

Weather conditions and breeding season length in blackbird (*Turdus merula*)

Authors: Jankowiak, Łukasz, Pietruszewska, Hanna, and Wysocki, Dariusz

Source: *Folia Zoologica*, 63(4) : 245-250

Published By: Institute of Vertebrate Biology, Czech Academy of Sciences

URL: <https://doi.org/10.25225/fozo.v63.i4.a3.2014>

BioOne Complete ([complete.BioOne.org](https://complete.bioone.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Weather conditions and breeding season length in blackbird (*Turdus merula*)

Łukasz JANKOWIAK, Hanna PIETRUSZEWSKA and Dariusz WYSOCKI*

Department of Vertebrate Anatomy and Zoology, University of Szczecin, Wąska 13, PL-71-412 Szczecin, Poland; e-mail: darekw@univ.szczecin.pl

Received 27 June 2014; Accepted 8 December 2014

Abstract. The timing of egg laying by songbirds is known to be strongly affected by local climate, with temperature and precipitation being the most influential factors. However, most research to date relates only to the start of the breeding season: later records and the duration of the whole have not been taken into consideration. In the case of multibrooded species, productivity usually depends on the length of the breeding season. In this work we analysed climatic factors affecting breeding season length of an urban blackbird (*Turdus merula*) population. The study was conducted in two parks in the city of Szczecin, north-western Poland, spanning 14 breeding seasons since 1997. We found that over the study period, the breeding season became shorter as a result of colder springs and possibly because of warmer June–July temperatures. Our study revealed a positive relationship between breeding season length and the mean and mean minimum temperatures in April. Total precipitation in April–July also positively influenced breeding season length. The present survey confirms the influence of temperature and precipitation on the breeding season length of blackbird.

Key words: climate change, temperature, phenology, phenotypic plasticity, urban areas

Introduction

The shift to earlier migration (Ahas & Aasa 2006, Both & te Marvelde 2007) and earlier breeding times has been observed in many birds as a result of climate warming (Goodenough et al. 2010, Donnelly et al. 2012, Sparks et al. 2013). Many studies have shown that the considerable plasticity in the timing of egg laying in songbirds enables them to respond quickly to local weather conditions (Goodenough et al. 2010). Birds start breeding earlier if the pre-laying period is warmer (Bauer et al. 2009, Goodenough et al. 2010). The different phenologies of species could have evolved in response to the influence of genes, photoperiod, temperature and precipitation (Forrest & Miller-Rushing 2010). In the case of songbirds in general and the blackbird (*Turdus merula*) in particular, temperature and precipitation are closely related to the availability of invertebrate prey, mostly earthworms and caterpillars. Earlier breeding benefits individuals with a better breeding territory (Goodenough et al. 2010), increases the possibility of multiple clutches, and therefore enhances the chances of breeding success. On the other hand, earlier breeding heightens the possibility of failure following sudden weather changes in early spring (Katz 2010, Moreno & Møller 2011, Pipoly et al. 2013) as well as

possible mismatches between food availability and the need to raise offspring successfully (Miller-Rushing et al. 2010, Sparks et al. 2013). Moreover, nests are less well concealed in the incompletely developed tree canopy, which means that the costs of predation are higher early in the season (Wysocki et al. 2004, Wysocki 2005). These can, however, vary regionally and may be alleviated by the availability of conifers (Mikula et al. 2014). Species with a greater plasticity are thus better fitted to fluctuating climate conditions. For our study, we used data on breeding timing relating to an urban blackbird population (Wysocki 2004a, Wysocki et al. 2004, Wysocki 2005, Wysocki 2006). Since the mid-19th century, the forest population of this species has colonised cities in Western Europe. In north-western Poland this process took place at the turn of the 19th and 20th centuries (Luniak et al. 1990, Evans et al. 2010, Møller et al. 2012, Møller et al. 2014). The population we studied is partly resident, so most individuals leave their territories after breeding (July–August) and reappear between October and December, although some birds do not reappear until just before the next breeding season (Wysocki 2004b). A comparison of the phenology of two different blackbird populations in Poland and the U.K. showed that the Polish population bred later and responded

* Corresponding Author

weakly to temperature (Sparks et al. 2007). The authors of that paper explained this phenomenon as being an adaptation to a different climate. Moreover, most published studies assessed the timing of only the first brood (Nielsen & Møller 2006, Sparks et al. 2007), because breeding pairs were usually not tracked throughout the breeding season. This is important: in single-brooded species, natural selection promotes one single optimised clutch time, but in multi-brooded species, justified selection of first-clutch timing is weaker because overall fitness can be achieved in subsequent broods. Conversely, this could be considered a trade-off, since chicks from the earlier clutch have better chances of survival than those from later clutches (Newton 1998). We thus monitored all the broods of the target pairs to estimate breeding length. The aim of our study was to find out how temperature or precipitation influence the length of the breeding season.

