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DATES OF ARRIVAL OF THE EURASIAN GOLDEN ORIOLE (*Oriolus oriolus* L.) IN DECIDIOUS FOREST IN RELATION TO INCREASE OF LOCAL AIR TEMPERATURE IN NW CROATIA

DATUMI POVRATKA VUGE (*Oriolus oriolus* L.) SA ZIMOVANJA U BJELOGORIČNE ŠUME SJEVEROZAPADNE HRVATSKE U ODNOSU NA SVE TOPLIJA PROLJEĆA

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SUMMARY

Numerous regions worldwide are affected by Earth climate warming. Most studies of bird phenology in relation to global and regional climate change have focused on trends in arrival dates and breeding dates. The study investigates the results of phenological spring migration research on Eurasian Golden Oriole during a period of 26 years (1991–2016) in relation to average spring air temperatures (April–May) and year in deciduous forests (northwestern Croatia). Data is available for spring arrivals detected by the first song. Arrival date advanced significantly during the research period. According to the linear regression slopes, models suggested that in Eurasian Golden Oriole arrival date has advanced 6 days in period 1991–2016. Furthermore, average spring air temperatures (April–May) increased significantly during the study period. Furthermore, date of arrival was significantly negative correlated with average spring temperatures. My results provide evidence that warms spring has impacted spring migration arrival dates of Eurasian golden oriole of the deciduous forests in northwestern Croatia.

KEY WORDS: Eurasian Golden Oriole, *Oriolus oriolus* L., spring migration, spring temperature, deciduous forests, NW Croatia

INTRODUCTION
UVOD

Earth climate warming has affected numerous regions worldwide (Parmesan, 2006). There are abundant documents of advances in spring phenology in different organisms over long-term period in relations to climate change, for example, plant flowering earlier in Hungary (Szabó et al., 2016). Most studies of bird phenology in relation to global and regional climate change have focused on trends in arrival dates and breeding dates. Earlier breeding dates have been associated in numerous species with higher air temperatures in some countries in Northern Hemisphere and South Hemisphere (Potti, 2009) and among them is also Croatia (Dolenec et al., 2012; Dolenec, 2019a). Earlier spring migration phenology is also associated with higher air temperatures in Croatia (Dolenec and Dolenec, 2010a; Dolenec 2019b) and other countries (Kolářová et al., 2017; Vengerov, 2017). Generally, early arrival is often linked with migration distance. In shorter-distance migrants

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arrival dates advance more than in long-distance migrants (Rubolini et al., 2007). Climate change has impacted birds also in other ways, for example, altitudinal range shift (Kirchman and van Keuren, 2017). Despite many difference discussion, there is consensus that climate warming already has effect on phenology of bird species and populations.

I investigated long-term fluctuations in dates (1991–2016) of spring migration of the Eurasian Golden Oriole (*Oriolus oriolus* L.), a long-distance migrant, wintering south of the Sahara to examine migration phenology in relation to average spring air temperatures over the period of 26 years. This species is common breeding bird in northwestern Croatia.

MATERIAL AND METHODS
MATERIJALI I METODE

Research took place in Mokrice area (46°00'N, 15°55'E) in north-western Croatia from 1991 to 2016. Study area situated at an altitude approximately 140 m above sea level. The investigated area is a mixed farming area with small deciduous forest, hedges, orchards, lawns, arable land etc. This study was conducted in the small deciduous mixed forests consisting of Hornbeam (*Carpinus betulus* L.) and Pedunculate Oak (*Quercus robur* L.). The shrub cover is formed by Blackthorn (*Prunus spinosa* L.) and Common Elder (*Sambucus nigra* L.). Data is available for spring arrivals of Eurasian Golden Oriole detected by the first song. Bird singing was observed each year consistently from 10 April on the daily basis. Bird singing was observed twice a day; in early morning and early afternoon. Dates were converted to numerical values such that 1 indicates 1 April. In this study, I focused on the long-term data. Long-term data have been important for documenting impact of temperature change in spring phenology (Askeyev et al. 2009; Dolenec and Dolenec, 2011a; Dolenec, 2018a). In some papers, shifts have significantly been correlated with changes (increase) in local air temperature (Biaduń et al., 2009; Dolenec and Dolenec, 2011b). Spring temperature data (mean April–May temperature, 1991–2016) were supplied by the station of Maksimir (123 m a.s.l.) – Meteorological Office in Zagreb, about ca. 20 km from the study area (April–May, mean = 9.2 ± 1.37 °C; range = 6.5 to 11.9 °C).

