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RELATIONSHIP BETWEEN SPRING MIGRATION, TEMPERATURE AND YEAR IN THE COMMON STARLING *Sturnus vulgaris*

Odnos između proljetne selidbe, temperature i godina istraživanja kod čvorka Sturnus vulgaris

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ABSTRACT

The global average temperature has increased over the past 100 years, and the climate change has produced many responses in the plants, animals and the whole ecosystems. Numerous researches have discussed about the use of birds (and other organisms) as sensitive bio-monitors for warm springs. I have been examining long-term trends of spring arrival in a population of Common Starling *Sturnus vulgaris* studied during 34 years in order to document patterns of its temporal variation and relationships to local spring temperatures. Common Starling is a short-distance migrant, wintering in the Mediterranean region (south-west Europe and northwest Africa). Many works from different areas have devoted attention to the negative correlation between the dates of spring migration and year, and the negative correlation between the dates of spring migration and air spring temperatures. In this study, the correlation between mean spring air temperatures and arrival date was not significant. Furthermore, the relationship between mean spring air temperatures and year was not significant either. Moreover, no significant correlation between arrival date and the entire research period (1980–2013) was detected.

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INTRODUCTION

The global average temperature has increased over the past 100 years (IPCC 2007), and the climate change has produced many responses in the plants, animals and whole ecosystems (e.g. Root *et al*. 2003, Parmesan 2006). For instance, as a response to increasing temperatures, edible dormouse *Glis glis* have advanced the termination of hibernation (Adamík & Král 2008), while in amphibians, the egg, embryonic and larval stages of their life cycles is impacted by long-term temperature change (Beebee & Griffiths 2005). Further, advances in leafing and flowering have been demonstrated from across the Northern Hemisphere (e.g. Fitter & Fitter 2002). These climate changes have a major effect on birds. These impacts include, for instance, changes in the timing of breeding (e.g. Dunn 2004, Potti 2009, Dolenec *et al.* 2011, Dolenec *et al.* 2012), changes in population dynamics (e.g. Sæther *et al*. 2000), changes in clutch size (e.g. Møller 2002), changes in brood size (e.g. Dolenec 2009), changes in egg size (e.g. Potti 2008), *etc.* One of the best-illustrated responses includes earlier arrival dates (e.g. Lehikoinen *et al.* 2004, Kralj & Dolenec 2008, Sokolov & Gordienko 2008). According to Crick & Sparks (2006), the timing of migration may be affected by weather conditions, and it has been predicted that climate change could cause a major impact. Furthermore, many recent papers have shown that birds are advancing their arrival date in response to long-term increases in spring temperatures. I have been examining long-term trends of spring arrival in a population of Common Starling *Sturnus vulgaris* studied for 34 years in order to document patterns of its temporal variation and relationships to local spring temperatures. Common Starling is a short-distance migrant, wintering in the Mediterranean region (southwest Europe and northwest Africa) (Dolenec 1994, Dolenec 1998, Dolenec 2008, Kralj *et al*. 2013).

MATERIAL AND METHODS

Common Starlings were studied during the period 1980–2013. All the data were collected in the nearby Mokrice village (46º00'N, 15º55'E; mixed agricultural landscape and small deciduous woods) at an altitude of 140 m, about ca. 20 km north of Zagreb in northwest Croatia. The author, who lives in Mokrice, collected the data on a daily basis. The arrival date for each year was calculated as the average of the first five birds recorded for that year (this method was previously used by Both *et al*. 2005). Dates were expressed as progressive days, where 1 indicates 1st February (1 = 1st February). In leap years, 1 day was added after February 28.

Several recent research papers have been focused on the analysis of local air temperatures (e.g. Askeyev *et al.* 2007, Wesołowski & Cholewa 2009, Dolenec 2005, Dolenec 2007, Dolenec *et al.* 2009); the same pattern was used in this paper. Croatia´s climate (temperature) was measured as the average of the mean

monthly temperature for two months adjusted to the arrival date of research species. The temperature data (1980–2013) were obtained from the weather station Maksimir (Meteorological Office in Zagreb), ca. 20 km from the study area (February, mean = 2.1 °C, s.d. = 2.87, range = –3.6 to 6.9 °C and March, mean = 6.8 °C, s.d. = 2.04, range = 1.7 to 10.3 °C). Mean spring air temperatures were calculated from the mean temperatures for February and March (mean = 4.5 °C, s.d. = 1.99, range = 0.3 to 7.9 °C).

