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A LONG-TERM STUDY OF EGG DIMENSIONS IN THE TREE SPARROW *Passer montanus* IN RELATION TO CLIMATE CHANGE

Dugogodišnje istraživanje dimenzija jaja populacije poljskog vrapca Passer montanus u odnosu na klimatske promjene

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ABSTRACT

Recent studies have illustrated that increasing temperatures have had considerable effects on species and entire ecosystems. In this study I examine long-term trends of egg dimensions (length, breadth and volume) in the population of Tree Sparrows (*Passer montanus*), investigated during 36 years (1980–2015), in relation to spring temperatures. This species is a common, sedentary, hole-nesting and socially monogamous passerine bird in research area. Research took place in Mokrice area in north-western Croatia. Average temperatures in spring (mean March–April) have significantly increased during the monitored period of time. In population in north-western Croatia there was no increase or decrease in egg dimensions. Correlations between mean spring temperatures and mean egg length, and egg breadth and egg volume were not significant. Spring precipitations (March–April) did not change over the years and did not affect egg dimensions. Data on changes in egg dimensions are relatively scarce in comparison with data on other breeding parameters in birds and, in some cases, controversial; some authors report increase in egg dimensions while others report decreases in egg dimensions in different bird species and populations as a response to climate warming. Thus, changes in egg dimension are a very complex issue in bird demography because there are many traits apart from climate that have impact on egg size, such as female condition, genetic

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and habitat characteristics etc., so further investigations on this subject are necessary.

Keywords: Tree Sparrow, *Passer montanus*, egg dimensions, spring temperature, spring precipitation, north-western Croatia

INTRODUCTION

Global mean temperature has increased by more than 0.75°C during the last century (IPCC 2007). Meta-analyses and other studies have illustrated that increasing temperatures have had considerable effects on many organisms in the world. For instance, higher spring temperatures have led to the earlier emergence of yellow-belied marmots (*Marmota flaviventris*) from hibernation in the USA (Inouye *et al.* 2000) and warmer air temperatures are associated with earlier spawning by amphibians (Tryjanowski *et al.* 2003). Increasing evidence suggests that climate change has consequences on birds. Numerous papers have reported changes in breeding phenology (e.g. Dunn & Winkler 1999, D'Alba *et al.* 2010; Dolenec & Dolenec 2011a, Dolenec *et al.* 2012) and migration phenology (e.g. Kralj & Dolenec 2008, Dolenec & Dolenec 2010b). On the other hand, some bird species have not changed their arrival dates or laying dates during approximately the last 30 years (Weidinger & Kral 2007, Dolenec 2012, Dolenec 2013a, Dolenec 2015). Furthermore, recent climate warming has been shown to affect the distribution of different species (e.g. Thomas & Lennon 1999, Jiménez-Valverde *et al.* 2011). The impacts of climate change on demographic factors, breeding performance and survival, which affect the population dynamics of species, have been less well explored than phenology; several studies have shown trends in various aspects of breeding performance that correlate with trends in climate (Crick 2004). Some studies documented increased brood size (e.g. Hušek & Adamík 2008, Dolenec 2009), while others reported changes in clutch size (e.g. Järvinen 1996, Møller 2002). Furthermore, some papers reported changes in egg size (e.g. Potti 2008, Barret *et al.* 2012).

In this study, I have examined long-term trends of egg dimensions (length, breadth and volume) in a population of Tree Sparrows (*Passer montanus*) during 36 years in relation to climate parameters (mean spring temperatures and precipitations) and research period (1980–2015). The size of eggs to lay is one of the first problems that an individual bird faces at the beginning of the reproductive cycle (Hõrak *et al.* 1995), and large eggs produce large offspring which may grow and survive more successfully than offspring hatched from small eggs (e.g. Wiliams 1994, Krist 2011). This species is a sedentary, hole-nesting and socially monogamous passerine bird (Cramp 1998) and common species in my research area (Dolenec *et al.* 2011a). Data on changes in egg dimensions are relatively scarce, in comparison with data on other breeding parameters (Crick 2004).

