

European Serin (*Serinus serinus*) expands nesting area to south and east

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Abstract In the context of anthropogenic and climatic changes in the faunas of numerous regions, species that were previously absent from there are now observed, accompanied by alterations in the number of animal populations and disruption of the usual trends of their dynamics. The changes in the range of the European Serin (*Serinus serinus*) within Ukraine were identified by creating a four-layer GIS map in the DIVA-GIS software. The analysis revealed that European Serin continues to disperse in Europe, with a notable shift towards the south and east. The current southern border of the breeding range of the species passes through Central Ukraine, encompassing the right bank of the Dnipro river. However, the status of European Serin in the Black Sea region remains unclear. In the territories inhabited in the 20th century, the density of European Serin in the breeding season has increased, although decreasing population size is described for old populations of Europe. It is relevant to study the comparative dynamics of bird numbers in old habitats and in newly developed areas, with a view to identifying new wintering grounds for birds and populations that have shifted to a sedentary lifestyle.

Keywords: population changes, species distribution, Ukraine

Összefoglalás Az antropogén és éghajlati változásokkal összefüggésben számos régió faunájában megfigyelhetők olyan fajok, amelyek korábban hiányoztak onnan. Egyik ilyen faj a csicsörke (*Serinus serinus*), amelynek az Ukrajnán belüli elterjedési területén bekövetkezett változásokat a DIVA-GIS programban négyrétegű GIS-térkép készítésével azonosítottuk. Az elemzés kimutatta, hogy a csicsörke továbbra is terjed Európában, jelentős elmozdulással dél és kelet felé. A faj költőterületének jelenlegi déli határa Közép-Ukrajnán halad keresztül, magába foglalva a Dnyipro folyó jobb partját. A Fekete-tenger térségében azonban továbbra is tisztázatlan a státusza. A 20. században nőtt a faj denzitása költési időszakban, de ezzel szemben a régebbi európai populációinak csökkent az állománya. Annak érdekében, hogy megállapíthassuk a vonulási viselkedés változását (telelőhelyek változása, áttelelő madarak számának emelkedése), fontos a madarak számában bekövetkező változások nyomon követése a régi és az újonnan kolonizált területeken is.

Kulcsszavak: csicsörke, fajok elterjedése, Ukrajna

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Introduction

In recent decades, there has been a notable shift in the number of animal populations and a disruption of the usual trends in their dynamics (Kinzelbach 2011, Masoero *et al.* 2016). There has been a shift in the ranges of species, with the disappearance of species from the composition of breeding birds in different territories (Huntley *et al.* 2008). Palaeontological records indicate that modern northern bird species, along with their associated vegetation types, have shifted southwards, while open country species have shifted from the south-east to the north-west (Holm & Svenning 2014). This has resulted in species that were previously absent from the faunal lists of many regions becoming established. The distribution of birds is influenced by a variety of factors, with the initial position of the primary centre of origin of the species being the most important (Payevsky 2015). Species have been moving for a long time, but the movement of people, intensification of trade and economic development have accelerated this process. Changes in the species composition of the fauna of many regions are associated with an increase in the abundance and range expansion of some species. In the 1970s, the planet faced the issue of global climate change. The warming of northern regions has contributed to range changes in many species (Huntley *et al.* 2008, Holm & Svenning 2014, McLaughlan *et al.* 2014). Some species are at risk of population and range declines (e.g. Shupova & Tytar 2022), while others are conversely at risk of increases (e.g. Londei 2020). In order to make informed conservation decisions for biotic communities and species, it is crucial to ascertain the extent to which changes in the distribution of biota are attributable to natural causes and the extent to which they are due to human activities (Huntley *et al.* 2008).

In the context of climatic and anthropogenic changes, several new species of birds have emerged in the modern fauna of Ukraine. The European Serin (*Serinus serinus*), for instance, was absent from the country for almost the entire 20th century (Parkhomenko 1950, Strautman 1963, Charlemagne 2020). The birds entered Ukraine independently, occupying urbanised biotopes. In urbanised biotopes, anthropogenic changes have been demonstrated to reduce the competitiveness of local species (Evans 2010, Díaz *et al.* 2011, Møller *et al.* 2015). This phenomenon may have contributed to the settlement of European Serin in Ukraine. Fortunately, alien bird species have a minimal impact on changes in local diversity, and respond to abiotic habitat gradients in a manner similar to native bird species (Andrikou-Charitidou & Kallimanis 2021, Lazarina *et al.* 2023). The European Serin is currently undergoing dispersal, and the breeding range boundaries of the species are not yet stable (Knaus 2020).

