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CHANGES IN SPRING ARRIVAL DATES OF CENTRAL EUROPEAN BIRD SPECIES OVER THE PAST 100 YEARS

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Over the past decades, spring temperatures have increased in temperate regions, which resulted in birds arriving earlier in spring. Nonetheless, the timing of some species' spring migration relies on endogenous rhythms that are not affected by climate change. In this study, we analysed changes in the spring arrival dates of 36 bird species over two periods in 22 towns and villages in Southeast Hungary and West Romania. The first period covered the national spring migration counts between 1894 and 1926, while the second period took place between 2005 and 2019 and is based on our recent observation data. Our results show that the average spring arrival dates of most long-distance migrant species have not changed significantly over the past 100 years. In contrast, in cases of medium- and short-distance migrants, most species arrive earlier recently than in the late 19th and early 20th centuries. This may be caused by the fact that the migration habit of long-distance migrants is characterized by strong genetic determinants, so they can not react as quickly to the warmer spring weather in Europe as the medium- and short-distance migrants. However, in cases of some long-distance migrants, the timing of spring migration changed due to the drying of wintering grounds.

Key words: climate change, spring migration, Csanádi-hát, Partium.

INTRODUCTION

Nature is a complex and dynamic network organised by species and their interactions (Olesen *et al.* 2011). Being dynamic, these systems are often characterized by long-term variations. Changes in environmental factors, such as habitat degradation (Ewers & Didham 2006) or the altered food availability (e.g. Siikamäki 1998) are important components of long-term temporal variations, but salinity (Lin *et al.* 2001), the concentration of minerals in water (Li *et al.* 2007), and anthropogenic factors (e.g. pollution) (Woodwell 1970, Clark & Frid 2001) could have effects on the ecosystems. However, there may be different factors behind these changes, in the recent years, researchers have focused on increasing temperatures and related climate change, and its effects on the environment (Haunschild *et al.* 2016).

Over the past decades, spring temperatures in temperate regions have increased, which resulted in birds arriving earlier in spring and later in autumn (Menzel *et al.* 2006, Gordo 2007). A shift to the advanced breeding season can also be observed in several bird species (e.g. Crick *et al.* 1997, Visser *et al.* 1998, Both & Marvelde 2007). The rate of climate warming has been more gradual in eastern North America than in Europe (Hansen *et al.* 2006), and the temporal shifts in avian migration are less obvious (MacMynowski & Root 2007, MacMynowski *et al.* 2007, Miller-Rushing *et al.* 2008*a*).

An increasing number of studies reported shifts in the timing of bird migration during the last decades, especially since the 1970's (Huin & Sparks 1998, Cotton 2003, Lehikoinen *et al.* 2004, Van Buskirk *et al.* 2009, Knudsen *et al.* 2011). However, the timing of spring migration in some species could principally be mediated by the factors that are not affected by climate change (e.g. endogenous rhythms, day-length variation on the wintering ground), especially in long-distance migrant species (Berthold 1996, 2001, Gwinner 1996, Both & Visser 2001, Coppack & Both 2002, Nott *et al.* 2002, Tryjanowski *et al.* 2002, Hubálek 2004, Miller-Rushing *et al.* 2008*a*, Kullberg *et al.* 2015). Food supply in the breeding grounds is also a very important regulator of the long-distance migrants. Early migrants generally face low food abundance, but over the course of the arrival period overall food abundance increase (Smith & Moore 2005). Short-distance migrants have also been shown to display a more flexible behavioural response to the local weather at stopover sites (Calvert *et al.* 2012).

The majority of these studies concern the last fifty years, a period when global warming has increased after 30-years of stagnation (Hansen *et al.* 2005, 2006, Rahmstorf 2008). Historical data on bird migration phenology before the middle of the 20th century, when a significant global warming started (Hansen *et al.* 2006), are scarce, but there are some studies from Sweden (Kullberg *et al.* 2015), Britain (Sparks 1999) and the USA (Ellwood *et al.* 2010). Most monitoring programs have began in the 1960–1980s, but a few go back to the early 20th century or before (Butler 2003, Hüppop & Hüppop 2003, Hubálek 2004, Gordo 2007). These data have been used primarily to test for changes in the timing of migration.

In Hungary, bird observation has long traditions, for example, the first Ornithological Centre of the world was established in Hungary in 1893, but there are many data and publications that date back to even earlier (www.arcanum.hu). According to the intensity of data collection by the Ornithological Centre in Hungary (see Bozó 2017*a*), we used data of spring arrival dates from 1894–1926 of 36 migratory bird species. In this study, we compared these data with our recent field observation data to examine whether the spring arrival dates of the first individuals varied between the two periods. We also investigated the possible correlation between the earliest arrival dates of the species and the average monthly temperature values.

