StatisticaSoft 7.1 Pl package. All statistical differences were adopted at a significance level equal or less than 0.05.

Results

The feeding intensity

The average provision rate was 2.22 and was ranged from 1.43 up to 3.74 (Table 1). The first pentad of life exhibited the lowest intensity of feedings, with about 1.10 feedings (Table 2). The intensity of feedings increased significantly in the third pentad of life (post hoc Dunn test $p < 0.001$). No significant changes in feeding intensity were found in the remaining pentads (Table 2).

The diet of animal origin

Syrian Woodpeckers provide their nestlings mostly with food of animal origin - 1.70 (Table 1). In the first pentad of life, the average frequency of administered feedings of animal food was the smallest and amounted to an average of 1.08. In the third pentad, this increased significantly to 2.01 (Dunn test $p < 0.05$) and remained at a similar level until fledging fluctuated (Table 2). Distinct

Table 1. Feeding frequency of nestlings with different categories of food (the average number of feedings / nestling /hour, n = 11 broods) for individual Syrian Woodpecker broods in 2003-2006. Key: H – Kruskal-Wallis test, F – one-way ANOVA.

	feeding frequency		
Diet components	average	range in particular broods (min.-max.)	statistical test
butterfly caterpillars Lepidoptera	0.70	0.21-2.11	$F_{10.55}$=5.34, P<0.001
larva of beetles Coleoptera	0.28	0.17-0.40	$H_{10.66}$=7.78, ns
Cockchafers imagines *Melolontha melolontha*	0.15	0.00-0.72	$H_{5.36}$=14.84, P=0.011
other Arthropods	0.58	0.28-0.99	$H_{10.66}$=19.84, ns
animal components together	1.70	1.09-3.37	$F_{10.55}$=5.99, P<0.001
flesh of Walnuts *Juglans regia*	0.34	0.05-0.75	$H_{10.66}$=27.04, P=0.003
Cherries *Prunus avium* and Sour Cherries *Prunus cerasus*	0.17	0.02-0.58	$H_{10.66}$=17.95, ns
other plants	0.01	0.00-0.06	$H_{5.36}$=1.61, ns
plant components together	0.52	0.07-1.21	$H_{10.66}$=20.26, P=0.003
Total	2.22	1.43-3.74	$F_{10.55}$=3.08, P=0.035

Table 2. Average frequency of providing various categories of food (the average number of feedings / nestling /hour, n = 11 broods) in particular pentads of Syrian Woodpecker nestling life in 2003-2006. The far right column shows if feeding frequency differed between pentads, while the bottom row shows if the feeding frequency of animal and plant items differed within a pentad. Key: in parentheses standard deviation, H – Kruskal-Wallis test, F – one-way ANOVA.