The primary range of the European Serin was the Canary Islands and the Mediterranean, including southern Europe and Asia Minor (Dementev *et al.* 1954). The species had already started to disperse in the 16th century, but stopped due to the influence of the Little Ice Age. At the end of the 16th century, there were no European Serin populations in Europe north of the 48°N. Nevertheless, the birds lived in Carinthia (Austria), Trentino (Italy), Ticino and the Jura (Switzerland), Provence and Gascony (France), Tyrol and the Rhône Valley (Kinzelbach 2004). By the end of the 18th century, the European Serin's range extended to Spain, Italy, parts of Switzerland and the Balkans (Payevsky 2015).

Since 1800, its range has undergone a resurgence of expansion (Mayr 1926, Kinzelbach 2004). In the early years of the 19th century, the European Serin occupied the area north of the Alps. By the mid-20th century, it had populated all of Central Europe and reached southern England (Payevsky 2015). From 1927 to 1943, the species expanded its range into the countries of the eastern Baltic (Kumari 1958). From 1950, it reached Belarus. From 1960 to 1972, it spread to Finland and the Leningrad region (Mal'chevskii & Pukinskii 1983). This second wave of bird dispersal continues to the present day (Kinzelbach 2011, Knaus 2020).

The European Serin is a thermophilic migratory bird, with the exception of southern Europe, where it is sedentary and winters on the coastal regions of France, the Iberian Peninsula, North Africa, and the northern Mediterranean coast (Ottaviani 2008, Senar *et al.* 2011). In winter, occasionally, the species has been observed in the vicinity of Gdansk and Kaliningrad (Dementev *et al.* 1954), Galicia (Bokotey 1995), and Bukovina (Skilsky 1998).

The average lifespan of the species is 1.98 years (Senar & Copete 1990). In different regions, the birds have one or two broods per breeding season (Ottaviani 2008), with instances of three broods (Knysh & Malyshok 2015, Haraszthy 2019). In the natural landscape, the species prefers forest edges and glades, ravines, and gorges of mountains, where there are trees and shrubs. In Europe, the European Serin is currently found mainly in cultural landscapes (Gil-Delgado & José 1981, Díaz *et al.* 2011, Knysh 2011), including open cultivated areas, hedgerows, gardens, and urban parks. It also occurs in large cities and small towns (Ottaviani 2008). It has been observed that birds tend to favour biotopes with individual coniferous trees, although they have been known to place nests in both coniferous and deciduous trees (Kumari 1958, Knysh & Malyshok 2015, Haraszthy 2019). The nests of the European Serin are located at heights of 1.50–10.0 m (Ouarab *et al.* 2007, Knysh & Malyshok 2015). The mean clutch size in western Europe was found to be 3.70–3.87 (Gil-Delgado 1981), in Germany (Gnielka 1978) and Hungary (Haraszthy 2019) 4.0, while in the east, it was 4.37 eggs (Strautman 1963, Knysh & Malyshok 2015). In western Europe, egg-laying occurs in early March and early July (Gil-Delgado & José 1981). In Hungary, the first clutches are complete in mid-May, the second clutches in late June – early July, while the third clutches in mid-August (Haraszthy 2019). In eastern Europe, it occurs in the second half of May and the beginning of June. However, there is a description of nest construction on 19 July in 2011, and a new nest on 4 August 2011 (Knysh & Malyshok 2015). The breeding productivity of the species ranges from 1.49 (Senar & Copete 1990) to 2.18 fledglings per nesting attempt (Knysh & Malyshok 2015). Predation, starvation and tree pruning have been identified as factors that affect the abundance and nesting success of the species (Gil-Delgado & José 1981, Hoi-Leitner *et al.* 1999).

The objective of this study is to elucidate the distribution of the European Serin in Ukraine and to ascertain the status of the species and its current range in different regions of the country.

