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ECOLOGY

Analysis of the Dates of Arrival of the Grey Crow *Corvus cornix* in the Lower Ob Region and the Relationship of the Dates of Arrival to Climatic Conditions

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Abstract—This paper considers the dates of arrival of the grey crow at the latitude of the Arctic Circle (the city of Labytnanga) for the period 1970–2016. The dynamics of the dates of arrival of the grey crow were revealed to have stable long-term trends of different directions, which reflect different climatic events that took place in these years. The dates of arrival of the grey crow were found to be correlated with the dynamics of the average temperatures in April and the average daily temperature on the day of the onset of migration with a delay of 1–2 years. It was established that the lower the air temperature in the previous spring, the earlier the first crows arrived.

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INTRODUCTION

The shift in the timing of bird migration under the conditions of global climate changes is a fact well known to ornithologists. This situation has been considered in many publications, including reviews (Lehikoinen et al., 2004; Sokolov, 2006). However, in many cases the picture is complex and ambiguous, and various researchers in different places have noted both the presence and the absence of a shift in the phenological dates (Lehikoinen et al., 2004; Sokolov and Gordienko, 2008; Zakharov, 2016).

It should be noted that most of the authors either limit themselves to a statement of the fact that migration dates have shifted or try to approximate them with the simplest linear dependencies (Grishchenko, 2010; Vengerov, 2011, 2015; Zakharov, 2016; etc.). However, as Grishchenko rightly pointed out, changes can occur nonlinearly over large intervals of time and attempts to approximate them with linear trends will not be successful (Grishchenko, 2010). Moreover, changes may be different over large periods of time. Recent publications (Sokolov and Gordienko, 2008; Vengerov, 2015; Zakharov, 2016) show that the dynamics of migration periods in almost all species studied have a complex nonlinear character with ups and downs. If there are long observation series covering several decades, one can detect time intervals that have different, sometimes multidirectional subtrends, which reflect the processes that occur in nature and are associated with climate fluctuations. Therefore, in order to establish changes in the timing of seasonal phenomena and to clarify the reasons that may cause them, it is necessary to carry out a more detailed analysis of the dynamics of phenological indicators with identification of the available subtrends.

The goal of this study is to analyze the arrival of the grey crow in the Lower Ob region and to identify periods with different dynamics and their subtrends and the relationship of the dates of the start of arrival to climatic conditions.

MATERIALS AND METHODS

The grey crow is a noticeable bird. In the cities and settlements of the Polar region where in winter there are no large birds other than the magpie *Pica pica* and raven *C. corax*, the appearance of the first grey crows, like that of snow buntings *Plectrophenax nivalis,* is a sign of the onset of spring, which does not go unnoticed by hunters, nature lovers, and locals. The ornithologists of the Ecological Station of the Ural Branch, Russian Academy of Sciences (city of Labytnanga), often simultaneously receive several reports about the appearance of the first crows in the cities of Salekhard and Labytnanga. Therefore, the dates of the start of arrival of grey crows in the Lower Ob region are usually accurate. Our analysis was made using the data on the first records of grey crows in the vicinity of the city of Labytnanga for the period 1970–2016. Climate changes were assessed using two indicators: the average daily temperatures on the day of arrival since 1977