Statistical analyses were performed using the SPSS 13.0 statistical package for Windows. To test the relationship between the aforementioned parameters, Pearsons's correlation and regression analysis was used. The correlation and regression analysis was used for revealing connections between the timing of the arrival on the one hand, and spring temperature and year on the other. All statistical tests were two-tailed, and the differences were considered significant at $p = 0.05$ or $p < 0.05$.

RESULTS

The average arrival date of the Common Starling (1980–2013) was 19 (s.d. = 5.93) February (range, 7 February – 3rd March). The correlation between mean February–March temperature and year was not significant ($r = 0.267$, $p = 0.127$,

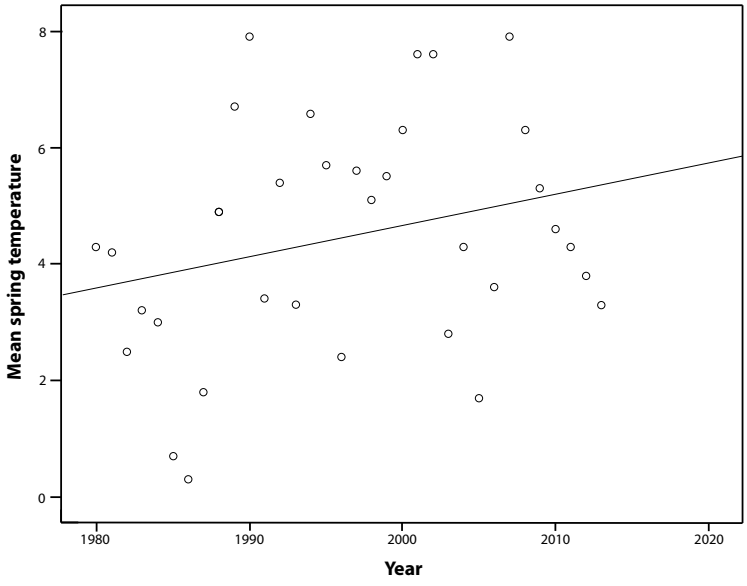

Figure 1. Relationship between mean temperatures (February–March) and year (1980–2013) in Mokrice area, Croatia.

Slika 1. *Odnos srednje temperature (veljača-ožujak) i godina (1980–2013) na području Mokrica, Hrvatska.*

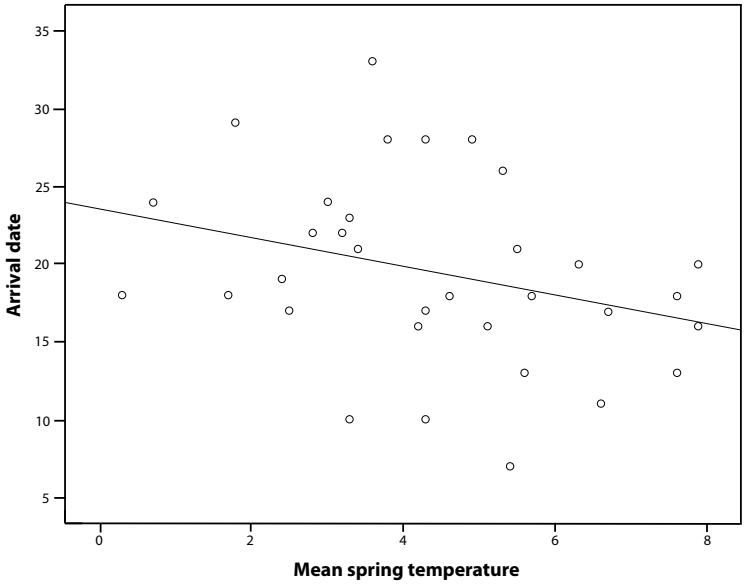

Figure 2. Relationship between arrival date and temperature (February–March) for Common Starling in Mokrice area, Croatia.

