

Reproductive performance of the Middle Spotted Woodpecker *Dendrocoptes medius* around Yasouj city (South Western Iran)

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Abstract In the spring of 2018, 18 nests of the Middle Spotted Woodpecker (*Dendrocoptes medius*) were surveyed in a 300 hectare area of the forest region in the south and north of Yasouj. Egg-laying began in late March. Clutch sizes were between three and seven (mean: 4.29 ± 1.25 , median: 4, $N = 8$). The incubation period varied from 11 to 13 days (mean: 12.4 ± 0.89 days). The number of eggs that hatched in successful nests ($N = 8$) ranged from 2 to 5 (mean: 3.75 ± 0.89). Hatching percentage ($N = 7$) was 90%. Duration of the nestling period was 23–25 days (median: 24 days). Fledging dates ranged from Apr 28 to June 10, and most chicks (77%) fledged in the first ten days of May. Number of fledglings from successful nests ($N = 17$) ranged from 1 to 5 (mean: 3.58 ± 0.71), whereas the mean number of fledglings from all nests ($N = 18$) was 3.39 ± 1.09 . The percentage of successful nests (at least one fledged young, $N = 17$) was 94.4%. The overall duration of breeding varied from 39 to 43 days (mean: 40.8 ± 1.48 days).

Keywords: breeding, primary hole nesters, hatching success, fledging, nesting success

Összefoglalás 2018 tavaszán 18 közép fakopáncs (*Dendrocoptes medius*) odút vizsgáltak 300 hektárnyi erdőterületen, Yasouj városától délre, illetve északra. A tojásrakás március végén kezdődött. A fészekaljméret három és hét tojás között változott (átlag: $4,29 \pm 1,25$, medián: 4, $N = 8$). A kotlási időszak 11–13 napig tartott (átlag: $12,4 \pm 0,89$ nap). A sikeres fészkekben ($N = 8$) 2–5 fióka kelt ki (átlag: $3,75 \pm 0,89$). A tojások kikelésének aránya 90% volt ($N = 7$). A fiókanevelési időszak 23–25 napig tartott (medián: 24 nap). A kirepülések április 28. és június 10. között zajlottak, és a legtöbb fióka (77%) május első tíz napjában repült ki. Az odúként kirepült fiókák száma ($N = 17$) 1 és 5 között volt (átlag: $3,58 \pm 0,71$). Mindemmellett, az összes fészkek esetében a kirepült fiókák átlagos száma ($N = 18$) $3,39 \pm 1,09$ volt. A költések 94,4%-ban bizonyultak sikeresnek (legalább egy kirepült fióka/fészek, $N = 17$). A költés teljes időtartama 39 és 43 nap között változott (átlag: $40,8 \pm 1,48$ nap).

Kulcsszavak: költés, elsődleges odúköltők, kikelési siker, kirepülés, költési siker

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Introduction

Middle Spotted Woodpecker (*Dendrocoptes medius*) depends on old, deciduous forests. Current knowledge of the reproductive biology of the species is based on only a few studies (Pettersson 1985, Pasinelli 2001, Kosenko & Kaygorodova 2003, Kosiński & Ksit 2006), but none of them has previously examined breeding behavior and performance of this species in Iran. The Middle Spotted Woodpecker breeds in the Zagros forests in West and Southwestern Iran and to a lesser extent also in the Alborz forests in Northwest Iran.

Reproductive biology, along with other demographic parameters, has been suggested as a superior estimator of habitat quality (Pasinelli 2001, Williamson *et al.* 2016). One of the most pivotal decisions in single-brooded birds is the timing of egg-laying that can greatly affect important parameters such as clutch size and other reproductive outputs (Klomp 1970, Perrins 1970, Daan *et al.* 1988). Numerous factors, which differ among bird species, affect reproductive success in birds (Newton 1989), such as the age of the breeding birds (Saether 1990) or food, predators, climatic conditions during the breeding period (Wiktander *et al.* 1994, Kosiński & Ksit 2006).