The relationship between the timing of migration and mean spring air temperatures and year in study area was assessed using a simple linear regression and Pearson correlation tests (r). Statistical data processing was performed using the SPSS 13.0 for Windows.

RESULTS
REZULTATI

The relevant variables used for this paper were the arrival date, mean spring temperature (April–May) and year. Correlation between study period (1991-2016) and arrival date was negative significant (r = – 0.48, n = 26, P = 0.013; y = 481.39 – 0.23x; Figure 1). The spring migration of Eurasian Golden Oriole advanced 0.23 days per year (statistically significant) on average

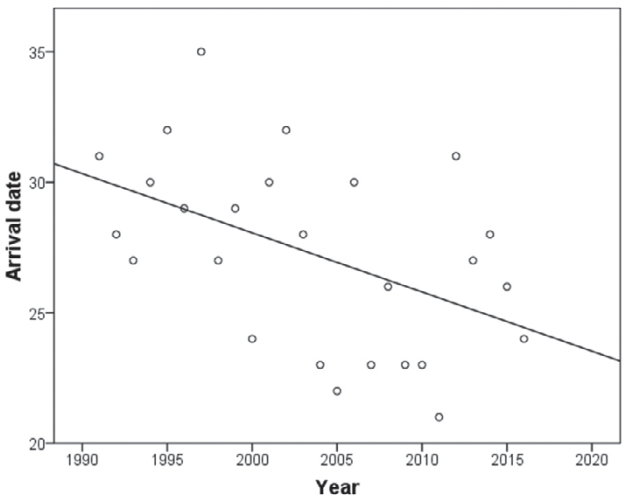

Figure 1. Correlation between study year (1991-2016) and arrival date of the Eurasian Golden Oriole in NW Croatia

Slika 1. Odnos između godina istraživanja (1991-2016) i datuma povratka vuge na područje sjeverozapadne Hrvatske

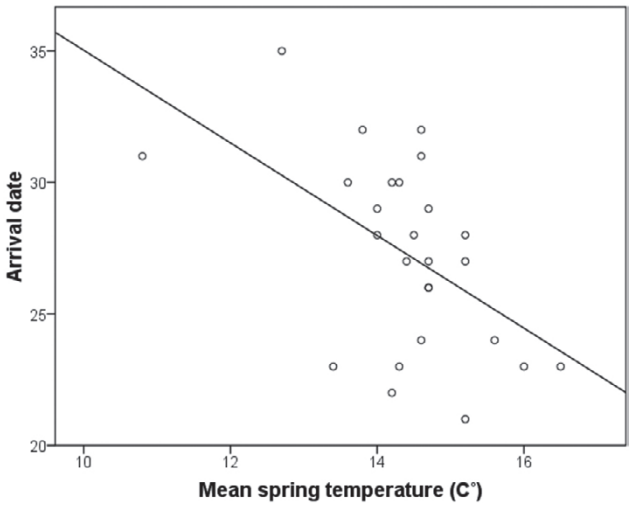

Figure 2. Correlation between average spring air temperature (April–May) and arrival date of the Eurasian Golden Oriole in NW Croatia

Slika 2. Odnos između srednje proljetne temperature (travanj–svibanj) i datuma povratka vuge na području sjeverozapadne Hrvatske

from the 1991 to 2016. Therefore, males are singing approximately 6 days earlier over 26-years. For the same time period average spring temperature (April–May) increased by 1.82°C ($r = 0.47$, $n = 26$, $p = 0.016$; $y = -117.86 + 0.07x$; data not shown). Therefore, temperature significantly increased in the research area during the study period. Relationship between arrival date and spring temperature was also significant ($r = -0.53$, $n = 26$, $p = 0.006$; $y = 52.63 - 1.76x$; Figure 2).