	pentads of Syrian Woodpecker nestling life						statistical
diet components	I	II	III	IV	V	VI	test
butterfly caterpillars Lepidoptera	0.15	0.59	0.89	0.96	0.88	0.73	$H_{5,66}$=22.59
	(0.18)	(0.36)	(0.53)	(0.73)	(1.07)	(0.87)	P<0.001
larva of beetles Coleoptera	0.57	0.38	0.26	0.16	0.11	0.17	$H_{5.66}$=29.53
	(0.26)	(0.23)	(0.15)	(0.12)	(0.11)	(0.14)	P<0.001
Cockchafers imagines	0.00	0.06	0.21	0.19	0.26	0.19	$H_{4,55}$=0.76
Melolontha melolontha	-	(0.10)	(0.49)	(0.42)	(0.55)	(0.28)	ns
other Arthoropds	0.37	0.58	0.64	0.60	0.58	0.68	$H_{5.66}$=5.37
	(0.18)	(0.32)	(0.38)	(0.34)	(0.33)	(0.52)	ns
animal components together*	1.08	1.61	2.01	1.92	1.83	1.73	$H_{5.66}$=15.66
	(0.24)	(0.44)	(0.60)	(0.85)	(1.10)	(1.29)	P=0.008
flesh of Walnuts	0.01	0.25	0.46	0.46	0.48	0.36	$H_{5.66}$=19.60
Juglans regia	(0.04)	(0.27)	(0.37)	(0.45)	(0.48)	(0.27)	P=0.002
Cherries *Prunus avium*	0.00	0.04	0.10	0.17	0.41	0.28	$H_{4.55}$=15.91
and Sour Cherries *Prunus cerasus*	-	(0.09)	(0.13)	(0.22)	(0.48)	(0.25)	P=0.003
other plants	0.00	0.00	0.02	0.01	0.01	0.04	$H_{4.55}$=3.85
	(0.01)	-	(0.03)	(0.02)	(0.03)	(0.10)	ns
plant components together**	0.02	0.29	0.58	0.65	0.91	0.69	$H_{5.66}$=31.38
	(0.04)	(0.31)	(0.40)	(0.48)	(0.66)	(0.43)	P<0.001
Total	1.10	1.90	2.59	2.56	2.74	2.42	$F_{5.60}$=5.68
	(0.23)	(0.42)	(0.55)	(0.99)	(1.32)	(1.26)	P<0.001
Mann-Whitney U test *vs**	Z=3.97	Z=3.97	Z=3.77	Z=3.48	Z=2.33	Z=2.72	
	P<0.001	P<0.001	P<0.001	P<0.001	P=0.020	P=0.006	

differences in the feeding intensity of animal food were noticed among pairs (Table 1).

The intensity of feeding different categories of animal food also varied statistically (one-way ANOVA, $F_{3,44}$ = 20.76, p = 0.001). Nestlings were mostly fed *Lepidoptera* butterfly caterpillars, which accounted for 31.5% of their diet (Table 1). The intensity of caterpillar feeding increased significantly in the third pentad of nestling life (Dunn test p < 0.032, Table 2) from 13.3% up to 35.6% feedings share (Fig. 1). It remained at the same level until fledging. The intensity of caterpillar feeding was statistical higher in one brood in 2004 (Dunn test p < 0.006, Table 1).

Breeding pairs also fed their young *Coleoptera* beetle larvae, which accounted for approximately 12.6% of their diet. From the first pentad to the fourth pentad of nestling life, the intensity of lar-

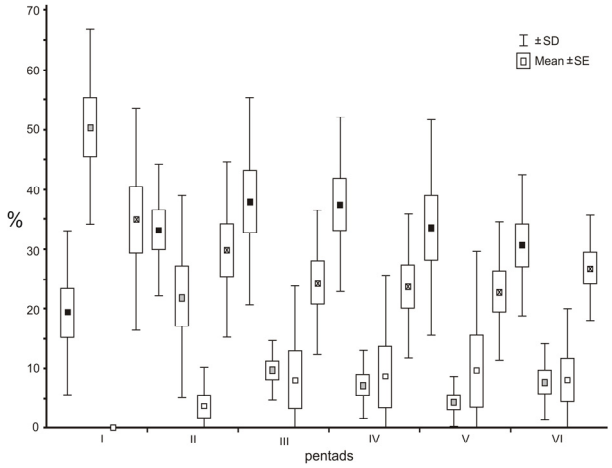

Figure 1. The seasonal variability in the animal origin food in the diet of Syrian Woodpecker nestlings in successive pentads of their lives (n=11 broods). Key: black - butterfly caterpillars Lepidoptera, grey - larva of beetles Coleoptera, white - Cockchafers imagines *Melolontha melolontha*, x-mark - other Arthropods.

vae feedings decreased significantly (Dunn test $p < 0.023$, Table 2) from 50.3% down to 4.4% feedings share (Fig. 1). The intensity of the feedings for this food item for each pair was not statistically significant (Table 1).

To a lesser extent, breeding pairs fed adult Cockchafer beetles to their nestlings, whose share was 6.8%. Some pairs never fed their young adult beetles, for example, in 2003 and 2004, but in the last two years, especially in 2006, the frequency of providing beetles to nestlings increased significantly (Dunn test $p < 0.05$, Table 1). There were no statistical differences in the feeding intensity of this dietary component for any pentad of nestling life (Table 2). In the first pentad, adults did not feed their nestlings beetles (Fig. 1), and the maximum quantities were brought in the fifth pentad – about 9.5% feedings (Table 2, Fig. 1).