Material and Methods

The study was performed in two parks in Szczecin: Zeromski park (53°26'2" N, 14°33'48" E) between 1997-2010 and Kownas (53°26'51" N, 14°32'6" E) between 1997-2003. The work was done each year from March to August. As our pre-analysis revealed no differences between the parks, the data were pooled. For more details about the parks, see Wysocki (2004b).

The blackbirds, trapped in mist nets, were sexed, aged (Svensson 1992) and ringed with aluminium and colour rings. Information on clutch initiation was obtained by regular nest inspections. The length of the breeding season was calculated as the difference between the laying date of the first egg of the first clutch and that of the first egg of the last clutch for

each breeding pair in each year. Where pairs had only one brood, the length was taken to be one day. The dates are given as day of year (DOY).

The length of the breeding season was averaged for each year. The total number of regularly checked pairs was 835 and the mean number for one breeding season was 60. Regression analysis was performed to assess the dependence of breeding season length on three climate variables: mean temperature, mean minimum temperature, and precipitation. Because of the high co-linearity between the climate variables, we performed simple regression for each one. Each of the regression lines was checked for outliers by Cook's distance statistics (observations greater than one were considered as outliers) and, if detected, were excluded (Quinn & Keough 2002).

For each year we averaged temperatures and precipitation for periods from one month to five months between March and July. From the different dependent variables we selected the ones that best explained the variation in breeding season length.

The climate data were obtained from the Szczecin weather station (53°23'42" N 14°37'21" E, <http://tutiempo.net>). Since 2003, spring has been colder than in earlier years ($p < 0.05$; Fig. 1A). On the other hand, early summer temperatures exhibited some increase during the study period ($p < 0.05$; Fig. 1B). The statistical analyses were performed using SPSS software. A 5 % significance threshold was adopted.

Results

During the study period, the breeding season length in blackbirds decreased significantly (Fig. 2A; $r = -0.64$, $F_{1,12} = 8.29$, $p < 0.05$). They started their first broods significantly later over the study period (Fig. 2B; $r = 0.60$, $F_{1,11} = 6.29$, $p < 0.05$), and completed

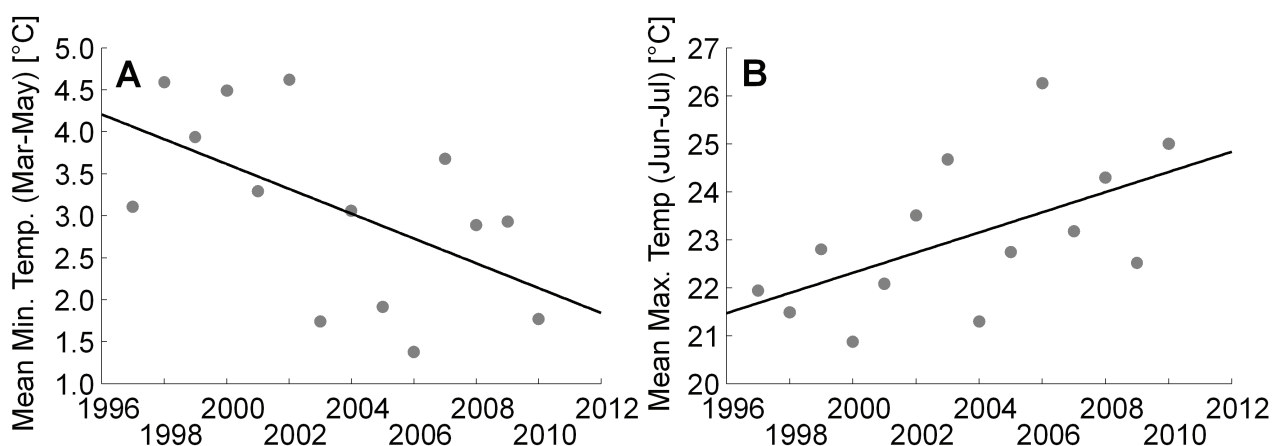


Fig. 1. Mean minimum temperature in spring (A) and mean maximum temperature in early summer (B) during the 14 years of this study.

