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## CLIMATE CHANGE AND THE SPRING MIGRATION OF THE EUROPEAN SERIN *Serinus serinus*

*Klimatske promjene i proljetne migracije žutarice *Serinus serinus**

**ZDRAVKO DOLENEC**

Mokrice 132, 49243 Oroslavlje, Croatia

### ABSTRACT

Numerous migratory bird species have advanced their spring arrival over the past few decades. These arriving changes may be associated with climate change. The aim of this paper was to examine how the timing of the European Serin *Serinus serinus* spring migration is related to the year and the local spring air temperatures. The study was conducted in the rural area of the village Mokrice in north-western Croatia. This study shows that the European Serins have significantly advanced their first arrival date over the 37-year period by eight days. Over the same research period, the mean spring air temperature has significantly increased as well. The results indicate that the average spring air temperature affects the spring migration phenology of the European Serin in north-western Croatia.

**Keywords:** climate change, European Serin, arrival date, NW Croatia

### INTRODUCTION

Earth climate is changing (IPPC 2014), and evidence of the effect of the recent climate warming on plants and animals has rapidly accumulated. For instance, studies from across the world have illustrated that the flowering phenology has advanced in the spring and that this is closely linked with temperature changes (e.g. GAIRA *et al.* 2014). Furthermore, spring warming is linked with the earlier

e-mail: [zdravko.dolenc@biol.pmf.hr](mailto:zdravko.dolenc@biol.pmf.hr)

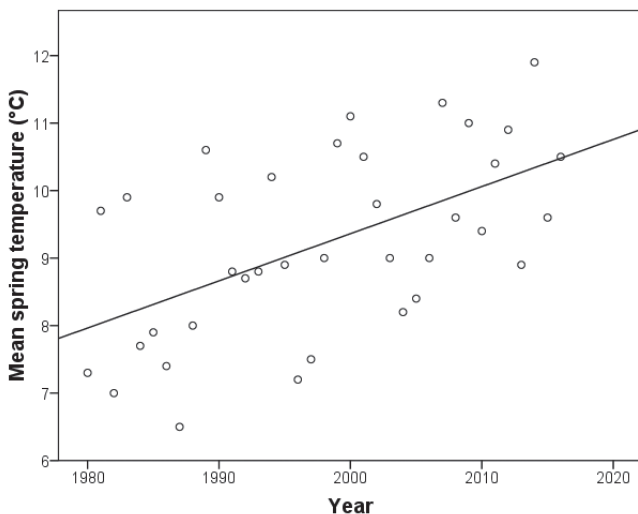
first spring flight by insects (e.g. KHAROUBA *et al.* 2014). In birds, climate change affects reproductive success (e.g. VENGEROV 2017), geographical distribution (e.g. LEHIKONEN & VIRKKALA 2016), clutch initiation (e.g. DOLENEC 2019a, 2019b), etc. Birds are one of the most studied groups of vertebrates, and most papers look at their phenology phenomena. Numerous studies show evidence of the advancement in the bird migration phenology. For instance, the arrival date of the Barn Swallow *Hirundo rustica* populations in Poland has advanced by 18 days over the period from 1970 – 2009 (BIADUN *et al.* 2011). Furthermore, arrival dates of the European Stonechat *Saxicola rubicola* have advanced by 21 days (1980 – 2016) in the mixed farmland area in north-western Croatia (DOLENEC 2018a). These shifts in migration phenology are associated with high spring air temperatures. Furthermore, there are reports from other continents on the shift in the bird spring migration as a response to climate change (e.g. BEAUMONT *et al.* 2006). The aim of this paper was to examine how the timing of the spring migration of the European Serin (*Serinus serinus*) related to the year and the local mean spring air temperatures in the period 1980 – 2016. The European Serin is a common, small and short-migratory bird in north-western Croatia. According to GILL & WRIGHT (2006), this bird species belongs to the family of Finches (Fringillidae) and the order of passerine (Passeriformes).

## MATERIAL AND METHODS

The area of this study is rural area located in the Mokrice village (46°00'N – 15°55'E, 6.4 km<sup>2</sup>, altitude approximately 140 m, Northwest Croatia). The data were collected between 1980 and 2016. This area mostly consists of mixed landscape (orchards, meadows, hedges, gardens etc.), with a small mixed deciduous forest (dominated by the Hornbeam *Carpinus betulus* and the Pediculate Oak *Quercus robur*). Observations between 1980 and 2016 were recorded by the author of this paper. The spring migration phenology for each year was calculated as the average of the first five bird arrivals registered for that year, according to BOTH *et al.* (2005). Dates were converted to numerical values in the following manner: 1 = 1<sup>st</sup> March. I have used temperature records for the study period from the nearest weather station (20 km) at the Maksimir station (Meteorological Office in Zagreb). The average mean spring air temperature was obtained from the average temperature for March and April (the arrival period). Temperature is an important parameter of weather in many long-term studies of bird phenology (e.g. TØTTRUP *et al.* 2010, DOLENEC 2018b). The statistical analysis of the trends in migration phenology and the spring average air temperatures was calculated by regression analysis and Pearson's coefficient of correlation. Significance was set at  $p \leq 0.05$  in all cases. Statistical analyses were performed using the SPSS 13.0 statistical package for Windows.