Another such out-of-human-control factor is rainfall, which is affecting breeding performance of Middle Spotted Woodpeckers (Pasinelli 2001). Therefore, determining and knowing reproductive performance and its numerous affecting factors is of great importance to take appropriate conservation measures and to assess their suitability.

Here, we report on different aspects of breeding performance of the Middle Spotted Woodpecker in Southwestern Iran. This study expands our knowledge about the biology of this species in Iran and our results are compared to the ones yielded from previous studies from other localities.

Materials and Methods

The study took place in an area of 300 hectare of the forest region in the south and north of Yasuj city in Southwestern Iran (31°35'N, 51°38'E) at 2000 meter above sea level with an average annual temperature and rainfall of 14 °C and 817 mm, respectively. The vegetation consists of shrubs of the genera *Acantholimon*, *Astragalus* and *Amygdalus*, as well as various species of trees including mostly Persian oak (*Quercus brantii* var. *persica*) and rarely ash (*Fraxinus angustifolia*), mount atlas mastic (*Pistacia atlantica*), dotted hawthorn (*Crataegus punctica*) and honeysuckle (*Lonicera nummularifolia*).

From early March to mid-May of 2018, surveys of woodpeckers were conducted by 2–3 people on foot (4–6 hours per day, often afternoon) to identify the approximate territory boundaries and to locate nests, which resulted in finding 18 active nests of Middle Spotted Woodpecker. Different approaches were used for this purpose. These include listening to the sound of birds excavating cavities, observing scratches and signs of cavity excavation, entering and/or leaving the cavity by woodpeckers, and finding wood chips under the tree on the ground. It must be noted that playbacks were not used as a potential way to find active birds. Later in the season, active nests were found by checking for eggs inside cavities and by listening for begging calls of chicks. For each active nest, a number of variables were recorded (*Table 1*). To prevent nest abandonment, recording of these variables (i.e. nest structure characters) were done after fledging of the nestlings or when a nest was depredated or abandoned. Nest contents were checked using a Bore-scope (Extech BR300).

To assess breeding performance, the following variables were recorded for each nest: date of laying of first and last eggs, clutch size, incubation period, hatching rate (eggs laid divided by hatchlings), number of nestlings, number of fledglings (when the muscles and

Table 1. Breeding phenology and parameters of the Middle Spotted Woodpecker
1. táblázat A közép fakopáncs költési fenológiája és paraméterei

Breeding parameter	Range	Mean \pm SD	Median	n	%
Beginning of laying date	March 21 to May 3				
Beginning of fledging date	Apr 28 to June 10				
Duration of breeding season (days)	39–43	40.8 \pm 1.48	41		
Clutch size	3–7	4.29 \pm 1.25	4	7	
Number of hatched nestlings in total nests	2–5	3.75 \pm 0.89	4	8	
Number of fledglings in a successful nest	2–4	3.58 \pm 0.71	4	17	
Number of fledglings in a failed brood	0–4	3.39 \pm 1.09	4	18	
Incubation phase (days)	11–13	12.4 \pm 0.89	13	5	
Nestling phase (days)	23–25	24 \pm 0.71	24	5	
Hatching success					90
n eggs				30	
n nestlings				27	
N nests				7	
Nesting success (all nests)					94.4
n successful broods				17	

feathers are developed enough to leave nest), duration of the nestling period, and fate of each nest (successful, if at least one fledgling hatched, or unsuccessful otherwise). Duration of the breeding season was defined as the time interval between the day on which the first egg was laid in the earliest nest until the day on which the last nestling of the latest nest fledged. The incubation period was calculated for individual nests as the time interval between the day on which the last egg was laid to the day before the first nestling hatched. The length of the nestling period was calculated as the time interval between the day of first egg hatching to the day on which the first nestling fledged (Pasinelli 2001, Kosiński & Ksit 2006, Michalczuk & Michalczuk 2016). Nesting success was defined as the ratio of the number of nests with at least one fledged young to the number of nests in which eggs or nestlings were found (Kosiński & Ksit 2006, Michalczuk & Michalczuk 2016). We checked all the nests every 2–3 days during the study period to record the breeding parameters. To figure out if the nests contained any unhatched eggs or dead chicks, we did a final check on all the nests after fledglings left the nests (Michalczuk & Michalczuk 2016). Based on Michalczuk and Michalczuk (2016), we monitored all the nests during egg-laying period, treated those with destroyed eggs or abandoned as incomplete clutches.