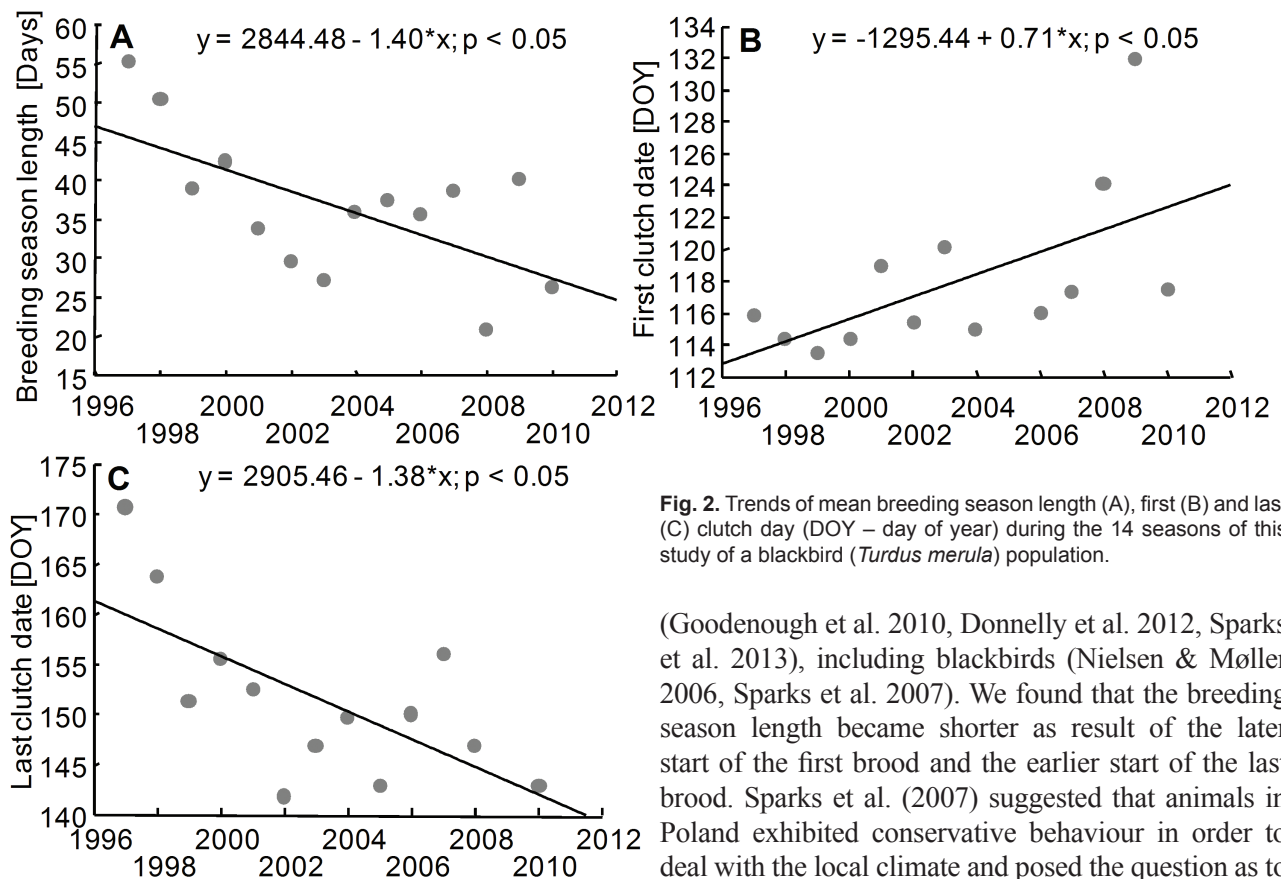


Fig. 2. Trends of mean breeding season length (A), first (B) and last (C) clutch day (DOY – day of year) during the 14 seasons of this study of a blackbird (*Turdus merula*) population.

their breeding season significantly earlier (Fig. 2C; $r = -0.66$, $F_{1,11} = 8.55$, $p < 0.05$).