We predicted that the spring arrival dates shifted earlier in short-distance migrants, but in the case of long-distance migrants a species-specific pattern is likely to occur. In addition, we assume that arrival time is related to the local temperature. In North America, as a result of climate change, milder winters with less snow, more variable and intense precipitation events and a shorter snow season, species overwinter in higher numbers in the northern regions. Also new species have the opportunity to overwinter there (Princé & Zuckerberg 2014). For this reason, we have also collected data on species that recently overwinter in the study area regularly but have only been observed occasionally in the winter periods of the late 19th and early 20th centuries.

MATERIAL AND METHODS

We used data from two different time periods. The first one (Period 1) took place between 1894 and 1926, while the second (Period 2) between 2005 and 2019.

We collected data from Period 1 from the area of the Csanádi-hát and Partium (Southeast Hungary and West Romania), in a circle of 40–45 km from Kevermes. The area is dominated by flatland plain and low mountains (up to 836 meters) and covers the following settlements: Battonya, Csanádpalota, Dombiratos, Elek, Kunágota, Arad (Oradea), Aradkövi (Cuvin), Kisjenő (Chișineu-Criș), Kispereg (Peregu Mic), Lippa (Lipova), Máriaradna (Radna), Ottlaka (Grăniceri), Pankota, Ópálos (Păuliș), Pécska (Pecica), Sikló (Șiclău), Solymosvár (Șoimoș), Szentpál (Sânpaul), Tornya (Turnu) and Világos (Șiria). All data from Period 1 were published in the journal Aquila (Magy. Orn. Központ 1895, Gaal 1896, 1897, 1898, Schenk 1899, 1901, 1905, 1906, 1907, 1908, 1909, 1914, 1915, 1916, 1919, 1920, 1921, Vezényi 1902, 1903, 1905, Greschik 1910, Lambrecht 1911, 1912, 1913, Hegyfoky 1917, Warga 1922, 1924, 1926, 1928). Arrival dates from Period 2 are from the area of Kevermes and Lőkösháza in Southeast Hungary. Detailed description of the study sites and the data collection can be found in Bozó (2017*b*). We collected 897 data from Period 1 and 298 data from Period 2.

For the analyses, we used the first field observation record of each species in each year. In studies dealing with long-term changes in spring migration phenology, researchers used the mean or median date of spring migration instead of the first arrival date which may be affected by both population size of the species and sampling effort (Tryjanowski & Sparks 2001, Miller-Rushing *et al.* 2008b). However, historical data sets usually include only the arrival time of the first birds and do not provide information on the median date of migration (Kullberg *et al.* 2015). Therefore, these studies are based on the first observation dates. In the case of Period 1, we used the first arrival dates from all available settlements, therefore, some species have more data than study years. The study species are listed in Table 1. It was not possible to separate the members of the local breeding birds from the migrants, therefore, in this study we consider the research area as a stopover site.

In each species, we calculated the mean values of the first arrival dates for both periods and to decide whether arrival dates differ between the two periods, we used two-sample t-probe. We also compared the shifts in arrival dates between the two periods for the species belonging to the two migration strategy groups by two-sample t-probe. In the case of the 11 species of which we have at least 15 data from Period 1, we tested the correlations between the earliest arrival dates and the average monthly temperature values by Pearson correlation. Average monthly temperature values were calculated from the mean daily temperatures. Monthly temperature values were obtained from the website of the National Meteorological Service (www.met.hu) and are derived from the regional temperature values of the study area. We used the temperature values of the months when the species arrived to the study area. We decided to use local weather data rather than values representing a larger spatial scale because some of these species never breed in the study area and therefore primarily used it as a stopover site. Arrival at or departure from the stopover site vary depending on the local weather (e.g. Dänhardt & Lindström 2001).

RESULTS

The mean spring arrival dates of the 36 study species between 1894–1926 (Period 1) and 2005–2019 (Period 2) are shown in Table 1.

Table 1. Mean spring arrival dates of the study species. Range means the earliest and the latest observation records (Month/Day), SD is the standard deviation, N is the number of the observation records while Pe is Period.