MATERIAL AND METHODS

Research took place in Mokrice village area (46°00'N, 15°55'E; ca. 140 m above sea level) in north-western Croatia from 1980 to 2015. The study area is a small mixed farming area with arable land containing small forests (up to 10 ha). The relief is mostly undulating lowland. I studied tree sparrows breeding in nest-boxes that had the dimensions of approximately 12 cm × 12 cm × 25 cm, the diameter of the entrance hole being 3.2 cm. The birds bred in nest-boxes placed at a height of 2.5–4 m, and all nest-boxes had a sliding top that allowed monitoring of breeding events. Mean number of breeding pairs for study period varied from year to year between 15 to 30 nests (mean = 23.8 nests; total = 855). The study area was visited daily during the breeding season. The study includes only first clutches. All eggs were measured ("Somet" callipers) to the nearest 0.01 mm (maximum length and maximum breadth). Egg volume (cm^3) was calculated from Hoyt's (1979) formula: volume (V) = 0.51 × length (L) × breadth $(B)^2$. This method was previously used on many bird species (e.g. Dolenec *et al.* 2008, Dolenec *et al.* 2011a, Dolenec 2013, Bowers *et al.* 2015).

Meteorological data (mean March–April temperature, 1980–2015) were supplied by the station of Maksimir (123 m a.s.l.) – Meteorological Office in Zagreb, about ca. 20 km from the research area (March–April, mean = 9.2 ± 1.37 °C; range = 6.5 to 11.9 °C). To evaluate the effect of climate on the egg size, I took into account temperature data from breeding grounds since local air spring temperatures are an important breeding parameter (e.g. Hušek & Adamík 2008, Dolenec *et al.* 2009, Dolenec & Dolenec 2010b). Another climate parameter I used was precipitations (in millimetres). Average spring precipitation (March–April) in research period was 55.2 (range = 18.2 to 97.9).

All the statistics were performed on average values per year, and tested using Pearson's correlations with two tailed P-values. The threshold for statistical significance has been set at the P = 0.05 level. Statistical analyses were performed using the SPSS 13.0 statistical package. Dates were expressed as progressive days, where 1st March = 1.

RESULTS

Overall, 855 nests were analysed between 1980 and 2015 located in Mokrice area (north-western Croatia). Eggs averaged 19.0±0.32 mm (range = 18.4 to 19.8 mm) in length, 14.1±0.23 mm (range = 13.7 to 14.5 mm) in breadth and 1.93±0.06 cm^3 (range = 1.81 to 2.07 cm^3) in volume. Egg length (r = 0.117, p = 0.496, n = 36), egg breadth (r = – 0.191, p = 0.267, n = 36) and egg volume (r = – 0.192, p = 0.261, n = 36) in the studied Tree Sparrow population did not decrease or increase over a 36-year period. Correlation between mean spring temperatures (March–April) and mean egg length (r = – 0.141, p = 0.415, n = 36), egg breadth (r = – 0.008, p =

0.964, n = 36) and egg volume (r = – 0.058, p = 0.737, n = 36) were not significant. However, spring temperatures (means of March–April values) have risen significantly (r = 0.537, p = 0.001, n = 36) from 1980 to 2015 in the research area, indicating a mean increase by 2.52 °C (slope = 0.07; Figure 1). Relationship between mean spring precipitations (March–April) and mean egg length (r = 0.071, p = 0.682, n = 36), egg breadth (r = 0.081, p = 0.641, n = 36) and egg volume (r = 0.156, p = 0.362. n = 36) were not significant. Mean spring precipitations (March–April) did not change systematically during 1980–2015 (r = 0.053, p = 0.761, n = 36).