The breeding season for the whole study period lasted 38 ± 11 days (mean \pm SD). There was a significant positive relationship between breeding season length and temperature in two predefined periods: April and April-May (both regression lines significant, $p < 0.05$). However, the mean April temperature better explained the variation of the dependent variable (Fig. 3A; $r = 0.73$, $F_{1,11} = 12.46$, $p < 0.005$). For July and June-July there were negative relationships, albeit non-significant (Fig. 3B showed the better fitted one for June-July; $r = -0.48$, $F_{1,12} = 3.51$, $p = 0.086$). Where the mean minimum temperature was concerned, the best-fitted variable was also the April temperature (Fig. 3C; $r = 0.67$, $F_{1,12} = 8.72$, $p < 0.01$).

Significant positive relationships were noted between breeding season length and the sum of precipitation for June, March-July, April-June, April-July, May-June, May-July, June-July (all $p < 0.05$). Of these variables, the best fit was the sum of precipitation for the April-July period (Fig. 3D; $r = 0.86$, $F_{1,11} = 30.40$, $p < 0.001$).

Discussion

Our results revealed a reverse shift in the timing of breeding compared to other studies of songbirds

(Goodenough et al. 2010, Donnelly et al. 2012, Sparks et al. 2013), including blackbirds (Nielsen & Møller 2006, Sparks et al. 2007). We found that the breeding season length became shorter as result of the later start of the first brood and the earlier start of the last brood. Sparks et al. (2007) suggested that animals in Poland exhibited conservative behaviour in order to deal with the local climate and posed the question as to whether these species could modify their phenological response in a period of a rapidly warming climate. On the other hand, the data from that study were collected in western Poland, a long way south of the Baltic coast; the climate of Szczecin experiences a greater influence of the Atlantic, and so is similar to the British climate. Nevertheless, our data indicate that our blackbird population is sensitive to climate conditions. The climatic data from the study period indicate that these changes could be related to the cooler climate since 2003, especially during breeding seasons 2003, 2005-06 and 2010, which were colder than other years. It seems that the higher temperatures in June-July may also be an influential factor, contributing to the shortening of the breeding season.

The mechanism of changes to the timing of breeding could be due to inherited genetic traits assisted by population evolution or could be caused by the phenotypic plasticity of individuals (Lyon et al. 2008). However, there is much agreement that these changes are more likely to be the results of phenotypic plasticity (Van Buskirk et al. 2012), which our study indirectly confirms. Moreover, phenotypic plasticity is a result of natural selection promoting individuals that are able to choose appropriate breeding times during periods when food is plentiful. Different genotypes differ in their responses to environmental cues. The decision to start