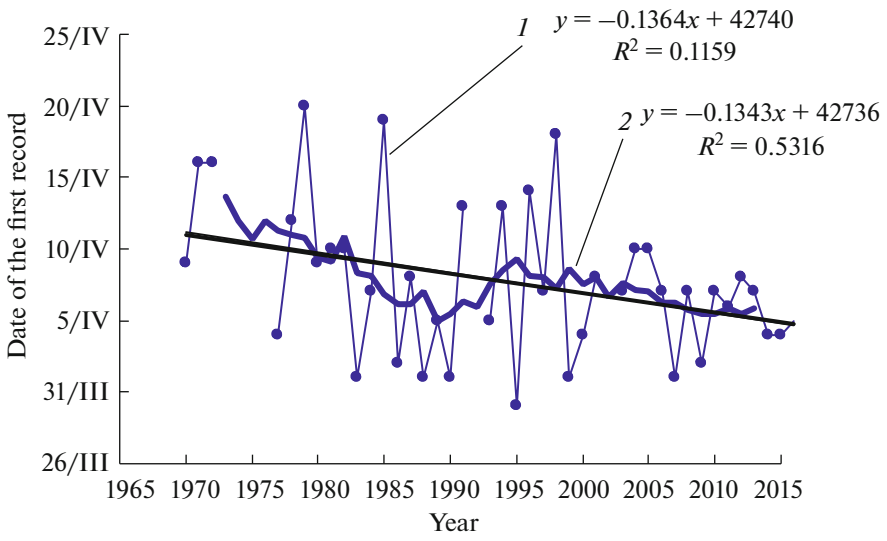

Fig. 1. Initial (*1*) and smoothed (*2*) dates of the start of arrival of the grey crow and trend of their changes.

for which there were data of an almost continuous series of observations and average monthly temperatures of April. The information on the air temperature in April for the years 1977–2016 was taken from the records at the Salekhard Weather Station (WMO #233300, 66°31′ N, 66°36′ E, 35 m above sea level).

The moving average method is traditionally used to smooth out random fluctuations and to identify the most common trends in time series. Our data were analyzed using moving averages of 3, 5, and 7 adjacent values, and the best result was achieved in the latter case. A regression analysis was also used.

To compare the time series, the Spearman correlation coefficients were calculated. The validity of applying the rank correlation method to detect the influence of the temperature factor on long-term fluctuations in the timing of migration was noted earlier (Sokolov et al., 2001). All calculations were performed in Microsoft Excel 2003 and Statistica 6.0.

RESULTS AND DISCUSSION

Trends in the Dynamics of Arrival Dates

Crows began to be encountered in the vicinity of the city of Labytnanga in the first ten-day period of April, but in some years in the second ten-day period (Fig. 1). The average date for 1970–2016 was April 7 ($n = 40$, where n is the number of individuals). For the 1960s V.A. Bakhmutov (Danilov et al., 1984) believed that the date of the start of arrival was April 7–14. Another author, after analyzing the dates of the start of arrival of grey crows for the years 1970–2002, came to the conclusion about a significant ($P = 0.01$) time shift to an earlier time (Paskhal'nyi, 2002). Adding the dates for the subsequent years (2003–2016) negates the significance of the negative trend, but a slight shift in the timing nevertheless does exist. The dates of the start of arrival that are average for the decade are April 13 for 1970–1979, April 7 for 1980–1999, April 6 for 2000–2009, and April 5 for 2010–2016. In general, the number of observations covers a 46-year period.

Figure 1 shows the initial data on the long-term dynamics of the date of arrival of grey crows and these data smoothed by the moving average method. The spread in the dates of the start of arrival is significant; they may differ by 15–20 days in adjacent years. The linear trend based on the initial data shows that there is a weak negative trend that indicates a shift in the arrival date to an ever earlier period. The moving average also shows the presence of this shift. The linear trend based on the smoothed data completely coincides with that for the initial data, but the approximation coefficient for the smoothed series is much higher (Fig. 1). Excluding random fluctuations, we get a clear indication of the shift in the date of arrival of grey crows to an earlier period.

Further analysis of the smoothed series showed that the dynamics of the start of arrival of grey crows had individual distinct periods (Fig. 2). Thus, from 1975 to 1990 the average dates of arrival of grey crows quickly shifted towards the early dates of April. In 1990–1995 there was the reverse trend; it was a period in which the arrival dates equally quickly shifted towards the late days of April. This period was short, and the average dates of arrival of the first crows did not reach the values of 1975. For 1995–2016 the arrival dates again began to shift towards the first days of April, but not as fast as in 1975–1990. Figure 2 shows that all these changes took place almost linearly, and in principle, the graphs of linear regression can also be built for these periods. The approximation coefficients are in all cases very high. It should be noted that there is some trend toward stabilization in the dates of the