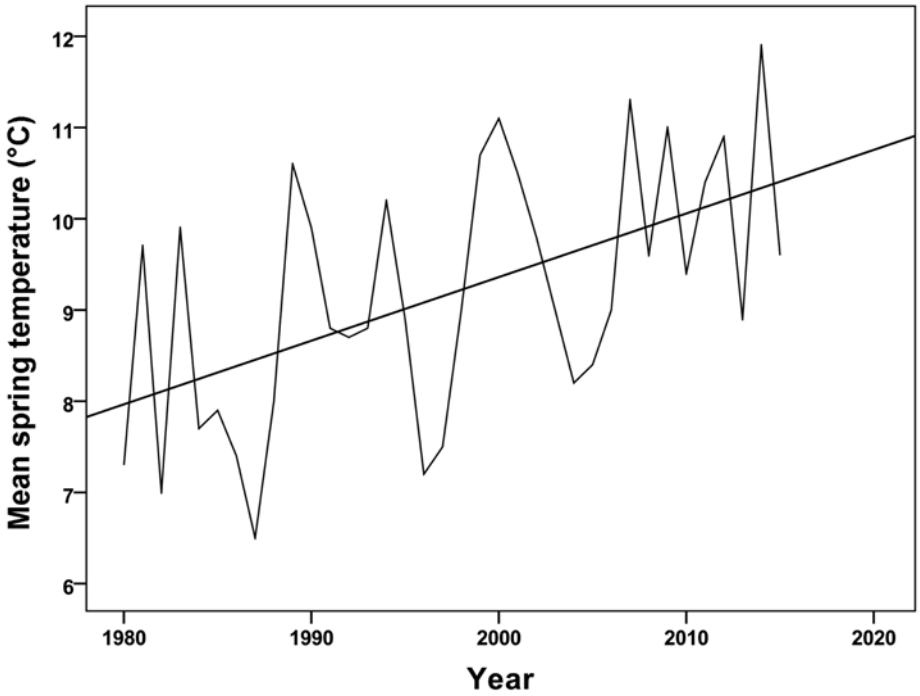

Figure 1. Increase in the mean temperature in March-April from 1980 to 2015 (r = 0.537, p = 0.001, n = 36). Meteorological data were supplied by the station of Maksimir – Meteorological Office in Zagreb.

Slika 1. *Porast srednje temperature u ožujku i travnju od 1980. do 2015. (r = 0.537, p = 0.001, n = 36). Meteorološki podaci dobiveni su za postaju Maksimir od Državnog hidrometeorološkog zavoda u Zagrebu.*

DISCUSSION

Laying dates of Tree Sparrow have advanced significantly in this area, while clutch size did not change (Dolenec *et al.* 2011b). Results of this study have shown that there has been no increase or decrease in egg dimension either. Significant growth of spring temperatures (March–April) in study period had

no influence on average egg dimensions (length, breadth and volume). Spring precipitation (March–April) did not change over the years and did not effect of egg dimensions. The importance of precipitation patterns change for animals remains poorly understood (e.g. Gordo 2007). So far, relatively few studies have examined the impact of climate change on egg dimensions, and the results appear to be variable. According to Potti (2008), in Pied Flycatcher *Ficedula hypoleuca*, population analyses demonstrate that egg breadth, yet not egg length, has decreased significantly along the 16-year period, leading to marginally non-significant decreases in egg volume. Tryjanowski *et al.* (2004) found a decrease of mean egg size with warmer temperatures in Polish populations of Red-backed Shrike (*Lanius collurio*), while Järvinen (1994) found exactly the opposite trend in a Pied Flycatcher (*Ficedula hypoleuca*) population in Finland. According to Tryjanowski *et al.* (2004), predictions about the consequences of climate warming on egg size are not straightforward; this is because climate change is only one of the traits that may have impact on egg size; other traits such as female condition, individual size, genetic characteristics, habitat characteristics etc. should also be taken into consideration (e.g. Christians 2002, Both & Visser 2005, Dolenec *et al.* 2007). Ornithology has provided several of the best examples of the effects of recent climate change on wildlife from around the world. We have, however, only begun to scratch the surface (Crick 2004).

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SAŽETAK

U posljednjih dvadesetak godina sve više radova dokumentira utjecaj klimatskih promjena kako na pojedine vrste tako i na cijele ekosustave. U ovome radu dati su rezultati dugogodišnjeg uzorkovanja dimenzija jaja (duljina, širina i volumen) populacije poljskog vrapca u odnosu na srednje proljetne temperature (ožujak–travanj) i srednju količinu padalina (ožujak–travanj) tijekom 36–godišnjeg razdoblja. Općenito, o utjecaju okolišnih čimbenika na dimenzije jaja ima malo objavljenih radova. Uzorkovanja u ovome radu obavljena su na području sela Mokrice (sjeverozapadna Hrvatska) u razdoblju od 1980. do 2015. godine. Proljetne su temperature u prosjeku značajno porasle u istraživanom razdoblju dok u padalina nije bilo promjena. Međutim, nije došlo do odgovora na porast srednje proljetne temperature (ožujak–travanj) u istraživane populacije u smislu povećanja ili smanjenja dimenzija jaja. Rezultati istraživanja u ovom području demografije ptica su oskudni i u nekim slučajevima kontradiktorni. Neki autori govore o povećanju prosječne veličine jaja, dok drugi govore o smanjenju veličine jaja u nekih vrsta ptica kao odgovor na porast temperature. Očito, veličina jaja u ptica složeno je pitanje budući da je tu uključeno i niz drugih čimbenika osim sve toplijih proljeća, primjerice stanje ženke, genetička komponenta, obilježja staništa itd.