Species	Mean		Range		SD		N	
	Pe1	Pe2	Pe1	Pe2	Pe1	Pe2	Pe1	Pe2
Nycticorax nycticorax	4.12.	4.8.	4.2.–4.24.	3.15.–4.30.	±10.1	±14.2	4	10
Sylvia atricapilla	4.12.	3.30.	4.12.–4.16.	3.20.- 4.10.	±2.8	±6.2	2	13
Motacilla alba	3.13.	3.4.	2.13.–4.1.	2.16.–3.22.	±9.3	±12.4	48	12
Vanellus vanellus	3.16.	2.23.	2.12.–4.5.	2.3.–3.12.	±15.5	±11.5	13	13
Actitis hypoleuca	4.3.	4.18.	3.25.–4.12.	4.4.–4.28.	±7.4	±9	4	8
Upupa epops	4.10.	3.28.	3.17.–4.23.	3.19.–4.6.	±8.8	±5.9	32	8
Saxicola torquata	3.23.	3.5.	3.17.–4.5.	2.17.–3.21.	±8.5	±9.9	5	9
Phylloscopus collybita	3.26.	3.18.	3.4.–4.8.	3.3.–4.1.	±10.2	±7.8	19	13
Grus grus	3.17.	3.5.	3.2.–4.9.	2.25.–3.22.	±9.2	±8.7	32	12
Scolopax rusticola	3.11.	3.24.	2.22.–4.4.	3.5.–4.6.	±8.4	±14.1	47	6
Ciconia ciconia	3.29.	3.25.	3.4.–4.20.	3.13.–4.5.	±9.2	±7.3	64	13
Luscinia megarhynchos	4.13.	4.12.	4.4.–4.23.	4.7.–4.22.	±4.7	±5.5	28	12
Coturnix coturnix	4.25.	4.26.	4.1.–5.10.	4.8.–5.7.	±8.6	±10	19	9
Hirundo rustica	4.3.	3.28.	3.16.–4.15.	3.20.–4.5.	±5.9	±4.2	71	14
Oenanthe oenanthe	4.7.	4.4.	3.26.–4.16.	3.28.–4.18.	±8.2	±5.6	6	9
Crex crex	5.2.	4.22.	4.17.–5.19.	4.7.–5.7.	±7.9	±21.2	17	2
Cuculus canorus	4.8.	4.17.	3.21.–4.24.	4.3.–4.28.	±6.8	±8.1	46	12
Falco vespertinus	4.25.	5.1.	4.18.–5.5.	4.17.–5.17.	±7.1	±9.6	5	8
Sylvia borin	4.21.	5.3.	4.16.–4.30.	5.1.–5.5.	±7.8	±2.8	3	2
Phoenicurus phoenicurus	4.12.	4.13.	4.6.–4.23.	4.5.–4.18.	±6.7	±5.4	5	5
Lanius minor	5.2.	5.9.	4.24.–5.6.	5.1.–5.16.	±4.3	±6.3	7	9

Table 1 *(continued)*

Species	Mean		Range		SD		N	
	Pe1	Pe2	Pe1	Pe2	Pe1	Pe2	Pe1	Pe2
Ficedula hypoleuca	4.5.	4.17.	4.5.–4.6.	4.7.–4.28.	±0.7	±6.1	2	10
Caprimulgus europaeus	4.21.	4.18.	3.31.–5.8.	4.18.–4.19.	±14.7	±0.7	5	2
Alauda arvensis	2.1.	2.21.	2.7.–3.15.	2.10.–3.5.	±8.1	±6.3	34	12
Delichon urbicum	4.6.	4.5.	3.21.–4.14.	3.30.–4.9.	±5.1	±2.6	32	12
Jynx torquilla	4.8.	4.16.	3.31.–4.17.	4.12.–4.21.	±5.6	±3.8	7	5
Columba palumbus	3.7.	2.28.	2.1.–3.26.	2.15.–3.19.	±14.6	±7.8	13	9
Ficedula albicollis	4.15.	4.19.	4.10.–4.23.	4.7.–4.27.	±4.9	±6.7	6	8
Riparia riparia	4.17.	4.10.	4.9.–4.28.	4.4.–4.19.	±6.5	±5.9	8	9
Oriolus oriolus	4.26.	4.26.	4.15.–5.8.	4.17.–5.3.	±5.1	±4.9	45	13
Sturnus vulgaris	3.4.	2.19.	2.20.–3.21.	2.12.–2.26.	±8.9	±4.5	27	11
Coracias garrulus	4.23.	4.30.	4.16.–5.3.	4.21.–5.14.	±6.2	±12.3	7	3
Muscicapa striata	5.5.	4.28.	5.1.–5.7.	4.18.–5.5.	±3.5	±5.3	3	8
Lanius collurio	5.2.	4.28.	4.25.–5.12.	4.22.–5.3.	±6.9	±4.1	5	10
Streptopelia turtur	4.20.	4.21.	4.4.–5.2.	4.16.–4.27.	±5.9	±3.4	36	10
Falco tinnunculus	3.17.	2.22.	3.8.–3.29.	2.12.–3.3.	±8.8	±7.1	4	7