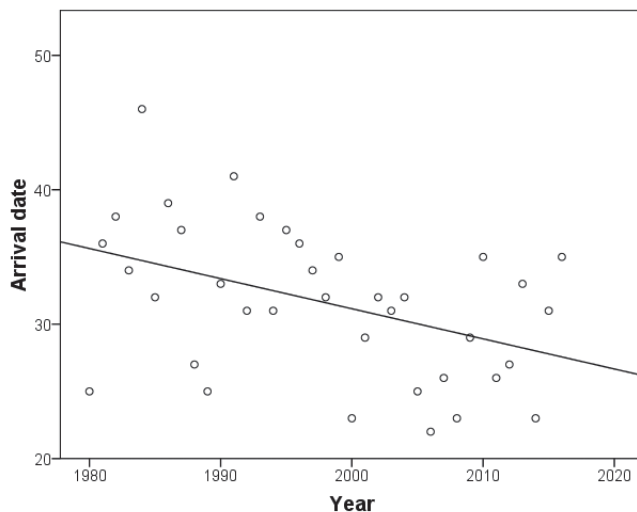
## RESULTS AND DISCUSSION

An analysis of long-term observations of the spring temperatures at the Maksimir meteorological station has revealed statistically significant trends of increase in the March-April mean air temperatures in the period between 1980 and 2016 (mean =  $9.2^{\circ}\text{C} \pm 1.36$ , range =  $6.5^{\circ}\text{C}$  (1987) to  $11.9^{\circ}\text{C}$  (2012); linear regression: slope =  $+0.07$ ,  $r^2 = 0.29$ ,  $p < 0.001$ ,  $n = 37$ ; Figure 1). In the research period, the spring warmed by 2.6 degrees Celsius. In the years between 1980 and 2016, the earliest spring migration of the European Serin was recorded on 22<sup>nd</sup> March (2006), whilst the latest was recorded on 15<sup>th</sup> April (1984). The mean arrival date was 31<sup>st</sup> March  $\pm 5.6$  (1980 – 2016). The difference between the minimum and the maximum values was 24 days. The relationship between the date of arrival and the year was statistically significant (linear regression: slope =  $-0.22$ ,  $r^2 = 0.18$ ,  $p = 0.008$ ,  $n = 37$ ; Figure 2). The arrival date of the European Serin advanced by up to eight days in the period 1980 – 2016. The relationship between the mean spring air temperature and the arrival was also significant (linear regression: slope =  $-1.97$ ,  $r^2 = 0.23$ ,  $p = 0.003$ ,  $n = 37$ ; Figure 3). Consequently, this results show that relatively high mean spring air temperatures can be associated with earlier arrival in the breeding grounds.



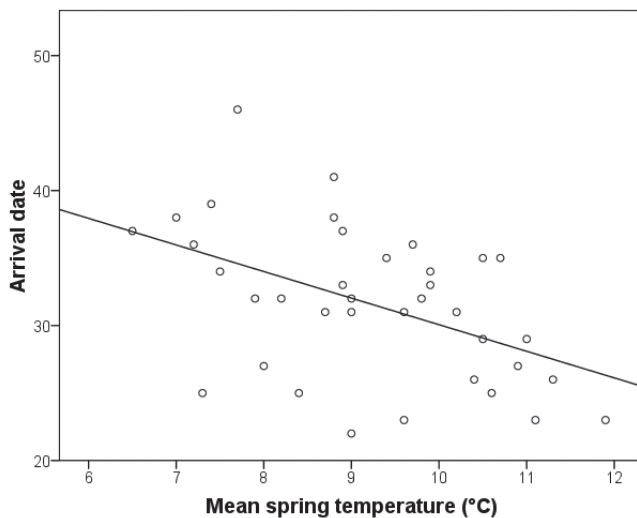
**Figure 1.** Relationship between the mean spring air temperature (March-April) and the year in the study area 1980 – 2016 (slope =  $+0.07$ ,  $r^2 = 0.29$ ,  $p < 0.001$ ,  $n = 37$ ).