Statistical calculations were performed using the SPSS software V.18. The relationships between variables were analyzed by the Kendall's tau correlations. The significance of relation between hatching success and nesting success was investigated by Fisher's exact test. A significance level of 0.05 was employed for all statistical tests.

Results

Nesting activities of Middle Spotted Woodpeckers began from mid to late March. Egg-laying started on March 21st and continued to May 3rd. In most of the nests, egg-laying date was in the last ten days of March (*Figure 1*). Clutch size ranged from 3–7 eggs ($\bar{x} = 4.29 \pm 1.25$ SD, median = 4, N = 8) (*Table 1*). 71.4% of the nests had four eggs (*Figure 2*).

Incubation period varied from 11 to 13 days ($\bar{x} = 12.4 \pm 0.89$, median: 13). Number of hatchlings averaged 3.75 ± 0.89 (range = 2–5, median = 4) in all nests (N = 8) (*Table 1, Figure 2*). Most of the nests had four chicks (62.5%). Overall hatching rate was 90% (N = 7).

The duration of the nestling period was 23–25 days, with median of 24 days (N = 5). The earliest and latest fledging dates were April 28 and June 10, respectively, and most chicks (77%) fledged in the first ten days of May (*Figure 3*). Length of the breeding duration ranged from 39 to 43 days ($\bar{x} = 40.8 \pm 1.48$, median = 41).

Mean number of fledglings was 3.58 ± 0.71 (range = 2–4) in successful nests (N = 17) and 3.39 ± 1.09 in all active nests (N = 18) (*Table 1*). No chicks were fledged only in 1 out of 18 nests. The most frequent number of fledglings per nest was four (70.6%, number of successful nests = 19) (*Figure 3*). There is a tendency towards increasing the hatching success ($\tau = 1.00$, $P = 0.0001$) as the clutch size increases. The relationship between both of clutch size and nesting success ($\tau = 0.071$, $P = 0.84$) and clutch size and the number of fledglings in successful nests ($\tau = 0.091$, $P = 0.81$) are not significant. There is no significant correlation between number of nestlings and fledglings ($\tau = 0.091$, $P = 0.81$), as well as nestling and nesting success ($\tau = 0.07$, $P = 0.84$).