Table 2. Comparison of spring arrival dates of the two study periods. Species with very small sample sizes (<3 years) marked with *. Differences mean the differences between the two periods (mean arrival date of Period 1 – mean arrival date of Period 2). Under migration strategies, SD means the short-distance migrants and LD the long-distance migrants.

Species	p value	t value	Differences (day)	Migration strategy
Nycticorax nycticorax	0.490	0.4	–4	LD
*Sylvia atricapilla**	0.009	3.1	–15	SD
Motacilla alba	0.007	2.8	–9	SD
Vanellus vanellus	<0.001	3.9	–21	SD
Actitis hypoleuca	<0.014	–2.9	15	LD
Upupa epops	<0.001	3.8	–13	LD
Saxicola torquata	0.009	3.2	–18	SD
Phylloscopus collybita	0.020	2.5	–8	LD
Grus grus	<0.001	3.8	–12	SD
Scolopax rusticola	<0.001	–3.2	13	SD
Ciconia ciconia	0.142	1.5	–4	LD
Luscinia megarhynchos	0.692	0.1	–1	LD

Table 2 (continued)

Species	p value	t value	Differences (day)	Migration strategy
Coturnix coturnix	0.897	–0.1	1	LD
Hirundo rustica	0.001	3.5	–6	LD
Oenanthe oenanthe	0.418	0.8	–3	LD
Crex crex	0.143	1.5	–10	LD
Cuculus canorus	<0.001	–4.2	9	LD
Falco vespertinus	0.284	–1.1	6	LD
*Sylvia borin**	0.139	–1.9	12	LD
Phoenicurus phoenicurus	0.763	–0.3	1	LD
Lanius minor	0.175	–1.4	7	LD
*Ficedula hypoleuca**	0.027	–2.6	12	LD
*Caprimulgus europaeus**	0.775	0.3	–3	LD
Alauda arvensis	0.007	2.8	–8	SD
Delichon urbicum	0.662	0.4	–1	LD
Jynx torquilla	0.018	–2.8	8	LD
Columba palumbus	0.195	1.3	–7	SD
Ficedula albicollis	0.271	–1.2	4	LD
Riparia riparia	0.032	2.4	–7	LD
Oriolus oriolus	0.758	–0.3	0	LD
Sturnus vulgaris	<0.001	4.7	–13	SD
*Coracias garrulus**	0.295	–1.1	7	LD
Muscicapa striata	0.102	1.8	–7	LD
Lanius collurio	0.236	1.2	–4	LD
Streptopelia turtur	0.790	–0.3	1	LD
Falco tinnunculus	0.001	4.7	–23	SD

Spring arrival dates were earlier in Period 2 in the case of Common Kestrel, Common Crane, Northern Lapwing, Eurasian Hoopoe, Eurasian Skylark, Barn Swallow, Sand Martin, White Wagtail, European Stonechat, Blackcap, Common Chiffchaff and Common Starling. Spring arrival dates were later in Period 2 in the case of Common Sandpiper, Eurasian Woodcock, Common Cuckoo, Eurasian Wryneck and Pied Flycatcher. There were no significant changes in other cases (Table 2). Short-distance migrants arrive significantly earlier than long-distance migrants in Period 2 ($t = 4.037$, $p < 0.0001$).

In Period 1, the earliest arrival dates correlated negatively with monthly temperature in the Eurasian Skylark, while positively in the Common Cuckoo.

Table 3. Correlations between the arrival dates and the average monthly temperature values.