Slika 2. *Odnos datuma dolaska čvorka i temperature (veljača – ožujak) na području Mokrica, Hrvatska.*

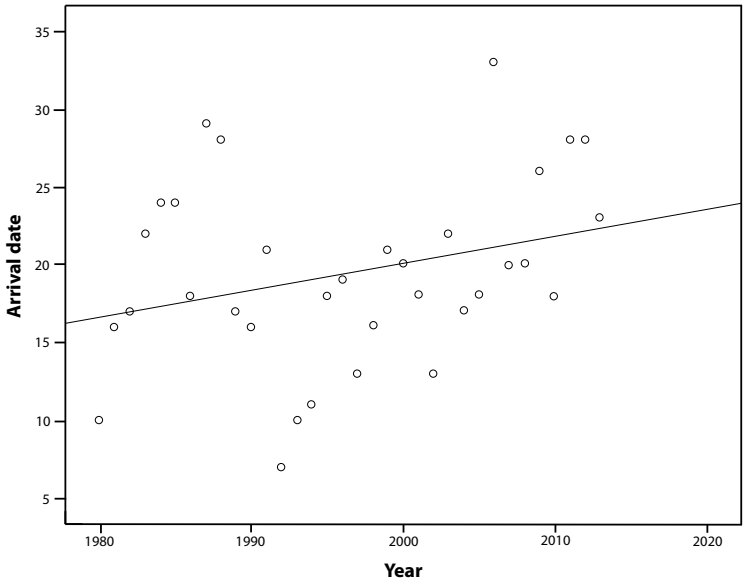

Figure 3. Relationship between arrival date and year (1980–2013) for Common Starling in Mokrice area, Croatia.

Slika 3. *Odnos datuma dolaska čvorka i godine (1980 – 2013) na području Mokrica, Hrvatska.*

n = 34; Figure 1), with the regression equation y = 234 + 12x. The correlation between mean air temperature in the investigated months and the arrival date was of no significance either (r = –0.307, p = 0.077, n = 34; Figure 2). The relationship between mean temperature and arrival date may be expressed as y = 234 + 12x. There was no significant correlation between year and arrival date (r = 0.286, p = 0.101, n = 34; Figure 3). The regression equation was y = 234 + 12x. These results demonstrate that Common Starlings did not return to their breeding grounds significantly earlier over the study period.

DISCUSSION

The regression for 1980–2013 shows a delay in the arrival date of European Starling with time, although this shift is not significant. The non-significant temporal trend in arrival dates of Common Starling is consistent with the findings of similar studies, for example, in Norway (Barrett 2002), Russia (Sokolov & Gordienko 2008), and Poland (Biaduń *et al*. 2011). In contrast, Zalakevicius *et al*. (2006) studied arrival as the first detected dates of 40 migratory birds for the period 1971–2004. They illustrated a significant trend towards earlier arrivals for Common Starling. These results are similar to the finding Gordo & Sanz (2005), where they reported an advance in arrival date for Common Starling. Numerous other bird species are changing their migratory behaviour and arrive earlier. In Scotland, for example, Jenkis & Sparks (2010) revealed trends toward earlier spring arrival dates in 24 of 38 bird species over a 37-year period. In Croatia, there are also some differences between species in spring arrival of the birds after wintering. In the region of Hrvatsko zagorje (NW Croatia), Wood Pigeon *Columba palumbus (*Dolenec & Dolenec 2010a), Blackcap *Sylvia atricapilla* (Dolenec & Dolenec 2010b), House Martin *Delichon urbicum* (Dolenec & Dolenec 2011), Chiffchaff *Phylloscopus collybita* (Dolenec 2013a), and Black Redstart *Phoenicurus ochruros* (Dolenec *et al*. 2013) are arriving earlier in contrast to Pied Wagtail *Motacilla alba* (Dolenec 2012) and Barn Swallow *Hirundo rustica* (Dolenec 2013b), in which no significant changes in arrival dates have been found.

In general, various researches working on diverse bird species and diverse populations (in some species) at different places have found disparate results. Global warming (climate change) is a long-term cumulative process, and its ecological consequences are complex.

References

Adamík P., Král, M. (2008): Climate- and resource-driven long-term changes in dormice populations negatively affect hole-nesting songbirds. J. Zool. 275: 209-215.

