

# Role of Temperature during Spring Migration of the European Stonechat *Saxicola rubicola* (Linnaeus, 1766) (Aves: Muscicapidae) in NW Croatia

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**Abstract:** Average global air temperature continues to increase and this warming has been linked to numerous different aspects worldwide, having strong effect on ecosystems. During the past few decades, birds have shown significant changes in their phenology, morphology, demography, etc. I analysed long-term changes in first arrival date of the European stonechat during the period 1980–2016 in north-western Croatia. As spring air temperature increased, arrival date advanced significantly in the studied period. Over the past 37 years, the average arrival date of the European stonechat has advanced by 0.58 days per year. The relationship between spring arrival and temperature was significant. The results indicate that changes in spring migration may be linked to changes in local air spring temperature.

**Key words:** European stonechat, *Saxicola rubicola*, arrival date, spring temperature, Croatia

## Introduction

Average global air temperature continues to increase (IPCC 2014) and this warming has strongly affected the ecosystems worldwide in numerous different ways (e.g. WALTHER et al. 2002, PARMESAN & YOHE 2003, ROOT et al. 2003). For example, some amphibians do show a trend towards earlier breeding (e.g. GIBBS & BREISCH 2001) and some plants have advanced flowering (e.g. GAIRA et al. 2014). A good evidence of the influence of climate change on wildlife comes from studies of the phenology of birds. Phenology studies of single and multiple species show earlier arrival dates with increased spring temperature (e.g. JENKINS & SPARKS 2010, DOLENEC & DOLENEC 2011a) and some studies have illustrated that the majority of species have advanced breeding dates in the last few decades (e.g. DOLENEC et al. 2011, DUNN & MØLLER 2014). Furthermore, a growing body of evidence indicates that the direct and indirect impacts of climate change may also affect the latitudinal and elevational distribution (e.g. HITCH & LEBERG

2007), demography (e.g. REIF et al. 2008), population size (e.g. D'ALBA et al. 2009), community (e.g. FRAIXEDAS et al. 2015), etc. of bird populations.

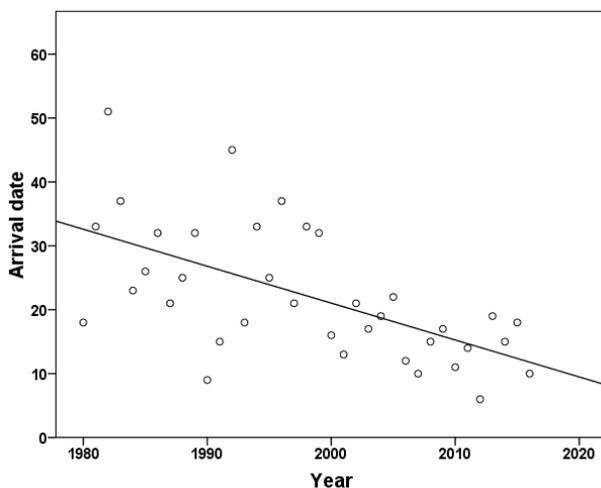
I examined the effect of long-term local air temperature on arrival date in the European stonechat *Saxicola rubicola* (Linnaeus, 1766), a common bird species in the study area. The European stonechat is a small insectivorous passerine that inhabits open landscapes (CRAMP 1998). This short-distance migration species is a regular breeding bird in northern coastal and in inland Croatia. According to HELM et al. (2006), it is an European migrant that winters around the Mediterranean Sea. Some papers have indicated short-distant bird migrants may advance arrival to nesting territory more than long-distance bird migrants (e.g. USUI et al. 2017).

## Materials and Methods

This study was conducted in the Mokrice rural area (46°00'N, 15°55'E; approximately 140 m a.s.l.;

6.4 km<sup>2</sup>), NW Croatia. The study area is a mixed farming area with small meadows and arable land. The arable land contains small woods (up to 10 ha) dominated by common oaks (*Quercus robur*) and European hornbeams (*Carpinus betulus*). First arrival date for each year was calculated as the mean of the first five bird arrivals recorded for the year (BOTH et al. 2005). Observations in the period 1980-2016 were recorded by the author who lives in the research area. Dates were converted to numerical values so that 1 indicates 1 March. To study the effect of mean spring air temperatures on the date of arrival, I used local temperature data for the months March and April (the studied species starts to arrive in north-western Croatia in these months). The recent advance in arrival date was illustrated for numerous passerine species and has been attributed to the local temperatures (e.g. RUBOLONI et al. 2007, DOLENEC & DOLENEC 2010a, 2010b, BIADUŃ et al. 2011, DOLENEC 2017). Similarly to earlier studies (e.g. HUŠEK & ADAMÍK 2008, DOLENEC et al. 2009, 2012, VISSER et al. 2015), I used information on local average March-April temperatures that was obtained from the weather station Maksimir (Meteorological Office in Zagreb, 123 m a.s.l.) located ca 20 km south of the Mokrice study area (March-April, mean = 9.2 °C, SD = 1.4, range = 6.5 to 11.5 °C).