Species	R	p	R	p	Number of years	
	Period 1		Period 2		Period 1	Period 2
Ciconia ciconia	–0.335	0.108	–0.131	0.670	30	13
Grus grus	0.149	0.566	–0.421	0.173	20	12
Streptopelia turtur	0.208	0.377	–0.402	0.249	22	10
Cuculus canorus	0.502	0.028	–0.508	0.092	22	12
Alauda arvensis	–0.513	0.020	–0.592	0.042	21	12
Hirundo rustica	0.130	0.544	0.317	0.269	28	14
Delichon urbicum	–0.069	0.812	–0.696	0.011	18	12
Motacilla alba	–0.283	0.214	–0.456	0.136	23	12
Luscinia megarhynchos	–0.162	0.581	–0.457	0.135	15	12
Sturnus vulgaris	–0.506	0.112	–0.581	0.061	15	11
Oriolus oriolus	–0.303	0.160	–0.529	0.077	26	12

In Period 2, we revealed negative correlations in the Eurasian Skylark and the House Martin. Furthermore, there were marginally significant negative correlations in the Common Starling in both periods, and in the Common Cuckoo and the Golden Oriole in Period 2 (Table 3).

Table 4. Overwintering species in the Period 1.

Species	Year	Location
Fringilla coelebs	1900	Arad
Fringilla coelebs	1907	Arad
Fringilla coelebs	1922	Arad
Falco tinnunculus	1907	Arad
Alauda arvensis	1915	Máriaradna
Turdus merula	1922	Arad

Overwintering species

There are some data from overwintering species from Period 1. These species overwinter regularly nowadays, therefore it is important to note all these data (Table 4).

DISCUSSION

As a result of climate change, the distribution area (e.g. Csörgő *et al.* 2009), the timing of moult (Pulido & Coppack 2004), the timing of breeding (Both *et al.* 2004) and the timing and phenology of migration (Lehikoinen *et al.* 2004, Tøttrup *et al.* 2006) of birds are changing.

Although, in many cases, the results contradict each other. It is hardly possible to draw general conclusions, as the change in the timing of migration may vary by geographical area for the same species, or the pattern of migration of sibling species may give a different picture (Csörgő *et al.* 2009). The spring migration of several bird species in the Carpathian Basin has also changed compared to previous decades (Csörgő *et al.* 2009, Kiss *et al.* 2009, Kovács *et al.* 2009, Nagy *et al.* 2009). For some species, such as Marsh Warbler *Acrocephalus palustris* (Csörgő *et al.* 2009), this change does not mean earlier arrival time, but on the contrary, birds arrive later to the breeding grounds. However, these studies are based on a series of data, dating back only a few decades, as standard ringing data from before the middle of the 20th century are not available to researchers. Gyurácz and Balogh (2012) conducted similar study based on historical data, but they did not deal with the migration of birds, but with the change of their area in Vas county.

Research on historical data suggests that recently both short-term and long-term migratory birds return to nesting sites earlier than in the past (Sparks 1999, Kullberg *et al.* 2015). According to our results, we cannot draw general conclusions in this geographical area, as there are examples of species following both short- and long-distance migration strategies. For most long-distance migratory species, the spring arrival time has not changed, which can be explained by the fact that spring arrival in long-distance migrants is less affected by the temperature of the target area (Tryjanowski *et al.* 2002, Hubálek 2004, Miller-Rushing *et al.* 2008*a*). Their endogenous time program is more restricted (Both & Visser 2001, Coppack & Both 2002), birds are phenotypically less flexible (Pulido & Widmer 2005) and genetic variance in migration behaviour may also be smaller in long-distance migrants (Berthold & Querner 1995), which may limit any micro-evolutionary response to climate change. Also, it is important to note that trans-Saharan migrants can advance spring arrival to the same extent as short-distance migrants in recent years, suggesting that onset of migration in long-distance migrants may be more flexible than previously assumed (Jonzén *et al.* 2006). In the case of three long-distance migratory bird species (Eurasian Hoopoe, Barn Swallow, Sand Martin), we have experienced a shift to the earlier arrival in spring. Of these species, Ambrosini *et al.* (2011) has shown that the wintering area shifted to the north every year, and birds can winter in places where feeding sites are less suitable (warmer, drier habitats). This is combined with the even warmer breeding sites preventing earlier departure from the wintering grounds. In the case of Eurasian Hoopoe, a slight trend to an earlier spring arrival in recent years was found by Gordo *et al.* (2005) in a western Mediterranean area.