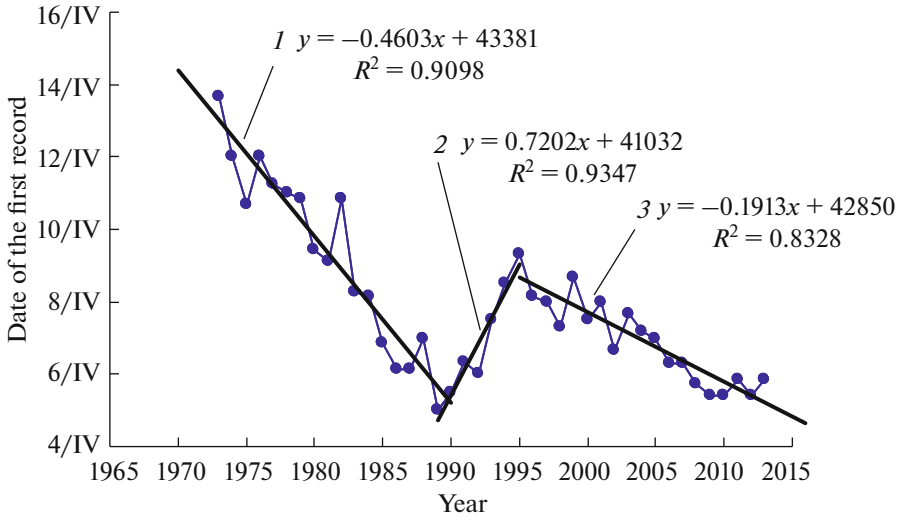

Fig. 2. Smoothed dates of the start of arrival of the grey crow and trends of their changes in April 1975–2016. (*1*) 1970–1989, (*2*) 1990–1995, and (*3*) 1996–2016.

start of arrival of grey crows in 2009–2010. The average dates of arrival during this period reached the minimum values that are characteristic of 1990.

Thus, despite the wide range of fluctuations and apparent randomness, the dynamics of the dates of arrival of grey crows in the Lower Ob region are revealed to have stable long-term trends, which have different directions and may reflect different climate events that took place at this time. We emphasize that it is not enough just to state one shift or another in the phenological dates in studying the dynamics of biota. It is necessary to perform a more in-depth analysis of the changes taking place, to identify all subtrends that may have various natures and directions in order to assess as accurately as possible the impact of environmental changes on ecosystems.

The Dynamics of Arrival Dates and Climate Changes

Since it is recognized that the main factor affecting the arrival time in birds for the Subarctic and Arctic regions is climate changes, primarily changes in air temperature (Uspenskii, 1969), we will consider the relationship between the timing of the start of arrival and the temperature conditions of April, which is the month when grey crows are noted to appear in the city of Labytnanga. A comparison of the data on the dynamics of arrival dates and the average daily temperatures on the day of arrival revealed a very weak correlation; Spearman's correlation coefficient (r) is –0.14 ($p = 0.409$). However, if the timing of arrival is shifted one year back, a clear correlation appears (Fig. 3) and Spearman's correlation coefficient increases ($r = 0.33$, $p = 0.052$); i.e., the date of arrival of grey crows proves to be significantly correlated with the temperature on the day of arrival in the last year. The average daily temperature was below –15°C (the temperature at night was below –20°C) on the day of arrival in 1978, 1984, 1987, 1989, 1994, 1998, 1999, 2005, 2006, 2008, and 2010. The earliest arrival on April 30–April 2 was observed in 1983, 1986, 1988, 1990, 1995, 1999, 2006, and 2009. Accordingly, the pairs of last year's cold spring and the current year's early arrival were observed in 1987/1988, 1989/1990, 1994/1995, 2005/2006, and 2008/2009, which also confirms the possible relationship of the cold spring in the previous year with the early arrival in the next year over the past 30 years.

If smoothing by the moving average method is applied to the values of the average daily temperature on the day of arrival, a comparison of the calculated temperature series and the arrival date also shows that they are correlated (Fig. 4a). Meanwhile, there is almost no correlation with the average daily temperature values in the year of observations ($r = –0.01$, $p = 0.973$), but if the series of arrival dates is moved two years back, the correlation proves to be high and significant ($r = 0.48$, $p = 0.006$; Fig. 4a). It should be emphasized that this is more than a shift for the initial, nonsmoothed values, but this can be an artifact known for the effect of the shift due to the smoothing procedure. It is important that this shift is detected when comparing both the initial and the smoothed series.

The temperature on the day of arrival is a quite variable value. In addition, short-term rises and falls in temperature may not have a significant effect on birds. The general course of spring that must influence the phenodates can be characterized by average temperatures over some period of time. We chose the average monthly temperature in April when crows arrive.

