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Research note

Zdravko DOLENEC[1], Petra DOLENEC[2], Jelena KRALJ[3], Darinka KIŠ NOVAK[4]

[1] Department of Zoology, Faculty of Science, University of Zagreb, Rooseveltov trg 6 HR-10000 Zagreb, Croatia, e-mail: dolenec@zg.biol.pmf.hr (*correspondening author*)
[2]Mokrice 132, HR-49243 Oroslavje, Croatia
[3] Institute of Ornithology, Croatian Academy of Sciences and Arts, Gundulićev a 24 HR-10000 Zagreb, Croatia
[4] Faculty of Teacher Education, University of Zagreb, Centre in Čakovec, Starčevićeva 55 HR-40000 Čakovec, Croatia

LONG-TERM TRENDS IN TIMING OF BREEDING OF THE BARN SWALLOW *HIRUNDO RUSTICA* L. IN CROATIA

ABSTRACT: Climate change is known to have number effects on plants and animals. Several studies have indicated advances in laying dates of birds in the last *ca*. 40 years, which could be attributed to air temperatures. The research was conducted in the village of Mokrice, a part of the Hrvatsko Zagorje region (northwestern Croatia). We studied the long-term variation in the laying date of Barn Swallow *Hirundo rustica* in order to examine their breeding phenology in relation to mean spring temperature. The Barn Swallow is a common bird species in the study area. We found a significant correlation between the first laying date and year. The coefficient of regression (slope = – 0.36) for Barn Swallows indicates an earlier breeding by 0.36 days per year, or 10 days over the period of the study (1979–2007). Our studies suggested that date of clutch initiation in the studied population is influenced by spring temperatures.

Mean global temperature have increased by 0.6°C over the past century (Houghton *et al*. 2001). Global warming is affecting many plant (e.g. Menzel and Fabian 1999) and animal (e.g. Beebe 1995) taxa. Many bird studies provide evidence of change in the timing of breeding (e.g. McCleery and Perrins 1998, Dunn and Winkler 1999, Sergio 2003) and migration (e.g. Sokolov *et al*. 1998, Croxton *et al*. 2006, Kralj and Dolenec 2008), and it is likely that these trends are caused by climate change. Furthermore, other biological features of birds, for example: geographical distribution (e.g. Hitch and Leberg 2007), fitness components (e.g. Sanz *et al*. 2003), egg size (Järvinen 1994) or population dynamics (Both *et al*. 2006) have been significantly linked to climate change. Local temperature changes have been shown to advance laying dates (e.g. Crick *et al*. 1997, Brown *et al*. 1999, Hušek and Adamík 2007).

We investigated the long-term variation in the laying date of Barn Swallow *Hirundo rustica* in order to examine their breeding phenology in relation to mean spring temperature. The Barn Swallow is a common bird in the study area. According to Møller (1994), the Barn Swallow is a *ca*. 20 g aerially foraging passerine that breeds in temperate and subtropical regions of the northern hemisphere, with European populations wintering south of the Sahara. The birds of our study area belong to the subspecies *Hirundo rustica rustica* (Vaurie 1959).

This study was conducted in the village of Mokrice, a part of the Hrvatsko Zagorje region (northwestern Croatia). The position of the study area is 46°00´N and 15°55´E and its

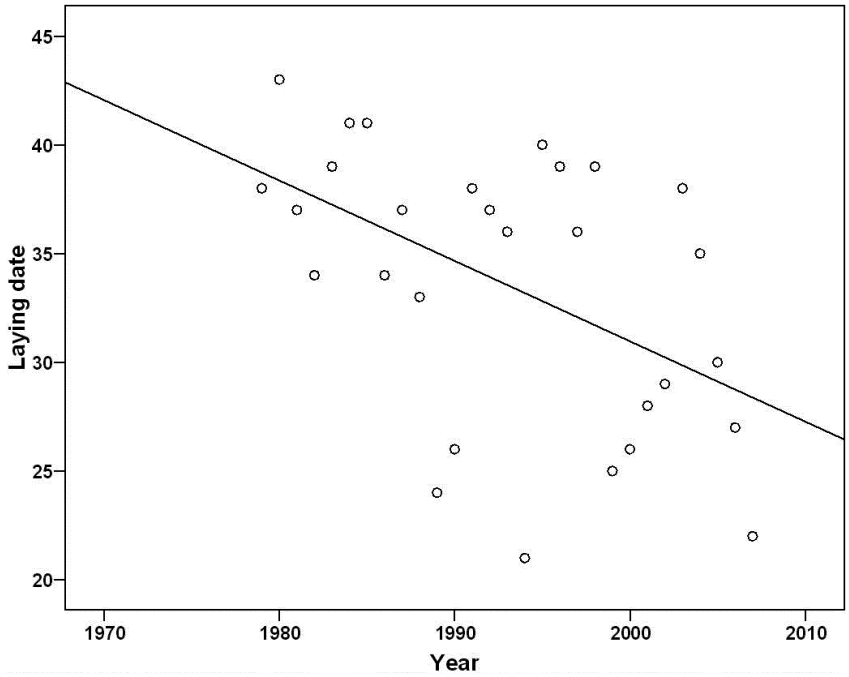

Fig. 1. Temporal trend in laying date (1 April = 1) of the Barn Swallow, 1979–2007. The term "laying date" is defined as the date of laying of the first egg in a clutch.