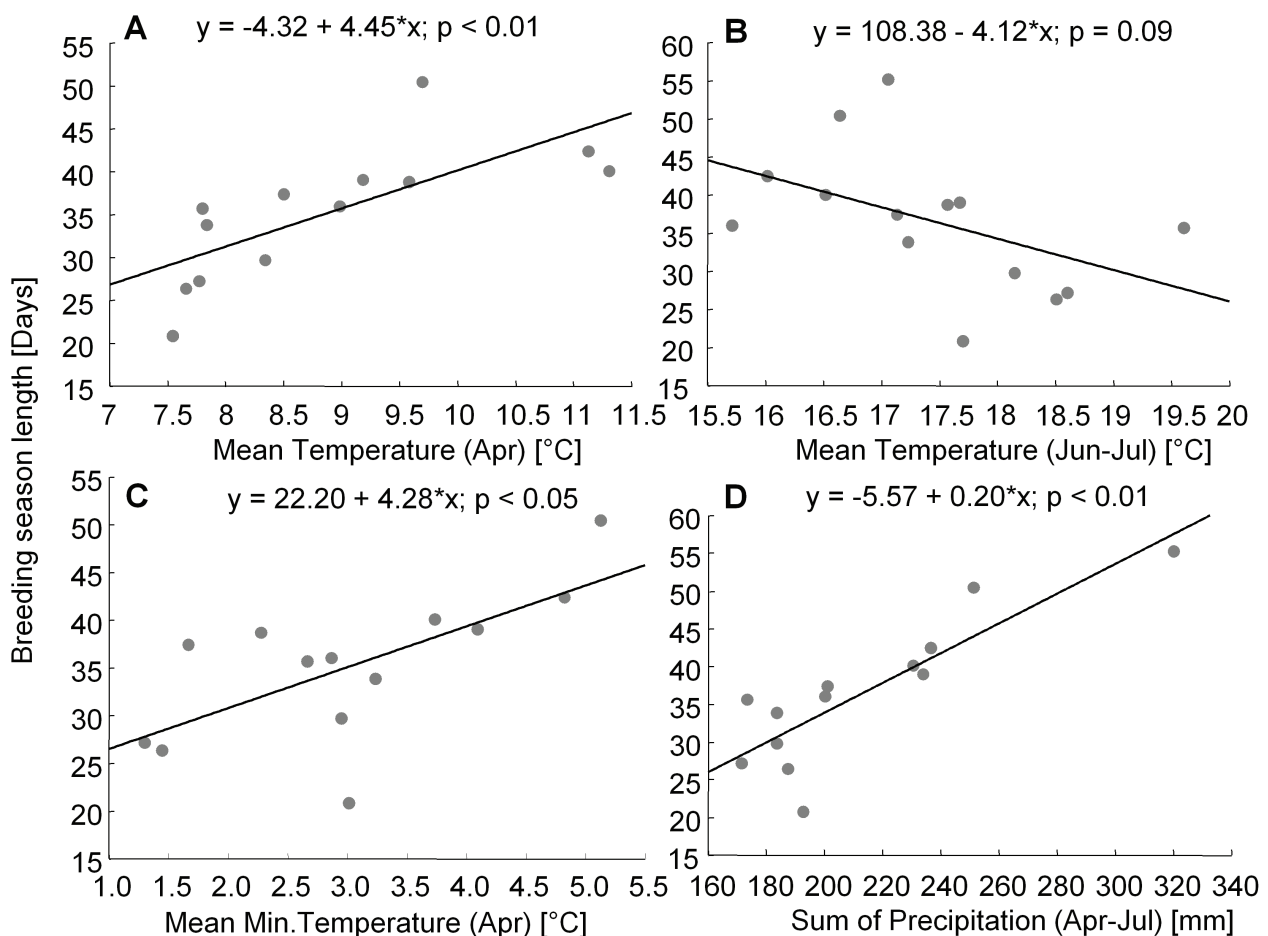


Fig. 3. Linear relationships between mean breeding season length of blackbird (*Turdus merula*) and (A) – mean temperature in April, (B) – mean temperature in June-July, (C) – mean minimum temperature in April, (D) – sum of precipitation in April-July.

breeding is made on the basis of different environmental cues, and it is crucial to understand which are the most important ones (Visser et al. 2010). Some researchers emphasise photoperiod, temperature, precipitation, food abundance and social interactions (Visser et al. 2010). On the other hand, Evans et al. (2012) suggested that genetic differences between rural and urban populations promote sedentary behaviour in blackbirds residing in cities, which could be related to the earlier onset of breeding (Partecke et al. 2004, Partecke & Gwinner 2007) and could also be due to the fact that urban birds have a broader environmental tolerance than rural birds (Bonier et al. 2007, Møller et al. 2014).

Breeding season length was positively influenced by the average temperature in April, which is when most first broods are laid. The most important factor influencing laying date in songbirds is the photoperiod, when the increasing day length acts on gonadal maturation and on the release of hormones (Dawson 2008). However, particular species differ in their first-egg laying date between years, so other factors, especially temperature, must also be important. The phenotypic

effect of temperature on the shift in breeding time is related directly to the effect of temperature on fecundity and indirectly to the influence of temperature on the abundance or availability of food (Desrochers & Magrath 1993, Møller 2013). These last two reasons appear to be the most significant if breeding is to be successful, especially if breeding time is to match peak prey abundance. The main food items of insectivorous songbirds are caterpillars. Whilst these are also an important food resource for the blackbird, this species feeds mainly on earthworms, especially at the beginning of the breeding season (Perrins 1998). In addition, the activity of insects – ectothermic animals – depends on the temperature, so warmer spring temperatures could result in an earlier peak of insect numbers. In order to achieve breeding success, the birds would have to adjust their laying time to match the food availability for their offspring (Dunn & Winkler 2008). Precipitation is associated with food accessibility, since the blackbird also feeds on earthworms, which are very abundant after rain (Perrins 1998, Chamberlain et al. 1999). Our study

confirmed this, indicating that the overall sum of precipitation was correlated with the duration of the breeding season. The blackbird is a multi-brooded species (Wysocki 2005), so in optimal breeding conditions, these birds can lay up to six clutches per breeding season. We also suggest that breeding season length was related to the average temperatures in June-July, when the last broods were laid. However, the higher temperatures in these months reduce the availability of food, mostly earthworms.