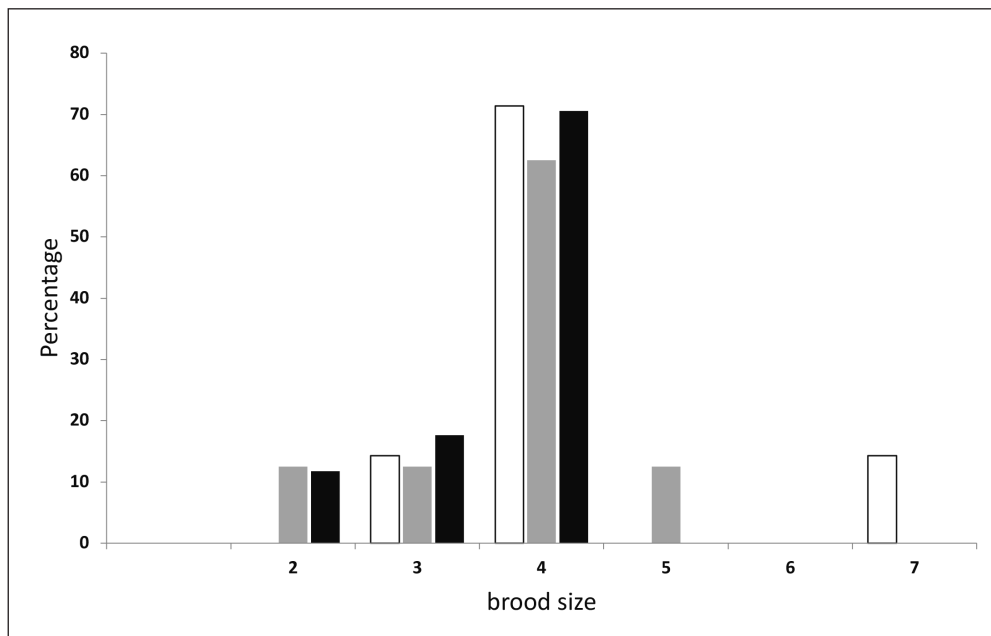


Figure 1. Egg laying date in Middle Spotted Woodpeck
 1. ábra A közép fakopáncsok tojásrakási időpontjai

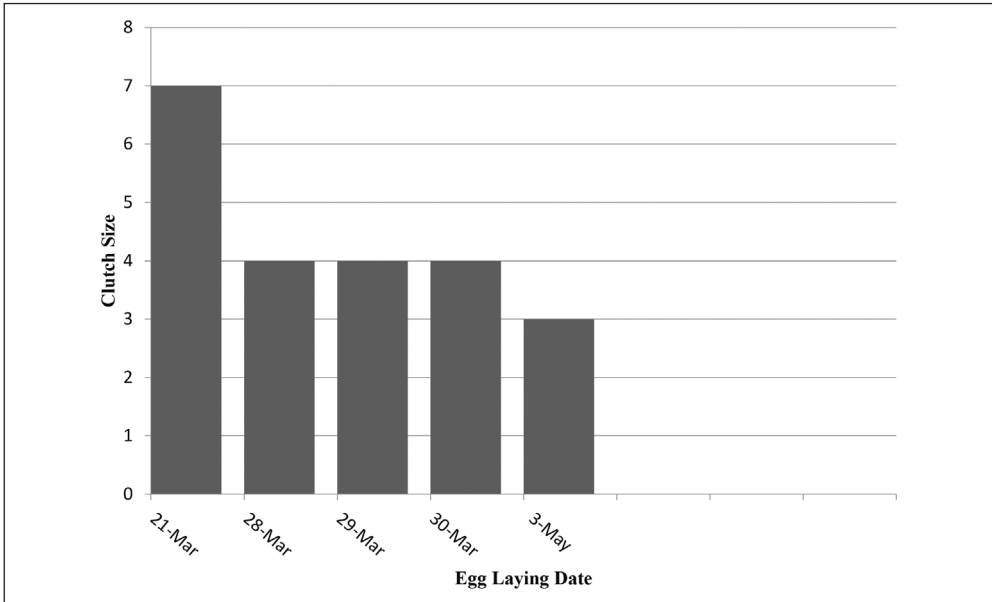


Figure 2. Distribution of Middle Spotted Woodpecker brood sizes. White bars show clutch size (N = 7), gray bars indicate number of hatched nestlings (N = 8), and black bars give number of fledglings (N = 17) in successful nest

2. ábra A közép fakopáncsok fiókszámának eloszlása. A fehér oszlopok a fészekalj méretet (N = 7), a szürke oszlopok a kikelt fiókák számát (N = 8), a fekete oszlopok a kirepült fiókák számát (N = 17) mutatják a sikeres költésekben