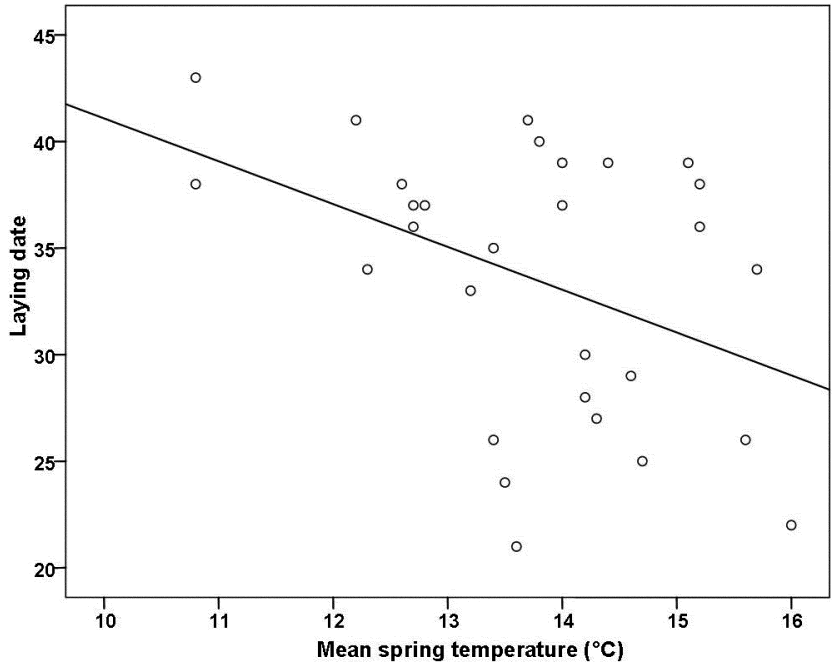

Fig. 2. Laying date (1 April =1) of Barn Swallow in relation to mean spring temperatures (°C), 1979–2007. The term "laying date" is defined as the date of laying of the first egg in a clutch.

altitude is about 140 m above sea level. Our investigations comprise the period from 1979 to 2007. Laying dates of first eggs were used as estimates of timing of breeding. The term "laying date" is defined as the date of laying of the first egg in a clutch. Only the first clutches were included. Nests were inspected every 1–5 days. Annual average of number of breeding pairs for research period varied (year to year) between 35 and 46 nests (mean =40.3

nests, total = 1168 nests). Spring temperature was calculated as a mean of April and May (breeding period) temperatures. This method was previously used by Møller (2008). Mean monthly Mokrice area (measured in town Maksimir – 20 km from village of Mokrice) air temperatures for April and May (1979–2007) were provided by the Meteorological Office in Zagreb (April, mean = 11.1°C, SD = 1.5, range = 8.2 to 14.2°C; May, mean = 16.3°C, SD = 1.6, range = 12.4 to 16.3°C; total mean temperature April–May, mean = 13.7°C, SD = 1.3, range = 10.8 to 16.0°C). All the statistics were performed on mean values per year, and tested using Pearson`s correlations with two-tailed *P*-values. Significance was assumed at $P \leq 0.05$.

The mean laying date of the Barn Swallow population (from 1979 to 2007) was 2 May (SD = 6.3; range: 21 April 1994–12 May 1984). Correlation between first laying date and year was significant (r = –0.49, $P = 0.006$, N = 29). The relationship between laying date (y) and year (x) can expressed as $y = 769.88 - 0.36x$ (Fig. 1). In order to analyse collected data two simple regression analyses with one dependent and one independent variable were conducted. In first analysis the predictor variable was mean spring temperature and the criterion varied was first laying date and in second analysis the predictor variable was year and the criterion variable was a standardised residual from first regression analysis. In first analysis mean spring temperature explained 19.3% of variance of dependant variable width significant $\beta = 0.440$ ($t = -2.544$, $P < 0.05$; Fig. 2). In second analysis 7.5% of variance of residual was explained with year as predictor variable, but $\beta = 0.274$ ($t = -1.48$, $P > 0.05$) was not significant. The lack of significance in second regression analysis suggests that the trend of laying date observed during 1979 to 2007 was caused by the long-term changes in temperature in Croatia.

Many studies have indicated advances in laying dates of birds in the last *ca*. 40 years, which can be attributed to spring air temperatures. For example, Hussel (2003) make the assumption that the earlier timing of breeding of the Tree Swallow (*Trachyneta bicolor*) were due to increasing spring temperatures. We can confirm this for the Barn Swallow in this study. The date of clutch initiations is significant related to April–May, being earlier in years with high than with low spring temperatures. The significant temporal trend in laying dates of Barn Swallows is consistent with the findings of a similar study in Italy (Rubolini *et al*. 2007) and Denmark (Møller 2008). According to Both *et al*. (2005), the ultimate reason for the advancement in timing of breeding in birds probably lies in the advancement of other parts of the food chain. The phenological consequences of climate change could lead to reductions in productivity and make bird populations to be unable to track changes in food availability and to adjust their timing of reproduction accordingly (Leech and Crick 2007).

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