Askeyev, O. V., Sparks, T. H., Askeyev, I. V., Tryjanowski, P. (2007): Is earlier spring migration of Tatarstan warblers expected under climate warming? Int. J. Biometeorol. 51: 459-463.

Barrett, R. T. (2002): The phenology of spring bird migration to north Norway. Bird Study 49: 270-277.

Beebee, J. C., Griffiths, R. A. (2005): The amphibian decline crisis: A watershed for conservation biology? Biol. Conserv. 125: 271-285.

Biaduń, W., Kitowski, I., Filipiuk, E. (2011): Study on the first arrival date of spring avian migrants to eastern Poland. Polish J. Environ. Stud. 20: 843-849.

Both, C., Bijalsma, R. G., Visser, M. E. (2005): Climatic effects on timing of spring migration and breeding in a long-distance migrant, the pied flycatcher *Ficedula hypoleuca.* J. Avian. Biol. 36: 368-373.

Crick, Q. P. H., Sparks, T. H. (2006): Changes in the phenology of breeding and migration to global climate change. Acta Zoolog. Sin. 52(Supll.): 154-157.

Dolenec, Z. (1994): Regular migrations of the autochthonous Starling (*Sturnus vulgaris* L.) of the Hrvatsko Zagorje Region (North-West Croatia**).** Rivista ital. Ornitol. 64: 14-20.

Dolenec, Z. (1998): The return of the local breeding population of starlings (*Sturnus vulgaris* L.) from their wintering quarters to the area of Hrvatsko Zagorje (NW Croatia). Natura Croatica 7: 121-126.

Dolenec, Z. (2005): Spring temperatures and laying dates of first eggs of three passerines in Croatia. Ardeola 52: 355-358.

Dolenec, Z. (2007): Spring temperatures in relation to laying dates and clutch size of the Blue Tit (*Parus caeruleus*) in Croatia. Wilson J. Ornithol., 119: 299-301.

Dolenec, Z. (2008): Bird ringing results in Hrvatsko Zagorje region (north-western Croatia): ringing recoveries in other countries. Natura Croatica 17: 325-333.

Dolenec, Z. (2009): Impact of local air temperatures on the brood size in Starling (*Sturnus vulgaris* L.). Pol. J. Ecol. 57: 817-820.

Dolenec, Z. (2012): Non-significant trends towards or later arrival date of the Pied Wagtail (*Motacilla alba* L.). Pol. J. Ecol. 60: 851-854.

Dolenec, Z. (2013a): Implications of temperature change on spring arrival dates of chiffchaff (*Phylloscopus colybita* Vieillot) in a site Croatia. Curr. Sci. 104: 700-702.

Dolenec, Z. (2013b): Monitoring of the arrival time in the barn swallow (*Hirundo rustica*) population from Mokrice village (Croatia), 1980–2011. Natura Croatica 22: 183-187.

Dolenec, Z., Dolenec, P. (2010a): Changes in spring migration of the wood pigeon (*Columba palumbus*) in northwestern Croatia. Tur. J. Zool. 34: 267-269.

Dolenec, Z., Dolenec, P. (2010b): Response of the Blackcap (*Sylvia atricapilla* L.) to temperature change. Pol. J. Ecol. 58: 605-608.

Dolenec, Z., Dolenec, P. (2011): Spring migration characteristics of the House Martin, *Delichon urbica* (Aves: Hirundinidae) in Croatia: A response to climate change? Zoologia (Curitiba) 28:139-141.

Dolenec, Z., Dolenec, P., Møller, A. P. (2011): Warmer springs, laying date and clutch size of tree sparrows *Passer montanus* in Croatia. Curr. Zool. 57: 414-418.

Dolenec, Z., Dolenec, P., Kralj, J. (2012): Egg-laying trends in black redstart (*Phoenicurus ochruros* Gmelin). Curr. Sci. 102: 970-972.

Dolenec, Z., Dolenec, P., Kralj, J., Kiš-Novak, D. (2009): Long-term trends in timing of breeding of the Barn Swallow *Hirundo rustica* L. in Croatia. Pol. J. Ecol. 57: 611-614.

Dolenec, Z., Kralj, J., Sirovina, D., Kiš-Novak, D. (2013): Consequences of spring warming for Black Redstart (*Phoenicurus ochruros*) in N.W. Croatia. Pak. J. Zool. 45: 878-881.