This study of an urban blackbird urban population has clearly indicated a shift of breeding time and breeding season length. Most studies of this phenomenon have revealed an earlier first brood time as a result

of climate warming (Nielsen & Møller 2006, Sparks et al. 2007, Goodenough et al. 2010, Donnelly et al. 2012, Sparks et al. 2013). Our study, by contrast, revealed a trend of later first brood timing and earlier last brood timing, which led to a shortening of the breeding season during the study period. We explain this difference as being the result of colder spring and higher summer temperatures.

Acknowledgements

The authors are grateful to all the students and volunteers for their help with the fieldwork, especially to Dawid Zyskowski, Piotr Nowacki, Helena Wojcieszak and Piotr Piliczewski. We would like to thank Margaret Kozak, Peter Senn and the anonymous referee for improving the language.

Literature

- Ahas R. & Aasa A. 2006: The effects of climate change on the phenology of selected Estonian plant, bird and fish populations. *Int. J. Biometeorol.* 51: 17–26.
- Bauer Z., Trnka M., Bauerová J., Možný M., Štěpánek P., Bartošová L. & Žalud Z. 2009: Changing climate and the phenological response of great tit and collared flycatcher populations in floodplain forest ecosystems in Central Europe. *Int. J. Biometeorol.* 54: 99–111.
- Bonier F., Martin P.R. & Wingfield J.C. 2007: Urban birds have broader environmental tolerance. *Biol. Lett.* 3: 670–673.
- Both C. & te Marvelde L. 2007: Climate change and timing of avian breeding and migration throughout Europe. *Clim. Res.* 35: 93–105.
- Chamberlain D.E., Hatchwell B.J. & Perrins C.M. 1999: Importance of feeding ecology to the reproductive success of blackbirds *Turdus merula* nesting in rural habitats. *Ibis* 141: 415–427.
- Dawson A. 2008: Control of the annual cycle in birds: endocrine constraints and plasticity in response to ecological variability. *Phil. Trans. R. Soc. Lond. B* 363: 1621–1633.
- Desrochers A. & Macraeth R.D. 1993: Age-specific fecundity in European blackbirds (*Turdus merula*): individual and population trends. *Auk* 110: 255–263.
- Donnelly A., Caffarra A., Kelleher C.T., O'Neill B.F., Diskin E., Pletsers A., Proctor H., Stirnemann R., O'Halloran J., Peñuelas J., Hodkinson T.R. & Sparks T.H. 2012: Surviving in a warmer world: environmental and genetic responses. *Clim. Res.* 53: 245–262.
- Dunn P.O. & Winkler D.W. 2008: Effects of climate change on timing of breeding and reproductive success in birds. In: Møller A.P., Berthold P. & Fiedler W. (eds.), *Effects of climate change on birds. Oxford University Press, Oxford*: 113–128.
- Evans K.L., Hatchwell B.J., Parnell M. & Gaston K.J. 2010: A conceptual framework for the colonisation of urban areas: the blackbird *Turdus merula* as a case study. *Biol. Rev.* 85: 643–667.
- Evans K.L., Newton J., Gaston K.J., Sharp S.P., McGowan A. & Hatchwell B.J. 2012: Colonisation of urban environments is associated with reduced migratory behaviour, facilitating divergence from ancestral populations. *Oikos* 121: 634–640.
- Forrest J. & Miller-Rushing A.J. 2010: Toward a synthetic understanding of the role of phenology in ecology and evolution. *Phil. Trans. R. Soc. Lond. B* 365: 3101–3112.
- Goodenough A.E., Hart A.G. & Stafford R. 2010: Is adjustment of breeding phenology keeping pace with the need for change? Linking observed response in woodland birds to changes in temperature and selection pressure. *Clim. Change* 102: 687–697.
- Katz R.W. 2010: Statistics of extremes in climate change. *Clim. Change* 100: 71–76.
- Luniak M., Mulsow R. & Walasz K. 1990: Urbanization of the European blackbird – expansion and adaptations of urban population. In: Luniak M. (ed.), *Urban ecological studies in Central and Eastern Europe. International symposium, Warsaw, Poland. Wydawnictwo PAN, Wrocław-Warszawa-Kraków-Gdańsk-Lódź*: 187–200.
- Lyon B.E., Chaine A.S. & Winkler D.W. 2008: Ecology. A matter of timing. *Science* 321: 1051–1052.
- Mikula P., Hromada M., Albrecht T. & Tryjanowski P. 2014: Nest site selection and breeding success in three *Turdus* thrush species coexisting in an urban environment. *Acta Ornithol.* 49: 83–92.
- Miller-Rushing A.J., Høye T.T., Inouye D.W. & Post E. 2010: The effects of phenological mismatches on demography. *Phil. Trans. R. Soc. Lond. B* 365: 3177–3186.
- Møller A.P. 2013: Biological consequences of global change for birds. *Integr. Zool.* 8: 136–144.
- Møller A.P., Diaz M., Flensted-Jensen E., Grim T., Ibáñez-Álamo J.D., Jokimäki J., Mänd R., Markó G. & Tryjanowski P. 2012: High urban population density of birds reflects their timing of urbanization. *Oecologia* 170: 867–875.
- Møller A.P., Jokimäki J., Skorka P. & Tryjanowski P. 2014: Loss of migration and urbanization in birds: a case study of the blackbird (*Turdus merula*). *Oecologia* 175: 1019–1027.
- Moreno J. & Møller A. 2011: Extreme climatic events in relation to global change and their impact on life histories. *Curr. Zool.* 57: 375–389.
- Newton I. 1998: *Population limitation in birds. Academic Press, San Diego.*
- Nielsen J.T. & Møller A.P. 2006: Effects of food abundance, density and climate change on reproduction in the sparrowhawk *Accipiter nisus*. *Oecologia* 149: 505–518.