**Slika 1.** Odnos između srednje proljetne temperature (ožujak-travanj) i godina istraživanja u razdoblju od 1980. do 2016. godine (nagib =  $+0,07$ ,  $r^2 = 0,29$ ,  $p < 0,001$ ,  $n = 37$ ).



**Figure 2.** Relationship between the arrival date and the year in the study area 1980 – 2016 (1 = 1<sup>st</sup> March; slope =  $-0.22$ ,  $r^2 = 0.18$ ,  $p = 0.008$ ,  $n = 37$ ).

**Slika 2.** Odnos između datuma povratka i godina istraživanja u razdoblju od 1980. do 2016. godine (1 = 1 ožujak; nagib =  $-0,22$ ,  $r^2 = 0,18$ ,  $p = 0,008$ ,  $n = 37$ ).



**Figure 3.** Relationship between the arrival date and the mean spring air temperature (March-April) and the year in the study area 1980 – 2016 (1 = 1<sup>st</sup> March; slope =  $-1.97$ ,  $r^2 = 0.23$ ,  $p = 0.003$ ,  $n = 37$ ).

**Slika 3.** Odnos između datuma povratka i srednje proljetne temperature (ožujak-travanj) u razdoblju od 1980. do 2016. godine (1 = 1 ožujak; nagib =  $-1,97$ ,  $r^2 = 0,23$ ,  $p = 0,003$ ,  $n = 37$ ).

The impact of the recent global warming has already been detected in numerous plant and animal species, including birds. I have examined the first arrival dates of the European Serin over a 37-year period, and their correlation with the local spring air temperatures and the research year. The European Serin has advanced its first arrival date between 1980 and 2016 by eight days in north-western Croatia. This advance was negative in correlation with the spring warmings. My results indicate that the average spring air temperature affects the spring migration phenology of the European Serin. Thus, the earliest arrival dates in this work can be associated with temperature changes. Previous studies showed different results: for instance, TRYJANOWSKI *et al.* (2002) documented an advance in the European Serin's spring arrival, whereas BIADUN *et al.* (2009) found no significant trend in this respect. This inter-population heterogeneity probably stems from different selection pressures in the environment, i.e. different phenotypic plasticity in different populations. In general, the first (or mean) arrival date of many, but not all, bird species and populations has advanced across the globe: for instance, in the USA (ZELT *et al.* 2017), Lithuania (ZALAKEVICIUS *et al.* 2006), and Australia (SMITH & SMITH 2012). Furthermore, birds breeding in Croatia have shown a trend towards an earlier arrival – both short- and long-distance migratory species (e.g. DOLENEC 2013, 2017), but not all (e.g. DOLENEC 2012, 2018c). The advancement in the arrival is related to the local mean spring air temperatures in Croatia.

Finally, numerous species and populations have shown major changes in many ecosystems in response to rapid climate warming over the past 40 years. Climate change has emerged as one of the most important topics in ecology and provides new challenges and opportunities for research (PRIMACK & MILLER-RUSHING 2012). According to TØTTRUP *et al.* (2010), „understanding what cues migratory organisms use to arrive at an optimum time is important for increasing our knowledge of fundamental issues like decision making in organisms during migration and is crucial for future protection of migratory organisms“.

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## SAŽETAK

Ptice su jedna od najbolje istraženih životinjskih skupina u odnosu na recentne klimatske promjene, a to se posebice odnosi na njihovu fenologiju. Mnoge vrste ptica reagiraju na sve toplija proljeća posljednjih desetljeća te se vraćaju ranije sa zimovanja ili sve ranije polažu jaja, ali ne sve vrste ili populacije unutar iste vrste. U ovom članku prezentirani su rezultati praćenja proljetne selidbe lokalne populacije žutarice *Serinus serinus* na području naselja Mokrice (46°00'N – 15°55'E; 6,4 km<sup>2</sup>; oko 140 m nadmorske visine; sjeverozapadna Hrvatska) u razdoblju od 1980. do 2016. godine. Prvo proljetno opažanje ptice često se koristi u analizama. Međutim u ovome članku, prvo pojavljivanje predstavlja prosjek prvih pet opaženih ptica kako bi se izbjegao mogući utjecaj eventualno ekstremno ranog povratka jednog primjerka na ukupni rezultat. Rezultati ukazuju na sve raniji povratak žutarice sa zimovanja na područje gniježđenja, odnosno, ptice se vraćaju osam dana ranije 2016. u odnosu na 1980. godinu. U spomenutom razdoblju došlo je do statistički značajnog porasta srednje proljetne temperature zraka, a korelacija između datuma povratka i srednje temperature ukazuje na značajnu povezanost tih parametara što u konačnici upućuje na zaključak da sve toplija proljetna temperatura utječe na raniji povratak žutarice sa zimovanja u 37-godišnjem razdoblju.