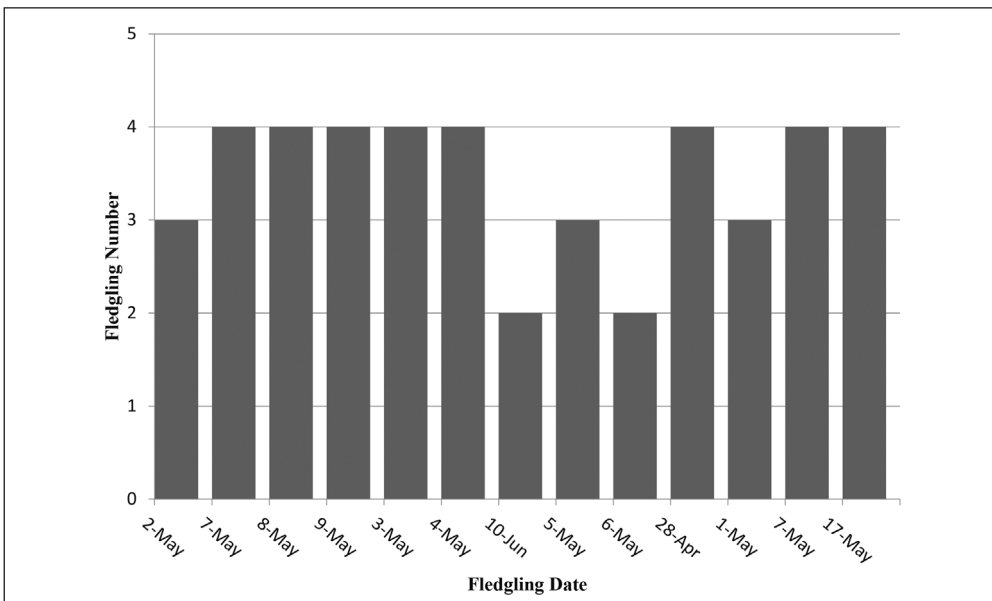


Figure 3. Fledgling date in Middle Spotted Woodpecker

3. ábra A közép fakopáncsok kirepülési időpontjai

The percentage of successful nests (at least one fledged young) ($N = 17$) was 94.4% (Table 1). Applying Fisher's exact test, there is no significant relationship between hatching success and nesting success ($P = 0.8$).

Discussion

Egg-laying dates of some Palearctic Woodpecker species have repeatedly been studied. For example, the time of egg-laying primarily occurs in late April to early May in the Middle Spotted Woodpecker (Pasinelli 2001 (in Switzerland), Kosinski & Ksit 2006 (in Poland)), in the last week of April in the Great Spotted Woodpecker (*Dendrocopos major*) (Mazgajski 2002), from April 24th to May 3rd in Syrian Woodpecker (*Dendrocopos syriacus*) (Michalczuk & Michalczuk, 2016), and from 27th March to 21st May in Black Woodpecker (*Dryocopus martius*) (Van Manen 2012). The results of this study indicated that egg-laying begins in late March. The general timing of breeding period in birds is controlled by photoperiodicity (Immelmann 1971). The onset of egg-laying was earlier in our study area compared to above-mentioned regions, most likely explaining by the differences in elevation and maybe availability of food resources in these study areas. Our study was carried out at an elevation of 2200 m a.s.l., while previous studies (i.e. Pasinelli 2001, Kosinski & Ksit 2006) had been done in lower elevations. The beginning of egg-laying may vary from year to year, being earlier in warmer springs (Pasinelli 2001, Mazgajski 2002). It has been shown that the timing of woodpecker breeding in temperate forests is synchronized with the time of caterpillar peak abundance (Török 1990, Pasinelli 2001, Wiktander *et al.* 2001, Kosenko & Kaygorodova 2003). For example, Kosenko and Kaygorodova (2003) suggested that the caterpillars appear a few days prior to commence of the hatching period. The young of Middle Spotted Woodpeckers are primarily fed by caterpillars (Török 1990), and since the appearance of caterpillars are associated with the appearance of the leaf buds (Van Balen 1973, Buse *et al.* 1999), it is very likely that the beginning of egg-laying in Middle Spotted Woodpeckers are somehow regulated by the commence of vegetation growth. An important factor in determining the timing of breeding is the availability of food resources (Daan *et al.* 1988, Pasinelli 2001). Another factor that seems to affect the breeding performance of the Middle Spotted Woodpecker is weather conditions during the nestling phase (Pasinelli 2001).