- Partecke J. & Gwinner E. 2007: Increased sedentariness in European blackbirds following urbanization: a consequence of local adaptation? *Ecology* 88: 882–890.
- Partecke J., Van't Hof T. & Gwinner E. 2004: Differences in the timing of reproduction between urban and forest European blackbirds (*Turdus merula*): result of phenotypic flexibility or genetic differences? *Proc. R. Soc. Lond. B* 271: 1995–2001.
- Perrins C. 1998: The complete birds of the Western Palearctic on CD-ROM. *Oxford University Press, Oxford*.
- Pipoly I., Bókony V., Seress G., Szabó K. & Liker A. 2013: Effects of extreme weather on reproductive success in a temperate-breeding songbird. *PLoS One* 8: e80033.
- Quinn G.P. & Keough M.J. 2002: Experimental design and data analysis for biologists. *Cambridge University Press, Cambridge*.
- Sparks T.H., Crick H.Q.P., Dunn P.O. & Sokolov L.V. 2013: Phenologies of selected lifeforms, part V. Birds, chapter 24. In: Schwartz M.D. (ed.), *Phenology: an integrative environmental science*. Springer, Netherlands: 451–466.
- Sparks T.H., Tryjanowski P., Cooke A., Crick H. & Kuźniak S. 2007: Vertebrate phenology at similar latitudes: temperature responses differ between Poland and the United Kingdom. *Clim. Res.* 34: 93–98.
- Svensson L. 1992: Identification guide to European passerines. *Stockholm*.
- Van Buskirk J., Mulvihill R.S. & Leberman R.C. 2012: Phenotypic plasticity alone cannot explain climate-induced change in avian migration timing. *Ecol. Evol.* 2: 2430–2437.
- Visser M.E., Caro S.P., van Oers K., Schaper S.V. & Helm B. 2010: Phenology, seasonal timing and circannual rhythms: towards a unified framework. *Phil. Trans. R. Soc. Lond. B* 365: 3113–3127.
- Wysocki D. 2004a: Age structure of urban population of blackbird (*Turdus merula*) in Szczecin (NW Poland). *Zool. Pol.* 49: 219–227.
- Wysocki D. 2004b: Within-season divorce rate in an urban population of European blackbird *Turdus merula*. *Ardea* 92: 219–227.
- Wysocki D. 2005: Nest site selection in the urban population of blackbirds *Turdus merula* of Szczecin (NW Poland). *Acta Ornithol.* 40: 61–69.
- Wysocki D. 2006: Factors affecting the between-season divorce rate in the urban populations of the European blackbird *Turdus merula* in North-Western Poland. *Acta Ornithol.* 41: 71–78.
- Wysocki D., Adamowicz J., Kościów R. & Śmietana P. 2004: The size of breeding territory in an urban population of the blackbird (*Turdus merula*) in Szczecin (NW Poland). *Ornis Fenn.* 81: 1–12.