The remaining proportion of animal food consisted of "other arthropods", whose share averaged 25.7% (with a range of 22.9% to 39.1%, Fig. 1). There were no statistically differences in the feeding intensity for this type of food among individual pairs (Table 1). The feeding intensity of this item was the smallest in the first pentad of nestling life, and the greatest before their departure from the nest but there were not statistically differences (Table 2).

The diet of plant origin

Plant food accounted for 23.4 % of the total feedings provided to nestlings by adults. However, the share of this category of food for each pair was quite variable and ranged from 4% to 44%. The feeding intensity of plant items was lower than the feeding frequency of animal items (t-Student test, $t = 6.24$, $p < 0.001$, Table 1). In the case of two pairs, the feeding frequency of these two components of food items did not differ significantly.For the other nine broods significant differences were detected (for all these cases t-Student test, $t \geq 2.67$, $p < 0.025$), The feeding frequency of plant items was lowest in the first pentad of nestling life. It was representing 1.6 % of the food items provided to young at this time (Fig. 2). As the nestlings grew, the feeding frequency of plant food items significantly increased to the fifth pentad their lives (Dunn test $p < 0.018$, Table 2). The proportion of this dietary item at that time increased to a level of 31-32% (Fig. 2), but it was found that the proportion for some broods was even 64% of the feedings

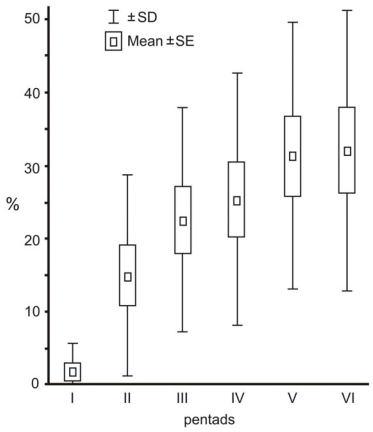

Figure 2. The seasonal variability in the plant origin food in the diet of Syrian Woodpecker nestlings in successive pentads of their lives (n=11 broods)

provided by breeding pairs. In all pentads of nestling life the feeding frequency of plant items was significantly lower than the feedings frequency of animal items (Table 2).

The feeding intensity of plant items varied in two broods (Dunn test $p < 0.04$, Table 1). The feeding intensity of different categories of plant food was also a statistically different (Kruskall-Wallis test, $H = 31.38$, $df = 2$, $p < 0.001$). The main component of the diet was the walnut, which accounted for 15.3% of nestling food (Table 1). The feeding frequency of this food item was statistically higher compared to other categories of plant food (Dunn test $p < 0.005$, Table 1). The nestlings in two broods (in 2005 and 2006) were already being fed this dietary component from the first pentad of their lives (Table 2). In the third pentad of nestling life, the intensity of feedings significantly increased (Dunn test $p < 0.017$, Table 2).

In the second pentad of nestling life, adults were already bringing pitted cherry pulp and sour cherry fruit to their young (Table 2). The respective proportion of these two components in the diet of young was 7.7%. Birds fed their nestlings cherries mostly in the fifth pentad of nestling life (Dunn test $p < 0.018$, Table 2). The amount of this component brought by each pair also varied but there were not statistically differences (Table 1).

Other components of nestlings' plant-based diet were provided to them from the third pentad of their lives. This group of plant food items accounted for only 0.5% (Table 2). This rate was not differentiated among pairs or over the distribution of pentads (Tables 1 and 2). Most of the items were white mulberry fruits *Morus alba* (14 feedings), and nine feedings of seed pulp (probably of sweet and sour cherries). There were also five cases of adults bringing flower petals to their young, such as peony *Paeonia* sp. and asters *Aster* sp. There were also isolated cases of hazelnuts and bits of green leaves confirmed as being fed to young.