Many studies have provided valuable data on clutch sizes of woodpecker species (e.g. Wiktander *et al.* 1994, Michalek *et al.* 2001, Mazgajski 2002, Pasinelli 2003, Kosinski & Ksit 2006, Pasinelli 2006, Vierling & Lentile 2006, Van Manen 2012, Zhu *et al.* 2012, Michalczuk & Michalczuk 2016). The average number of eggs differ for different species or even within the same species, e.g. for Middle Spotted Woodpecker 6.4 eggs (Pasinelli 2006), 6.5 eggs (Kosinski & Ksit 2006), and 5.6 in Hungary and Vienna (Michalek *et al.* 2001, Pasinelli 2003); for Great Spotted Woodpecker 5.4 eggs (Mazgajski 2002), 5.6 eggs (Michalczuk & Michalczuk 2016); for Syrian Woodpecker 5 eggs (Van Manen 2012); for Black Woodpecker 3.8 eggs (Wiktander *et al.* 1994); for Lesser Spotted Woodpecker (*Dendrocopos minor*) 5.9 eggs; for Lewis's Woodpecker (*Melanerpes lewis*) 5.00 eggs (Zhu *et al.* 2012, Vierling & Lentile (2006); and for Red-headed Woodpecker (*Melanerpes erythrocephalus*) 5.4 eggs.

In our study, clutch sizes ranged from 3 to 7, with an average of 4.29. This was lower than findings of other studies. In Central and Eastern Europe, clutch sizes ranged from three to ten (Pasinelli 2001, Kosenko & Kaygorodova 2003, Kosiński & Ksit 2006), although, Pasinelli (2003) has reported that 10-egg clutches are extraordinary in the Middle Spotted Woodpeckers. The low clutch size in the current study is probably due to reduced rainfall, poor vegetation and food shortages in the study year.

In the Middle Spotted Woodpecker, duration of the incubation period has been reported to range from 7 to 12 days (Pasinelli 2001). In our study, incubation lasted from 11 to 13 days, with an average of 12.4 days, which is consistent with prior studies. Moreover, duration of the nestling period ranged from 23 to 25 days, with an average of 24 days which is also similar to the results of other studies such as Pasinelli (2001).

In this study, the percentage of hatched eggs was 90%, which is much higher than the studies of Pasinelli (2001) with 71% and Kosiński and Ksit (2006) with 70%. In our study, the average number of fledglings from successful nests was 3.58, which was different from those in Poland with 4.5 (Kosiński & Ksit 2006), in Switzerland with 3.2 (Pasinelli 2001), and in Southwest Russia with 5.4 fledglings (Kosenko & Kaygorodova 2003).

Nest success in woodpeckers typically varies between 70% and 100% (Winkler *et al.* 1995, Pasinelli 2006). Nest success in this study was 94.4%, which was much higher than Pasinelli (2001) with 74.3%, Kosiński and Ksit (2006) with 83.1%, but closer to Michalek and Winkler (2001) with 89.5 and Kosenko and Kaygorodova (2003) with 89.7%. In our study, only one nest failed for unknown reasons.

One of the reasons for the difference in the results of the same parameters in various studies is the negative impacts of weather and rainfall. Pasinelli (2001) and Mazgajski (2002) have previously reported these negative effects during the breeding period on breeding success of Middle and Great Spotted Woodpeckers. According to Pasinelli (2001), mortality of nestlings increase in cold and humid weather conditions, because parents barely find enough food to feed chicks. In another study, Wiebe (2011) figured out that there was a direct relationship between clutch size and warmer temperatures in nest cavities; nevertheless, this parameter (cavity temperatures) has no affect on hatching and fledging success.

It has noted that territory quality is one of the affecting factors of breeding success in birds (Stacey & Ligon 1987, Catchpole & Phillips 1992, Pasinelli 2001, Nappi & Drapeau 2009). In woodpeckers, measuring the availability of hole-trees (Walters, 1990) or the densities of dead stems and deciduous trees is important (Carlson 1998). The most population densities of Middle Spotted Woodpecker are found in mature deciduous forests with many old Oak stems (e.g. Muller 1982, Schmitz 1993, Winkler *et al.* 1995) with few exceptions (see: Gunther & Hellmann 1997). Finally, habitat quality affects the reproductive performance of this species on the landscape level (Pasinelli 2001).