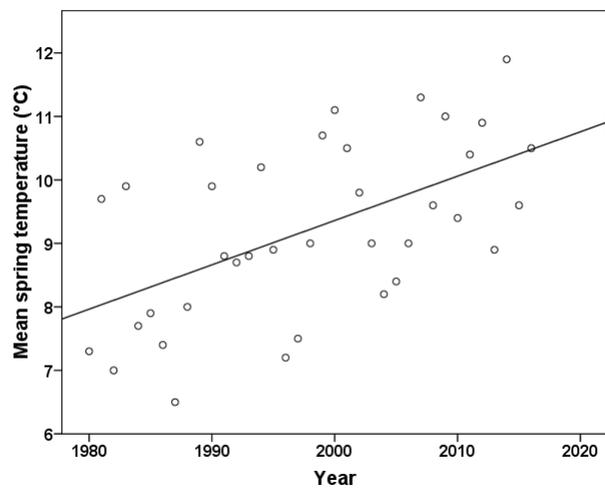
I performed a simple linear regression and correlation to assess trends in arrival date and temperature over the years of study. Graphical and statistical analyses were performed in SPSS 17.0 for Windows. The level of significance was set at  $P < 0.05$ .



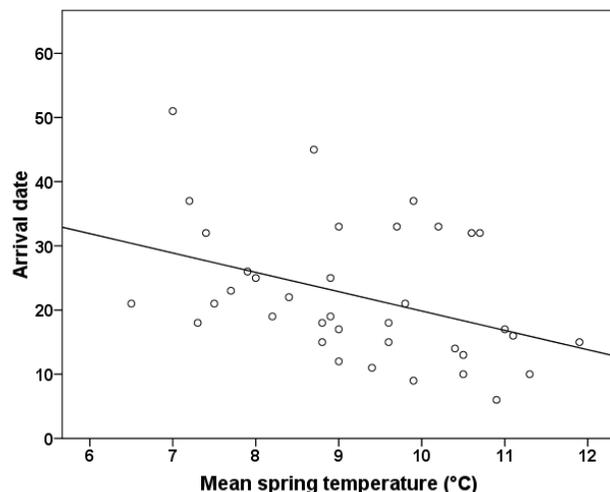
**Fig. 1.** Long-term trends in first arrival dates of the European stonechat *Saxicola rubicola* in north-western Croatia, 1980-2016 (1 = 1 March; the line is the linear regression line)

## Results

The average first arrival date of the European stonechat was 22 March (ranging 6 March to 20 April; SD = 10.41; 1980–2016). The relationship between arrival date and year was significantly negative  $y = 117.08 - 0.58x$  (simple linear regression,  $r = -0.601$ ,  $p < 0.001$ ,  $N = 37$ ; Fig.1), indicating that birds arrived earlier over the study period. Linear regression slopes indicated that arrival dates for the European stonechat have advanced by  $-0.58$  days/year (approximately 21 days/37 years). The average temperature in spring (March-April) for the period 1980–2016 for north-western Croatia is shown in Fig. 2. Regression reveals a significant increase ( $r = 0.553$ ,  $p < 0.001$ ,  $N = 37$ ;  $y = -130.33 + 0.07x$ ) equat-



**Fig. 2.** Relationship between mean spring temperatures (March-April) and year in north-western Croatia, 1980-2016 (the line is the linear regression line)



**Fig. 3.** Relationship between first arrival date and mean spring temperatures (March-April) of the European stonechat *Saxicola rubicola* in north-western Croatia, 1980-2016 (1 = 1 March; the line is the linear regression line)

ing to 2.6 °C over the 37 years. Average arrival date was significantly negatively associated with average spring air temperature ( $r = -0.396$ ,  $P = 0.015$ ,  $N = 37$ ;  $y = 49.99 - 3.01x$ ; Fig. 3). This result indicated that European stonechat responded to air spring temperatures by earlier arrival at breeding grounds.

## Discussion

Many studies have illustrated that particular species of birds are arriving earlier than in the past. For instance, long-term studies of the house martin (*Delichon urbicum*) in north-western Croatia (DOLENEC & DOLENEC 2011b) provide clear evidence that they have responded to long-term trends in spring temperatures by adjusting their arrival dates. Earlier studies show similar trends, e.g. the sand martin (*Riparia riparia*) in United Kingdom (CROXTON et al. 2006), reed bunting (*Emberiza schoeniclus*) in Denmark (TØTTRUP et al. 2006), barn swallow (*Hirundo rustica*) in Italy (RUBOLINI et al. 2007), warbling vireo (*Vireo gilvus*) in the United States of America (ELLWOOD et al. 2010), lesser whitethroat (*Sylvia curruca*) in Poland (BIADUŃ et al. 2011) and black redstart (*Phoenicurus ochruros*) in Croatia (DOLENEC et al. 2013). In contrast, some authors illustrated non-significant trends, e.g. for the red-backed shrike (*Lanius collurio*) in Lithuania (ZALAKEVICIUS et al. 2006), bluethroat (*Luscinia svecica*) in Norway (BARRETT 2011) and white wagtail (*Motacilla alba*) in Croatia (DOLENEC 2012). It can be expected that the ability of species to adapt to climate warming will depend on their phenological adaptability; species with poor phenological adaptability may face increasing stress during prolonged climate changes. Understanding ways in which plant and animals are responding to global warming is crucial to predict future responses. According to SCHNEIDER (2008), “the current available evidence gained through long-term datasets gives ample support for the impacts of global warming on avian life histories and individual fitness. However, the observed patterns of changes in fitness correlates in relation to increasing temperatures are far from showing a uniform picture”. Understanding the impact of the climate in bird phenology is a crucial step in future conservation of the bird species.

## Conclusion

I studied the response in terms of arrival date of a passerine bird, the European stonechat to long-term increasing of spring air temperatures (climate change). The European stonechat arrived around

21 days earlier in 2016 than in 1980. The arrival date was significantly negatively correlated with the spring temperature over the study period (1980–2016). These results indicate that changes in spring migration timing are linked to changes in the local air spring temperature.

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