Discussion

Variability in nestlings' diet

The varied feeding intensity of nestlings recorded for the Syrian Woodpecker may depend on the type and size of food portions brought to nestlings (e.g. Ruge 1969). It has been shown that Syrian Woodpeckers collect that food which is the easiest to come by at a given moment (Ruge 1969, Winkler 1972). The observed differences are therefore probably derived from the availability of particular food categories in the birds' territory during breeding season and in successive years because the items fed to nestlings varied significantly among years and among broods. In the 2006 season, when a massive appearance of cockchafers occurred, woodpeckers often exploited this food source. In other years of the study, when large populations of these beetles were not recorded, butterfly caterpillars were the dominant part of their diet. Butterfly caterpillars, as the dominant component of the nestling diet, were found in Austria (Ruge 1969) and Ukraine (Marisova & Butenko 1976). However, in 2005, none of the specified categories of food dominated in the diet of nestlings but the main food of nestlings was still insects. Similar observations were also confirmed in another studies e.g. from Vojvodina (Szlivka 1962).

The amount of plant food feedings provided also varied widely within years and broods. Some pairs fed their young fruit and seeds only rarely, and similar observations were made in Austria (Ruge 1969). According to that author, one pair did not feed their nestlings any plant food and other broods received almonds or the pulp of cherries, strawberries and walnuts sporadically. A significant role is most likely played here by the time of woodpecker breeding and the phenology of fruiting trees. Pairs nesting early did not feed fruit to their young, because, for example, sour and sweet cherries had not yet ripened. Nestlings obtained these dietary components only in the cases of subsequent broods (Ruge 1969). During the study, it was found that feeding plant items to nestlings also occurred less frequently after spring frosts and frost damage to the flowers of such plants as cherry, when the significantly weaker fruiting of these trees was reported. It was observed, however, that in this situation, the birds brought large amounts of last year's walnuts. These observations suggest that the differences in nestling diet may also resulted from weather conditions before or during breeding season.

In some broods, plant components accounted for nearly half of the feedings brought by breeding adults, just as in Ukraine, where plant food can make up three-quarters of nestlings' diet (Mitjaj 1986). In Vojvodina, the plant component (mainly mulberries) in the diet of nestlings was found to be in a one-to-one proportion (Szlivka 1962). In Austria, during the three-day observation of one brood, cherries were noted to be as much as 60%

of the weight of all components delivered by feeding birds (Glutz von Blotzheim & Bauer 1980). This is probably the reason this species prefers orchards in the anthropogenic tree stands of south-eastern Poland (Michalczuk & Michalczuk 2011, 2016c, 2016d) or fruit plantations in another regions (e.g. Szlivka 1957, 1962, Ruge 1969, Al-Safadi 2004, Aghanajafizadeh et al. 2011), where probably there is a broad access to food.

The varied diet of nestlings is also a result of the fact that Syrian Woodpeckers inhabit different geographical regions, which have various tree stands (Szlivka 1957, 1962, Ruge 1969, Al-Safadi 2004, Ar et al. 2004). This study and other research show that in central Europe, these birds often use walnuts as food (Ruge 1969, Marisova & Butenko 1976). Also included are the seeds of other tree species, such as oak, hornbeam or beech (Marisova 1965, Klitin et al. 1994). In southern Europe, a significant portion of the diet also includes the fruits and seeds of cherry, sour cherry and mulberry fruit (Stevanović 1960, Szlivka 1962). In Asia Minor, foods items can include almonds, pecans, pistachios or also citrus species (Glutz von Blotzheim & Bauer 1980, Cramp 1985), which shows the low selectivity of food species for this bird, indicating that the Syrian Woodpecker is a trophic opportunist.