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References

- Buse, A., Dury, S. J., Woodburn, R. J. W., Perrins, C. M. & Good, J. E. G. 1999. Effects of elevated temperature on multi-species interactions: the case of Pedunculate Oak, Winter Moth and tits. – *Functional Ecology* 13: 74–82. DOI: 10.1046/j.1365-2435.1999.00010.x
- Carlson, A. 1998. Territory quality and feather growth the White-backed Woodpecker *Dendrocopos leucotos*. – *Journal of Avian Biology* 29: 205–207. DOI: 10.2307/3677201
- Catchpole, C. K. & Phillips, J. F. 1992. Territory quality and reproductive success in the Dartford Warbler *Sylvia undata* in Dorset, England. – *Biological Conservation* 61: 209–215. DOI: 10.1016/0006-3207(92)91118-C
- Daan, S., Dijkstra, C., Drent, R. & Meijer, T. 1988. Food supply and the annual timing of avian reproduction. – *Proceedings of the International Ornithological Congress* 19: 392–407.
- Gunther, E. & Hellmann, M. 1997. Der Mittelspecht und die Buche: Versuch einer Interpretation seines Vorkommens in Buchenwiddern [The Middle Spotted Woodpecker and the Beech: An attempt to interpret its occurrence in beech rams]. – *Ornithologische Jahresberichte des Museum Heineanum* 15: 97–108. (in German)
- Immelmann, K. 1971. Ecological aspects of periodic reproduction. – In: Farner, D. S. & King, J. R. (eds.) *Avian Biology* 1: 342–389. Academic Press, New York
- Klomp, H. 1970. The determination of clutch size in birds. – *Ardea* 58: 1–124. DOI: 10.5253/arde.v58.p1
- Kosenko, S. M. & Kaygorodova, E. Yu. 2003. Ecological features of the Middle Spotted Woodpecker (*Dendrocopos medius*) in the Desna Polesie. – *Ornithologia* 30: 94–103 (in Russian)
- Kosiński, Z. & Ksit, P. 2006. Comparative reproductive biology of Middle Spotted Woodpeckers *Dendrocopos medius* and Great Spotted Woodpeckers *Dendrocopos major* in a riverine forest. – *Bird Study* 53: 237–246. DOI: 0.1080/00063650609461438
- Mazgajski, T. D. 2002. Nesting phenology and breeding success in Great Spotted Woodpecker *Picoides major* near Warsaw (Central Poland). – *Acta Ornithologica* 37: 1–5. DOI: 10.3161/068.037.0101
- Michalek, K. G., Auer, J. A., Großberger, H., Schmalzer, A. & Winkler, K. 2001. Die Einflüsse von Lebensraum, Witterung und Waldbewirtschaftung auf die Brutdichte von Bunt- und Mittelspecht (*Picoides major* und *P. medius*) im Wienerwald [The effects of habitat, weather and forest management on the breeding density of Black and Middle Spotted Woodpecker (*Picoides major* and *P. medius*) in the Vienna forest]. – *Abhandlungen und Berichte aus dem Museum Heineanum* 5: 31–58. (in German)
- Michalek, G. & Winkler, H. 2001. Mating system and parentage in monogamous Great Spotted Woodpeckers (*Picoides major*) and Middle Spotted Woodpeckers (*Picoides medius*). – *Behaviour* 138: 1259–1285.
- Michalczyk, J. & Michalczyk, M. 2016. The reproductive biology of the Syrian Woodpecker *Dendrocopos syriacus* in a newly colonized area of south-eastern Poland. – *Journal of Ornithology* 157: 179–187. DOI: 10.1007/s10336-015-1265-7
- Muller, W. 1982. Die Besiedlung der Eichenwälder im Kanton Zurich durch den Mittelspecht *Dendrocopos medius* [The colonization of the oak forests in the canton of Zurich by the Middle Spotted Woodpecker (*Dendrocopos medius*)] – *Ornithologischer Beobachter* 79: 105–119. (in German)
- Nappi, A. & Drapeau, P. 2009. Reproductive success of the Black-backed Woodpecker (*Picoides arcticus*) in burned boreal forests: are burns source habitats? – *Biological Conservation* 142(7): 1381–1391. DOI: 10.1016/j.biocon.2009.01.022
- Newton, I. 1989. *Lifetime reproduction in birds*. – Academic Press, London
- Pasinelli, G. 2001. Breeding performance of the Middle Spotted Woodpecker *Dendrocopos medius* in relation to weather and territory quality. – *Ardea* 89(2): 353–361.
- Pasinelli, G. 2003. *Dendrocopos medius* Middle Spotted Woodpecker. – *BWP Update* 5(1): 49–99.
- Pasinelli, G. 2006. Population biology of European Woodpecker species: a review. – *Annales Zoologici Fennici* 43: 96–111.
- Perrins, C. M. 1970. The timing of birds' breeding seasons. – *Ibis* 112: 242–255. DOI: 10.1111/j.1474-919X.1970.tb00096.x
- Pettersson, B. 1985. Extinction of an isolated population of the Middle Spotted Woodpecker *Dendrocopos medius* (L.) in Sweden and its relation to general theories on extinction. – *Biological Conservation* 32: 335–353. DOI: 10.1016/0006-3207(85)90022-9
- Saether, B. E. 1990. Age-specific variation in reproductive performance of birds. – *Current Ornithology* 7: 251–283.
- Schmitz, L. 1993. Distribution et habitat du Pic mar *Dendrocopos medius* en Belgique [Distribution and habitat of Middle Spotted Woodpecker *Dendrocopos medius* in Belgium]. – *Aves* 30: 145–166. (in French)