Dunn, P. O. (2004): Breeding dates and reproductive performance. Adv. Ecol. Res. 35: 69-87.

Fitter, A. H., Fitter, R. S. R. (2002): Rapid change sin flowering time in British plants. Science 296: 1689-1691.

Gordo, O., Sanz, J. J. (2005): Phenology and climate change: a long-term study in a Mediterranean locality. Oecologia 146: 484-495.

IPCC, Climate Change (2007): The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (eds Solomon S. *et al*.) Cambridge: Cambridge University Press.

Jenkins, D., Sparks, T. H. (2010): The changing bird phenology of Mid Deeside, Scotland 1974–2010. Bird Study 57: 407-414.

Kralj, J., Dolenec, Z. (2008): First arrival dates of the Nightingale (*Luscinia megarhinchos*) to Central Croatia in the early 20 century and at the turn of the 21 century. Central European J. Biol. 3: 295-298.

Kralj, J., Barišić, S., Tutiš, V. Ćiković, D. (2013): Atlas selidbe ptica Hrvatske. HAZU, Zagreb.

Lehikoinen, E., Sparks, T. H., Zalakevicius, M. (2004): Arrival and departure dates. Adv. Ecol. Res. 35: 1-31.

Møller, A. P. (2002): North Atlantic Oscillation (NAO) effects of climate on the relative importance of first and second clutches in a migratory passerine bird. J. Anim. Ecol. 71: 201-210.

Parmesan, C. (2006): Ecological and evolutionary responses to recent climate change. Annu. Rev. Ecol. Evol. Syst. 37: 637-669

Potti, J. (2008): Temperature during egg formation and the effect of climate warming on egg size in a small songbird. Acta Oecol. 33: 387-393.

Potti, J. (2009): Advanced breeding dates in relation to recent climate warming in Mediterranean montane population of Blue Tits *Cyanistes caruleus*. J. Ornith. 150: 893-901.

Root, T. L, Price, J. T., Hall, K. R., Schneider, S. H., Rosenzweig, C., Pound, J. A. (2003): Fingerprints of global warming on wild animals and plants. Nature 421: 57-61.

Sokolov, L. V., Gordienko, N. S. (2008): Has recent climate warming affected the dates of bird arrival to the Il'men reserve on the Southern Urals? Russ. J. Ecol. 39: 56-64.

Sæther, B-E., Tuffo, J., Engen, S., Jerstadt, K., Røstad, O. W., Skåtan, J. E. (2000): Population dynamical consequences of climate change for a small temperate songbird. Science 287: 855-856.

Wesołowski, T., Cholewa, M. (2009): Climate variation and bird breeding seasons in a primeval temperate forest. Clim. Res. 38: 199-208.

Zalakevicius, M., Barkeviciene, G., Raudonikis, L., Janulaitis, J. (2006): Spring arrival response to climate change in birds: a case study from eastern Europe. J. Ornithol. 147: 326-343.

SAŽETAK

Na području Mokrica (Hrvatsko zagorje) je u razdoblju od 1980. do 2013. godine praćena proljetna selidba čvorka. Statistička je analiza pokazala da nije bilo ranijeg povratka čvoraka sa zimovanja u spomenutom razdoblju. Također, srednja mjesečna temperatura mjeseca veljače i ožujka nije se značajno promijenila od 1980. do 2013. godine. Prosječna temperatura na globalnoj je razini porasla u posljednjih stotinjak godina te su mnogi organizmi, pa tako i ptice, odgovorili na te promjene svojim životnim ciklusima. Mnoge se ptičje vrste vraćaju ranije sa zimovanja, neke su počele ranije s polaganjem jaja, jedne nesu veći broj jaja, druge nesu veća jaja, treće pomiču areal rasprostranjenja itd. Do sada je najviše radova objavljeno iz područja fenologije. Stupanj fenoloških promjena varira između vrsta, između lokaliteta, ali i unutar iste vrste različitih lokaliteta. Nužna su daljnja istraživanja i traženja još mnogih odgovora na klimatske promjene za razne životne cikluse ptica budući da je ornitofauna važna sastavnica mnogih ekosustava, a ptice imaju i značajnu ulogu bioindikatora.