Variation in diet and nestling growth

During the study, it was noticed that as nestlings grew, the proportion of larvae in their diet decreased, whereas the remaining components of animal items in their diet increased, such as *Lepidoptera* butterfly caterpillars. The significant proportion of this dietary component of nestlings was also observed during the study in Ukraine (Marisova & Butenko 1976). It is also consistent with observations of breeding Syrian Woodpeckers from Austria, where nestlings received caterpillars with greater frequency as they grew (Ruge 1969). As the nestlings increased in size, so did the proportion of plant food in their diet. The provision of plant components at an early stage of life was also found for the nestlings in Austria (Winkler 1972). According to the author, they were fed sweet cherry fruit in the fourth day of their life. Our studies have shown that before fledging, plant items accounted for about one-third of the feedings provided to nestlings. Clear dietary opportunism allows the Syrian Woodpeckers to produce broods in anthropogenic afforestations and probably allows this species to occupy a variety of tree stands. However, in primary range and also in a newly colonized area like Central Europe, the fruit trees settlements may play an important role for Syrian Woodpeckers as feeding habitats.

References

Aghanajafizadeh, A., Heydari, F., Naderi, G., Hemami, M.R. (2011): Nesting hole site selection by the Syrian Woodpecker, *Dendrocopos syriacus*, in Yazad province, Iran. Zoology in the Middle East 53: 3-6.

Al-Safadi, M.M. (2004): On the breeding biology of the Syrian Woodpecker, *Dendrocopos syriacus*, in the Gaza Strip. Zoology in the Middle East 32: 7-12.

Ar, A., Barnea, A., Yom-Tov, Y., Mersten-Katz, C. (2004): Woodpecker cavity aeration: a predictive model. Respiratory Physiology & Neurobiology 144: 237-249.

Cramp, S. (ed.). (1985): The Birds of the Western Palearctic. 4. Oxford University Press. Oxford.

Fröhlich, A., Ciach, M. (2013): [*Distribution and abundance of the Syrian Woodpecker* Dendrocopos syriacus *in Kraków*]. Ornis Polonica 54: 237-246. [in Polish]

Glutz von Blotzheim, U.N., Bauer, K. (eds) (1980): Handbuch der Vögel Mitteleuropas. 9. Akademische Verlag, Wiesbaden.

Holzer, G., Holzer, G. (1982): Erstnachweis der Brut des Blutspechtes (*Dendrocopos syriacus*) für Oberösterreich im Stadtgebiet von Linz. Öko- L. 4: 18-22.

Klitin, A.N., Skilsky, I.V., Bundzyak, P.V. (1994): Distribution and feeding of the Syrian Woodpecker in the Bukovinian Pre-Crapathians and Prut-Dniester Interfluve. Berkut 3: 108-111.

Kondracki, J. (2000): [*Regional geography of Poland*]. PWN, Warszawa, pp. 450. [in Polish]

Lill, A., Hales, E. (2015): Behavioural and Ecological Keys to Urban Colonization by Little Ravens (*Corvus mellori*). The Open Ornithological Journal 8: 22-31.

Marisova, I.V. (1965): [*On the Syrian Woodpecker (Dendrocopos syriacus Hemp. et Ehrenb.) in the Ukraine*]. Zoologicheskii Zhurnal 44(11): 1735-1737. [in Russian]

Marisova, I.V., Butenko, A.G. (1976): [*Data on distribution and ecology of Dendrocopos syriacus in the Ukraine*]. Vestnik Zoologii. 2: 29-34. [in Russian]

Mersten-Katz, C., Barnea, A., Yom-Tov, Y., Ar, A. (2012): The woodpecker's cavity microenvironment: advantageous or restricting? Avian Biology Research 5: 227-237.

Michalczuk, J. (2014): Expansion of the Syrian Woodpecker *Dendrocopos syriacus* in Europe and Western Asia. Ornis Polonica 55: 149-161.

Michalczuk, J., Michalczuk, M. (2006): Reaction on playback and density estimations of Syrian Woodpecker *Dendrocopos syriacus* in agricultural areas of SE Poland. Acta Ornithologica 41: 33–39.