The series of the average temperature of April and the dates of the start of arrival are correlated, which is manifested best of all if the arrival dates are shifted

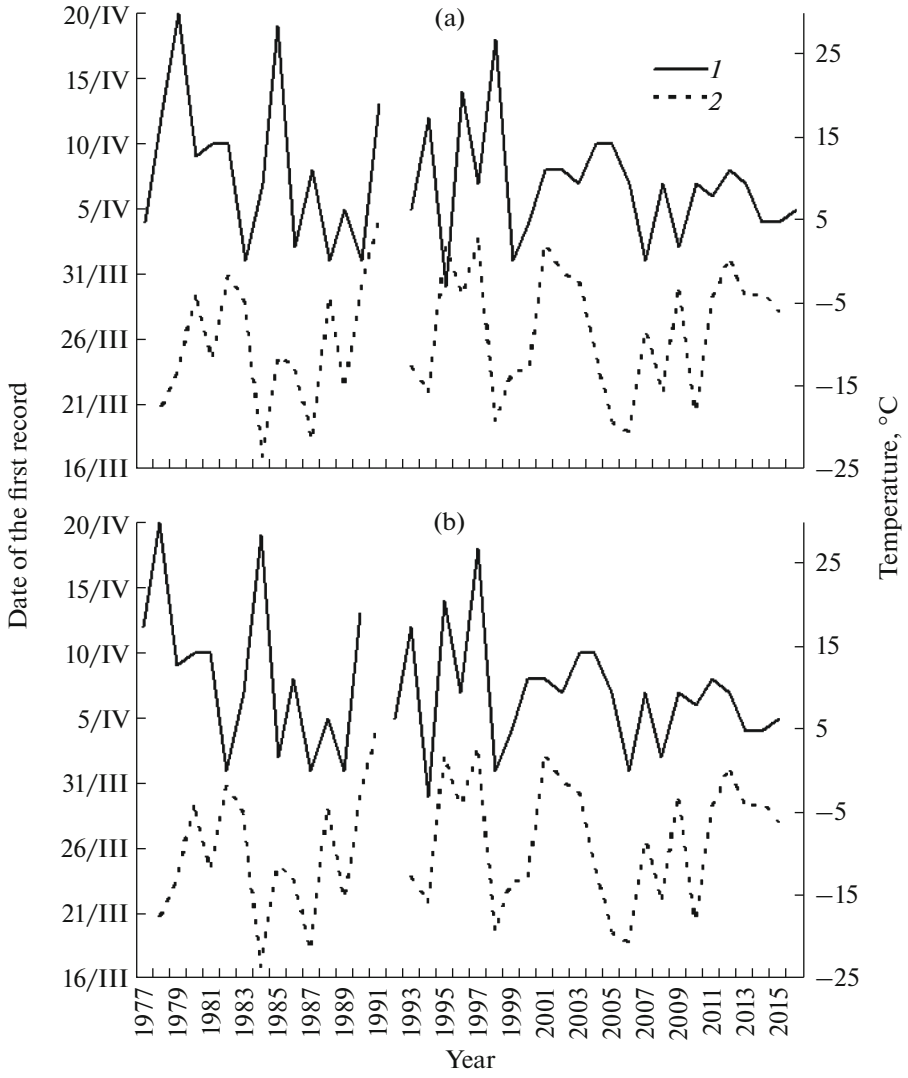

Fig. 3. (*1*) Dates of arrival of the grey crow and (*2*) average daily temperatures on the day of arrival. (a) Initial data, (b) dates of arrival are shifted one year back.

three years back ($r = -0.14$, $p = 0.461$ without the shift and $r = 0.37$, $p = 0.024$ with the shift of the arrival dates by three years) (Fig. 4b). This shift is greater than for the temperatures on the day of arrival, but this may also be partly due to the effect of shift due to the smoothing procedure.