- Stacey, P. B. & Ligon, J. D. 1987. Territory quality and dispersal options in the Acorn Woodpecker, and challenge to the habitat saturation model of cooperative breeding. – *The American Naturalist* 130: 654–676.
- Török, J. 1990. Resource partitioning among three woodpecker species *Dendrocopos* spp. during the breeding season. – *Holarctic Ecology* 13: 257–264. DOI: 10.1111/j.1600-0587.1990.tb00617.x
- Van Manen, W. 2012. Breeding biology of Black Woodpecker *Dryocopus martius* in The Netherlands. – *Limosa* 85:161–170.
- Vierling, K. & Lentile, L. 2006. Red-headed Woodpecker nest-site selection and reproduction in mixed ponderosa pine and aspen woodland following fire. – *The Condor* 108(4): 957–962. DOI: 10.1650/0010-5422(2006)108[957:RWNSAR]2.0.CO;2
- Walters, J. R. 1990. Red-cockaded Woodpeckers: a ‘primitive’ cooperative breeder. – In: Stacey, P. B. & Koenig, W. D. (eds.) *Cooperative breeding in birds: long-term studies of ecology and behavior*. – Cambridge University Press, Cambridge, pp. 69–101.
- Wiebe, K. L. 2001. Microclimate of tree cavity nests: is it important for reproductive success in Northern Flickers? – *Auk* 118: 412–421. DOI: 10.1642/0004-8038(2001)118[0412:MOTCNI]2.0.CO;2
- Wiktander, U., Nilsson, S. G., Olsson, O. & Stagen, A. 1994. Breeding success of a Lesser Spotted Woodpecker *Dendrocopos minor* population. – *Ibis* 136: 318–322. DOI: 10.1111/j.1474-919X.1994.tb01101.x
- Wiktander, U., Olsson, O. & Nilsson, S. G. 2001. Annual and seasonal reproductive trends in the Lesser Spotted Woodpecker *Dendrocopos minor*. – *Ibis* 143:72–82.
- Williamson, L., Garcia, V. & Walters, J. R. 2016. Life history trait differences in isolated populations of the endangered Red-cockaded Woodpecker. – *Ornis Hungarica* 24(1): 55–68. DOI: 10.1515/orhu-2016-0003
- Winkler, H., Christie, D. & Nurney, D. 1995. *Woodpeckers. A Guide to the Woodpeckers, Piculets and Wrynecks of the World*. – Pica Press, Sussex
- Zhu, X., Srivastava, D. S., Smith, J. N. & Martin, K. 2012. Habitat selection and reproductive success of Lewis’s Woodpecker (*Melanerpes lewis*) at its northern limit. – *PLoS One* 7(9): e44346. DOI: 10.1371/journal.pone.0044346