Michalczuk, J., Michalczuk, M. (2011): [*Syrian Woodpecker Dendrocopos syriacus in the Upper Huczwa River Watershed in 2004-2006*]. Chrońmy Przyrodę Ojczystą 67: 426-432. [in Polish]

Michalczuk, J., Michalczuk, M. (2015): [*Decline of the Syrian Woodpecker Dendrocopos syriacus population in rural landscape in SE Poland in 2004-2012*]. Ornis Polonica 56: 67-75. [in Polish]

Michalczuk, J., Michalczuk, M. (2016a): The reproductive biology of the Syrian Woodpecker *Dendrocopos syriacus* in a newly colonized area of south-eastern Poland. Journal of Ornithology 157: 179-187.

Michalczuk, J. Michalczuk, M. (2016b): Differences in reproductive investment between male and female Syrian Woodpeckers *Dendrocopos syriacus*. Acta Zoologica Bulgarica 68: 77–84.

Michalczuk, J., Michalczuk, M. (2016c): Habitat preferences of Picidae woodpeckers in the agricultural landscape of SE Poland: Is the Syrian Woodpecker *Dendrocopos syriacus* colonizing a

vacant ecological niche? North-Western Journal of Zoology 12: 14–21.

Michalczuk, J., Michalczuk, M. (2016d): Nesting preferences of Syrian Woodpeckers *Dendrocopos syriacus* in the agricultural landscape of SE Poland. Acta Ornithologica 51: 71–81.

Michalczuk, J., Michalczuk, M. (2016e): Syrian Woodpecker *Dendrocopos syriacus* and Great Spotted Woodpecker *Dendrocopos major* coexistence in non-forest tree stands of the agricultural landscape in SE Poland. Turkish Journal of Zoology 40: 743-748..

Mitjaj, I. S. (1986): [*Syrian Woodpecker in the forest-steppe in Pridneprovsky Land. Birds distribution in SSSR, conservation and rational management*]. Akademija Nauk SSSR, Leningrad, 70-71. [in Russian]

Neubauer, G., Zagalska-Neubauer, M., Gwiazda, R., Faber, M., Bukaciński, D., Betleja, J., Chylarecki, P. (2006): Breeding large gulls in Poland: distribution, numbers, trends and hybridisation. Vogelwelt 127: 11-22.

Ruge, K. (1969): Beobachtungen am Blutspecht *Dendrocopos syriacus* im Burgenland. Vogelwelt 90: 201-223.

Skórka, P., Wójcik, J.D. (2008): Habitat utilisation, feeding tactics and age related feeding efficiency in the Caspian Gull *Larus cachinnans*. Journal of Ornithology 149: 31-39.

Skórka, P., Wójcik, J.D., Martyka, R. (2005): Colonization and population growth of Yellow-legged Gull *Larus cachinnans* in southern Poland: causes and influences on native species. Ibis 147: 471-482.

Stevanović, A. (1960): Über die jahreszeitliche Spcezialisierung der Nahrungsaufnahme beim Blutspecht, *Dendrocopos syriacus*, in der Umgebung von Kruševac (Župa) in Serbien. Larus 12-13: 55-64.

Szlivka, L. (1957): Von der Biologie des Blutspechts *Dendrocopos syriacus balcanicus*, und seinen Beziehungen zu den Staren, *Sturnus vulga*ris. Larus 9/10: 48-70.

Szlivka, L. (1962): Weitere Angaben über den Blutspecht aus der näheren Umgebung von Gunaroš. Larus 14: 121-134.

Tomiałojć, L., Stawarczyk, T. (2003): [*The avifauna of Poland. Distribution, numbers and trends*]. PTPP "pro Natura". Wrocław. [in Polish]

Winkler, H. (1972): Beitrege zur Ethologie des Blutspechts (Dendrocopos syriacus). Das nicht-reproduktive Verhalten. Zaitschrift für Tierpsychologie 31: 300-325.

Winkler, H. (1973): Nahrungserwerb und Konkurrenz des Blutspechts *Picoides* (*Dendrocopos*) *syriacus*. Oecologia 12: 193-208.

Zavialov, E., Tabachishin, V.G., Mosolova, E.Y. (2008): Expansion of Syrian Woodpecker in European Russia and Ukraine. Dutch Birding 30: 236-238.