Thus, the dates of arrival of grey crows prove to be correlated not with the current temperatures, but with the temperatures of the last year or the year before last. This may be somehow connected with the memory of birds about the conditions of the last year, with some previous experience. The returns of rings of fledglings, which were marked in the Ob floodplain (Ryzhanovskiy, 2005), indicate their arrival in the hatching area in the first year of life, but these crows start breeding over the age of two years, also having information about the spring of the previous year. However, in our opinion, the most important fact is that all the detected correlations of arrival dates with temperatures are positive. In other words, the lower the temperatures were 1–3 years ago, the earlier the crows arrive and vice versa. This relationship seems paradoxical: it would seem that the warmer and more favorable the spring, the earlier the birds could arrive. It is possible that the influence of the temperature conditions at the beginning of the season on the birds is mediated by some additional factor, but for now it is difficult even to suppose what this factor is.

CONCLUSIONS

The northern borders of the mass breeding of grey crows in the Lower Ob region are limited by the forest tundra; the species rarely penetrates into the tundras of the Yamal. For this reason, we observed the arrival in the nesting area, and not the passage of northern

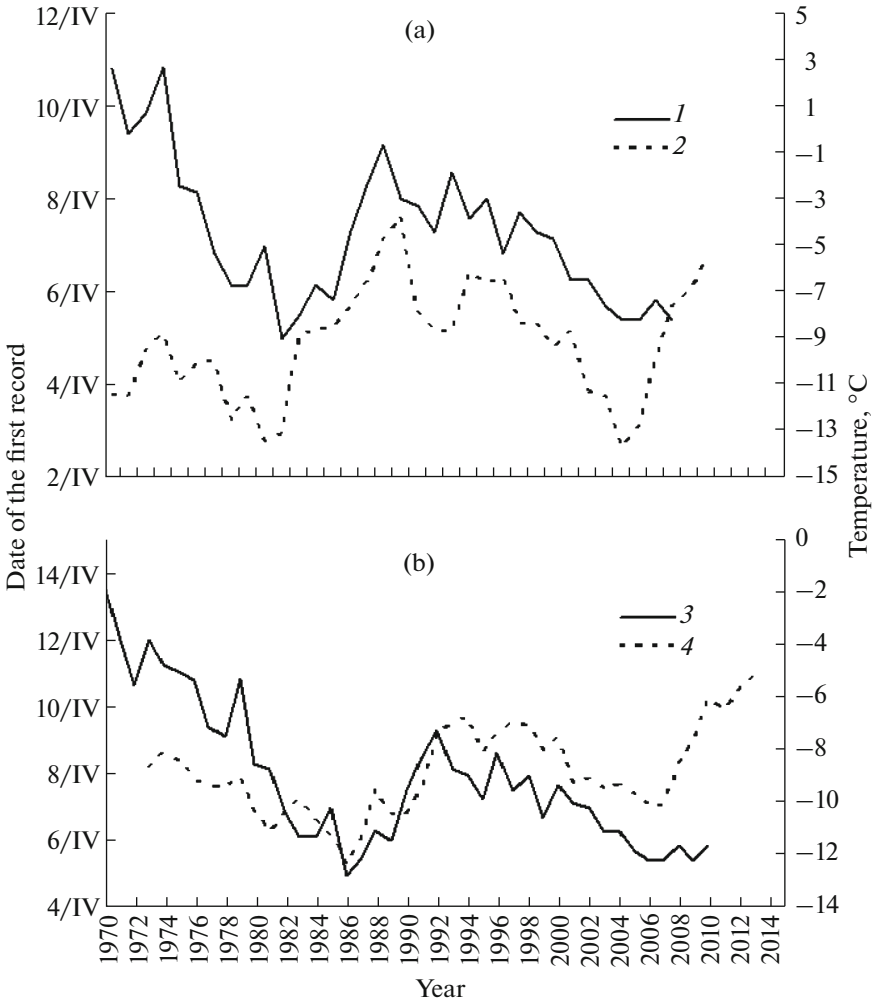

Fig. 4. Smoothed dates of arrival (April) of the grey crow shifted 2 years back (*1*) and average daily temperatures (*2*) on the day of arrival (a) as well as shifted 3 years back (*3*), and the average temperatures of April (*4*) (b).

birds. It should also be noted that the arrival began not earlier than one week after the day of the vernal equinox, during an intensive increase in the light part of the day before the beginning of the polar day in May. Some years were notable for warm weather in the second half of March and the intense sexual activity of crows, magpies, and house sparrows, but the arrival of grey crows did not start despite their cold resistance. The internal rhythm that synchronizes the timing of arrival with the photoperiodic conditions of the region is decisive. The external climatic conditions correct the arrival.

