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Influence of the local spring warming on the breeding phenology in blackcap (*Sylvia atricapilla*) in Croatia

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Abstract

Recent papers have shown that climate change affects many species, including birds. Several papers from different areas have devoted attention to the negative correlation between the dates of breeding and year, and also negative correlation between the dates of breeding and air spring temperatures. Recent work give some firm evidence for postulating causal relationship between spring temperature and laying dates. We used 31 years (1979-2009) of data from blackcap *Sylvia atricapilla* in Mokrice area, Northwestern Croatia to assess whether there has been any systematic change in breeding phenology through time. Among environmental factors possibly affecting the breeding date, consideration was given to mean monthly air temperatures (April-May). Over the past three decades, the breeding date of blackcap in our study population has changed significantly: They started breeding progressively earlier (11.77 days). Two regression analysis with laying date as criterion variable showed that spring temperatures can significantly predict variation of laying date and that there are also some other unknown factors which significantly explain variation of laying date. We conclude that blackcaps across northwestern Croatia are breeding earlier and that mean air spring temperatures is probably the most important factor causing it, among other factors.

Key words

Blackcap, Trend, Laying date, Spring temperatures, Croatia

Introduction

Global mean air temperatures have risen by 0.6°C since the late 19th century, primarily trough an increase in mean spring and winter temperatures (Houghton *et al.*, 2001). According to Hughes (2000), climate change may affect the distribution, phenology, physiology and adaptations of many organisms. For example, the active growing season of plants has advanced eight days in northern latitudes (Myneni *et al.*, 1997), warmer air temperatures are associated with earlier spawning by amphibians (Tryjanowski *et al.*, 2003) and global climate changes have shortened the hibernation period of a marmot species (Inouye *et al.*, 2000). These climate changes have had a major impact on birds. Birds are a very–studied group of organisms and it is believed that they can respond very rapidly to environmental changes (Lemoine *et al.*, 2007). These effects include, for example: earlier arrival (Tryjanowski *et al.*, 2002; Dolenec and Dolenec, 2010), changes in population dynamics (Both *et al.*, 2006; D'Alba *et al.*, 2010), increase in clutch size (Schaefer *et al.*, 2006), changes in egg dimensions (Järvinen, 1994; Potti, 2008) changes in brood size (Hušek and Adamík, 2008; Dolenec, 2009a) *etc.* Increasing evidence suggests that climate warming has impacted on timing of breeding (Crick *et al.,* 1997; Halupka *et al.*, 2008; Dolenec *et al.,* 2009). Furthermore, changes in climate have led to several bird species extending their geographic ranges northward (Thomas and Lennon, 1999; Hitch and Leberg, 2007).

In this study we analyse trend in timing of breeding and the effect of temperature on that trend of blackcap *Sylvia atricapilla*, studied during 31 breeding seasons during 1979-2009.

Materials and Methods

A population of blackcap was studied during 1979-2009 in the Mokrice area (ca. 30 ha), Northwestern Croatia (46°002 N, 15°552 E). The attitude of the research area is about 140 m above sea level. The blackcap is a dominant open-nesting passerine in

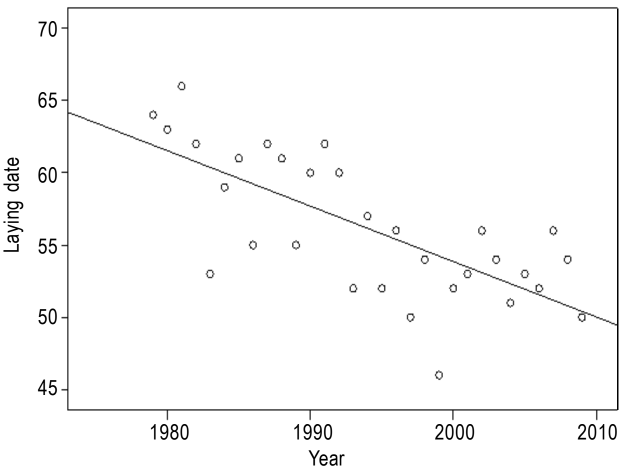

Fig. 1: Scatter diagram for regression analysis with year (1979–2009) as predictor variable and first egg laying date (1 April = 1) as a criterion variable ($R = 0.714$, $R^2 = 0.511$, $b = -0.38 \pm 0.07$, $F = 30.26$, $p < 0.001$)

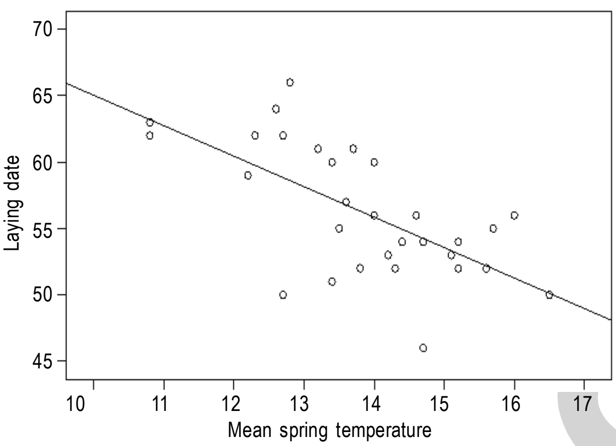

Fig. 2: Scatter diagram for regression analysis with mean April–May temperature (°C) as predictor variable and first egg laying date (1 April = 1) as a criterion variable ($R = 0.644$, $R^2 = 0.414$, $b = -2.29 \pm 0.51$, $F = 20.50$, $p < 0.001$)