DISCUSSION AND CONCLUSION
RASPRAVA I ZAKLJUČAK

My results provide evidence that warmer spring has impacted spring migration arrival dates of Eurasian Golden Oriole in the deciduous forests in northwestern Croatia The advance of the arrival date of Eurasian Golden Oriole has been reported in some papers (Zalakevicius et al., 2006), but on the other hand, some authors found not significant trend (Biaduń et al., 2009). Concurrent trends in spring temperatures and bird phenology over recent few decades are well described also in other scientific literature. According to meta-analysis (413 species across five continents) birds have significantly advanced their spring migration time by 2.1 days per decade (Usui et al., 2017). Murphy-Klassen et al. (2005) revealed significantly earlier arrival in 27 of 96 species in Canada (1939-2001), on average, laying dates advanced 9 days. Furthermore, a long-term study of the phenology of the long-distance migratory Reed Warbler *Acrocephalus scirpaceus* (Hermann) and Sedge Warbler (*Acrocephalus schoenobaenus* L.) in Hungary demonstrated that arrival dates advanced 7.5 and 6.6 days between 1989 and 2009, respectively (Kovács et al., 2011). Contrary, spring phenology of bird migrants in Norway did not show any changes (Barrett, 2002). Some studies conducted in Croatia showed significant phenological response to spring temperatures, for instance, for the Blackcap [(*Sylvia atricapilla* L.) (Dolenec and Dolenec, 2010b)] and European Stonechat [(*Saxicola rubicola* L.) (Dolenec, 2018b)] but not all - for instance, White Wagtail [(*Motacilla alba* L.) (Dolenec, 2012)]. Therefore, the responses of bird species to climate warming are complex. For instance, some papers discuss possible negative repercussions of a mismatch between spring migration phenology and peak food in breeding period (Visser et al., 1998). This mistiming during the past few decades has caused decrease in population sizes in some species (Both et al., 2006), because of climate change. The stable population sizes of the Eurasian Golden Oriole in NW Croatia could be a consequence of their ability to effectively track air temperature variation.

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SAŽETAK

Klimatsko zatopljenje dokumentirano je na mnogim područjima Zemlje. Mnogi znanstveni radovi o utjecaju klimatskih promjena na ptičji svijet ponajprije se odnose na fenologiju, a u prvom redu na povratak ptica sa zimovanja i početak nesidbe jaja. U ovome članku prezentiraju se rezultati 26-godišnjeg (1991-2016) praćenja proljetne migracije vuge u bjelogoričnim šumama na području sjeverozapadne Hrvatske u odnosu na prosječne proljetne temperature travnja i svibnja (razdoblje povratka sa zimovanja). Podaci su se prikupljali na temelju prvog glasanja vuge pojedine godine. Dobiveni rezultati sugeriraju da se vuge vraćaju šest dana ranije u odnosu na početnu godinu istraživanja. U spomenutom istraživačkom razdoblju osim što se vuge na području gniježđenja pojavljuju sve ranije, istodobno je došlo do signifikantnog porasta prosječnih temperatura travnja i svibnja. Zabilježena je značajna negativna korelacija između datuma povratka i prosječnih proljetnih temperatura, što nas upućuje na zaključak da su sve toplija proljeća vjerojatno razlogom sve ranijeg povratka vuge sa zimovanja u bjelogorične šume sjeverozapadne Hrvatske.

KLJUČNE RIJEČI: vuga, *Oriolus oriolus* L., proljetna migracija, proljetna temperatura zraka, bjelogorične šume, sjeverozapadna Hrvatska