The materials presented in this article allow us to draw a number of conclusions:

—The long-term dynamics of the dates of arrival of grey crows in the Ob forest tundra for the period 1970–2016 were revealed to include three periods that differ in the pace and direction of change. Leaving this fact out of account leads to a significant underestimation of the general nature and scale of the shift of phenological dates.

—The dates of the start of arrival of the grey crow were found to be correlated with the dynamics of the average temperatures in April and the average daily temperature on the day of the migration onset with a delay of 1–3 years.

—The relationship with April temperatures in the grey crow turns out to be paradoxical: the lower the air temperature in the previous spring, the earlier the first crows arrive.

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COMPLIANCE WITH ETHICAL STANDARDS

The authors declare that they have no conflict of interest. This article does not contain any studies involving animals or human participants performed by any of the authors.

REFERENCES

Danilov, N.N., Ryzhanovskii, V.N., and Ryabitsev, V.K., *Ptitsy Yamala* (Birds of Yamal), Moscow: Nauka, 1984.

Grishchenko, V.N., Changes in the dates of bird migration in the Kanev Nature Reserve, *Branta: Sb. Nauch. Tr. Azovo-Chernomorsk. Ornitol. Stantsii*, 2010, no. 13, pp. 33–39.

Lehikoinen, E., Sparks, T.H., and Zalakevicius, M., Arrival and departure dates. The effect of climate change on birds, *Adv. Ecol. Res.*, 2004, vol. 35, pp. 1–31.

Paskhal'nyi, S.P., Dates of arrival of some species of birds to the lower reaches of the Ob River in 1970–2002, in *Mnogoletnyaya dinamika chislennosti ptits i mlekopitayushchikh v svyazi s global'nym izmeneniem klimata. Materialy mezhdunarodnogo simpoziuma (11–16 noyabrya 2002, Rossiya, Respublika Tatarstan, Kazan')* (Long-Term Dynamics of the Abundance of Birds and Mammals in Relation to the Global Climate Change: Proc. Int. Symp. (November 11–16, 2002, Kazan, Republic of Tatarstan, Russia)), Kazan, 2002, pp. 151–156.

Ryzhanovskii, V.N., Distribution of hooded crows from the Lower Ob region in non-breeding season (according to the results of banding), in *Materialy po rasprostraneniyu ptits na Urale, v Priural'e i Zapadnoi Sibiri* (Materials on Bird Distribution in the Urals, Cis-Urals, and Western Siberia), Yekaterinburg: Ural. Univ., 2005, p. 234.

Sokolov, L.V., Influence of global warming on migration and breeding periods of passerine birds in the 21st century, *Zool. Zh.*, 2006, vol. 85, no. 3, pp. 317–341.

Sokolov, L.V. and Gordienko, N.S., Has recent climate warming affected the dates of bird arrival to the Il'men Reserve in the Southern Urals?, *Russ. J. Ecol.*, 2008, vol. 39, no. 1, pp. 56–62.

Sokolov, L.V., Tropp, E.A., Morozov, Yu.G., and Efremov, V.D., Effect of the temperature factor on the long-term fluctuations of the dates of migration, breeding, and dispersal of passerine birds, *Dokl. Biol. Sci.*, 2001, vol. 379, no. 2, pp. 362–365.

Uspenskii, S.M., *Zhizn' v vysokikh shirotakh. Na primere ptits* (Life in the High Latitudes: A Case Study of Birds), Moscow: Mysl', 1969.

Vengerov, P.D., The impact of climate change on the dates of arrival and breeding of the song thrush (*Turdus philomelos*) and the chaffinch (*Fringilla coelebs*) in the Voronezh Reserve, *Usp. Sovrem. Biol.*, 2011, vol. 131, no. 4, pp. 416–424.

Vengerov, P.D., Dates of spring arrival of birds in the Voronezh Reserve against the background of long-term climate changes, *Nauch. Vedom. BelGU. Ser: Estestv. Nauki*, 2015, vol. 30, no. 3 (200), pp. 82–92.

Zakharov, V.D., The influence of climate change on the dates of bird arrival to the Ilmen State Reserve (Southern Urals), *Russ. J. Ecol.*, 2016, vol. 47, no. 6, pp. 546–551.

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