Some long-distance migrant species (Common Sandpiper, Common Cuckoo, Eurasian Wryneck, Pied Flycatcher, Lesser Grey Shrike) arrive later to the breeding grounds. In the case of Common Cuckoo, Gordo *et al.* (2005) found the same pattern in the western Mediterranean area, however, in Sweden, Kullberg *et al.* (2015) found that birds arrive earlier to the breeding ground recently. To explain such differences between populations, Gordo *et al.* (2005) suggested that long-distance migrants are obviously unable to gather direct information about the environmental conditions in their European breeding areas, but climatic variations in sub-Saharan Africa are better predictors than local climate conditions in Europe. Namely, different European populations overwinter in different African regions under contrasting climatic constraints leading to geographic variations in the onset of migration. The Pied Flycatcher is a typical example of species not arriving earlier to Europe in recent times (Both & Visser 2001). Six out of 14 long-distance migrant species (e.g. Sedge Warbler *Acrocephalus schoenobaenus*, Common Whitethroat *Sylvia communis*) studied in Scotland between 1974 and 1999 also arrived later in spring (Jenkins & Watson 2000), while two shorebirds, the Lesser Yellowlegs *Tringa flavipes* and Greater Yellowlegs *T. nebularia* also arrived later to the Delta Marsh, Canada (Murphy-Klassen *et al.* 2005). Our results are also consistent with these findings. In the case of the Pied Flycatcher, the main regulator of starting spring migration is the available food supply in the wintering ground, therefore the species cannot come back earlier. The background of this phenomenon may be that with the drying of wintering areas the amount of available food decreases, which results that the birds can start the migration with less and less fat, so they can move more slowly towards the breeding area (Gordo *et al.* 2005, Nagy *et al.* 2009). Thus, their arrival in the breeding grounds will be delayed.

Short-distance migrants display a more flexible behavioural response to local weather at stopover sites (Calvert *et al.* 2012) and the genetic control is also much smaller than in the case of long-distance migrants. Nine out of the 11 species arrive earlier to the study area than 100 years ago. These results are similar to the findings of Kullberg *et al.* (2015) in Sweden, who found that all short-distance migrants arrive earlier recently including five species studied by our work. However, in the case of Eurasian Woodcock, we found that the species arrive significantly later during Period 2. The reason for this pattern is probably the fact that the species is rarely observed during Period 2, in contrast, during Period 1, it was much easier to detect by the large number of the foresters. Somewhat surprising that there was no shift in the arrival date of Common Wood Pigeon despite the fact that the species recently regularly overwinter in the Carpathian Basin (MME Nomenclator Bizottság 2008).

Temperature and climate analyses have proven that birds, in general, respond to high temperature and positive NAO phases by arriving earlier (Lehikoinen *et al.* 2004). Birds cannot directly predict the conditions in the target area of their next flight (Lehikoinen *et al.* 2004), and, in addition to temperature, many other weather parameters may play a role (Zalakevicius 1993, Zalakevicius *et al.* 1995, Sparks *et al.* 2002). Most studies found a negative relationship between arrival time and spring temperature (Lehikoinen *et al.* 2004, Gienapp *et al.* 2007). From our study species, the same pattern was detected only for the Eurasian Skylark and Common Starling in both periods. In the case of three species (Common Cuckoo, House Martin, Golden Oriole), negative correlation was found in Period 2. This might mean that some of the short-distance migrants have been able to react to the current weather a century earlier as well as nowadays, while for the long-distance migrants this pattern is typical nowadays.

The latter can be paralleled with the aforementioned statement that the long-distance migrants are much more flexible than previously thought (Jonzén *et al.* 2006) and are able to depart to the breeding sites sooner due to the weather conditions prevailing at wintering sites (Gordo *et al.* 2005). It is very interesting that in the case of Common Cuckoo we found a significant positive correlation between arrival time and temperature in Period 1.

The winter occurrences of Chaffinch and Blackbird are now quite common, with a large number of birds overwintering in the Carpathian Basin (MME Nomenclator Bizottság 2008). Although, in the second half of the 19th century and at the beginning of the 20th century, these species were only described as forest nesters (Simonkai 1893). The author mentioned that Chaffinches also occur in winter with Crested Larks *Galerida cristata* and buntings along roadsides. However, urban nesting is not mentioned for any species. Thanks to milder winters, the migration habits of the Blackbirds have changed and more and more remain in the country (Móra *et al.* 1998), therefore also in the study site in winter (Bozó 2017*b*). In Common Kestrel and Eurasian Skylark, Simonkai (1893) did not mention winter occurrence, although he described both species as common breeders in the area. Consequently, it is likely that they could overwinter in the region much less often in the past than today (Bozó 2017*b*).

Since spring bird surveys in Period 1 had been carried out throughout the Carpathian Basin, it would be worthwhile to process these data and carry out a similar comparative analysis. All of these would be important so we could learn about the changes in species migration not only from a small local area, but from the entire Carpathian Basin.

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