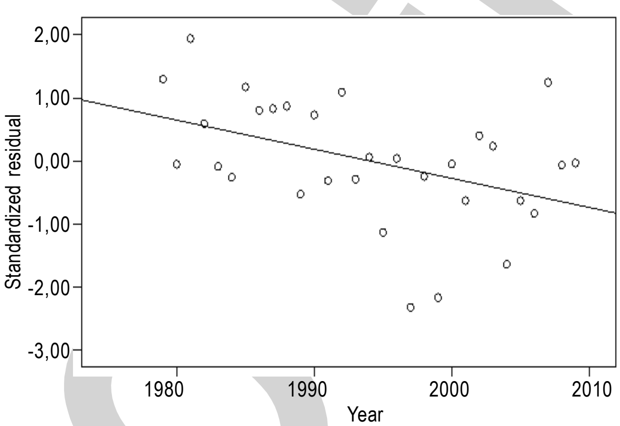

Fig. 3: Scatter diagram for regression analysis with year (1979–2009) as predictor variable and standardised residual from second regression analysis as a criterion variable ($R = 0.428$, $R^2 = 0.183$, $b = -0.046 \pm 0.018$, $F = 6.49$, $p < 0.05$)

numerous habitats (Hagemeijer and Blair, 1997).This area is mostly mixed landscape with small deciduous forests.

Laying date was calculated as mean of the date when the first egg of a clutch was laid for all recorded pairs. Dates were converted to numerical values such that 1 = 1st April and 31 = 1st May. Research area was visited on daily basis starting with April 1st. Mean of number of breeding pairs for study period (1979–2009) was 14.09 yr^{-1} (range 9 – 24, SD = 3.351). Thus, the study includes only first clutches (renests after failure and second clutch were not included). To evaluate the effect of climate on the earliest laying date, we took into account temperature data from breeding grounds since air spring temperature is an important environmental parameter (Sokolov *et al.*, 1998; Dolenec, 2005; Hušek and Adamík, 2008). April and May are the months when most blackcaps make their first reproductive attempts so our assumption is that April and May temperature would be the most important environmental factors influencing the onset of clutch initiation. Local spring temperature was obtained from the weather station at Maksimir – Meteorological Office in Zagreb (ca. 20 km from the centre study area, 123 m above sea level)(April–May, mean = 13.9°C, SD = 1.369, range = 10.8 to 16.5°C).

Regression analysis was used for revealing connections between timing of breeding, on the one hand, and spring temperature and year, on the other hand. All statistics were calculated using SPSS 13.0 for Windows, p-values higher than 0.05 were considered non–significant.

Results and Discussion

The onset of reproduction in blackcap in Mokrice area has advanced 11.77 days (0.38 days $year^{-1}$) over the past three decades (range: 15 April – 6 May, mean = 25 April; trend over time: regression analysis $R = 0.714$, $R^2 = 0.511$, $b = -0.38 \pm 0.07$, $F = 30.26$, $p < 0.001$; Fig. 1). In order to analyse data two more regression analysis with one dependent and one independent variable were conducted. In second analyses predictor variable was mean spring temperature and criterion variable was first laying date and in third analyses predictor variable was year and criterion variable was a standardised residual from first regression analyses. In second analysis mean spring temperature explained 41.4% of variance of dependant variable width significant $\beta = 0.644$ ($R = 0.644$, $R^2 = 0.414$, $b = -2.29 \pm 0.51$, $F = 20.50$, $p < 0.001$; Fig. 2). In third analysis 18.3% of variance of residual was explained with year as predictor variable, $\beta = 0.428$ ($R = 0.428$, $R^2 = 0.183$, $b = -0.046 \pm 0.018$, $F = 6.49$, $p < 0.05$; Fig. 3) was significant. This significance of β in last two regression analyses suggests that beside mean spring temperature there are also other important factors that influence timing of breeding which still have to be investigated.

The date of laying was significantly predicted with the mean spring air temperatures. Between 1979 and 2009, mean ambient temperature (April–May) increased significantly. This result suggests that blackcap respond to spring temperatures by earlier breed in study area (and period). Similar relationships have been found in several other bird species. For example, studies of the mexican jay (*Aphelocoma ultramarina*) in USA (Brown *et al.*, 1999), black kite (*Milvus migrans*) in Italy (Sergio, 2003), reed warbler (*Acrocephalus scirpaceus*) in Poland (Halupka *et al.*, 2008), red–backed shrike (*Lanius collurio*) in the Czech Republic (Hušek and Adamík, 2008) and nuthatch (*Sitta europaea*) in Croatia (Dolenec, 2009b) all show similar results. According to Crick *et al.* (1997), earlier nesting could be beneficial if juvenile survival is enhanced by a prolonged period before winter. Furthermore, warmer temperatures could lead to a greater supply when parents are feeding nestlings and, hence, greater fledging success; conversely, it could also produce a mismatch between the timing of breeding food supply and, consequently, lower fledging success (Dunn, 2004). Relatively few works have researched the impacts of climate change on fledging success. The results appear to be variable: (1) long-term decrease (Moss *et al.*, 2001), (2) long–term increase (Møller, 2002) and (3) no changes in fledging success (Winkler *et al.*, 2002). According to Dunn (2004), studies on birds have made major contributions to understanding the response of animals to climate change, and they will be important in the future for monitoring and understanding the mechanistic basis for phenological change. Although there is a large body of knowledge about the breeding biology of birds, one of the biggest challenges in the future will be to predict how climate change will affect the reproductive performance of different species throughout their ranges. The degree to which different individuals are able to track these temporal changes will have a significant bearing on population sizes and distributions in the future (Leech and Crick, 2007).

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