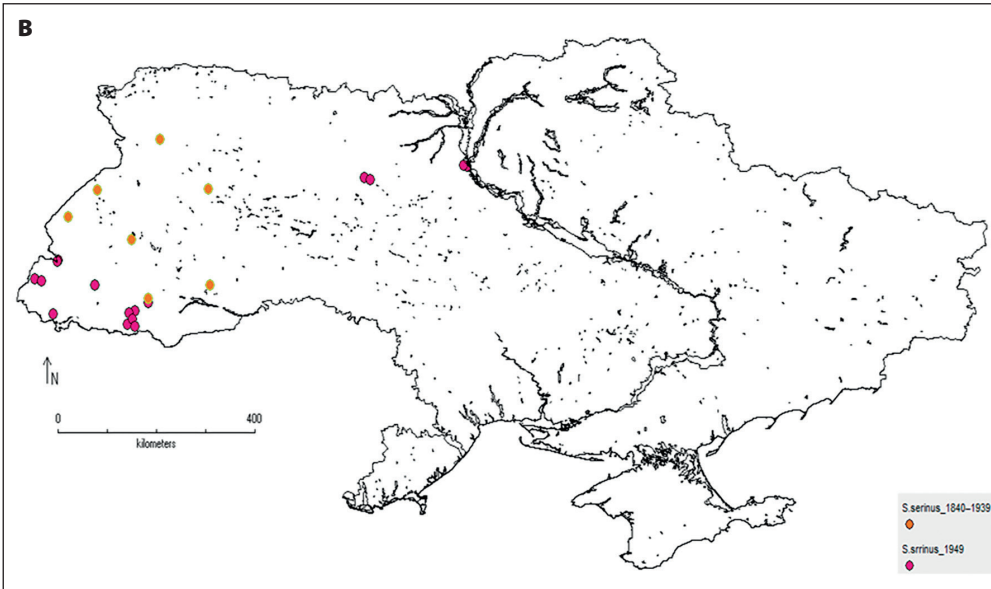
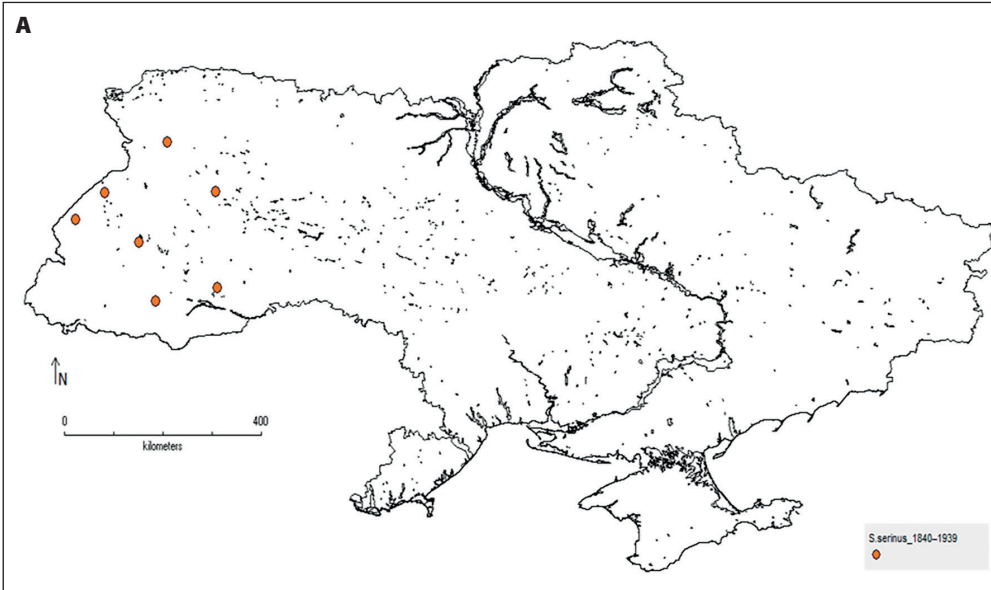
Methods

To clarify the changes in the European Serin range in Ukraine, we created a GIS map in the DIVA-GIS software (<http://www.diva-gis.org/>). The map was constructed using geographic coordinates obtained during our own observations and indicated in the analysed literature sources and museum collections. These coordinates were subsequently determined by recalculation with a geocalculator in DIVA-GIS. A total of 45 literature sources containing information about European Serin occurrences in Ukraine and 13 in adjacent territories were analysed. Articles devoted to the European Serin, catalogs of museum collections, and articles that contain lists of the regional faunas were analysed. For map construction, 39 of these sources (Parkhomenko 1950, Strautman 1963, Talposh 1974, 1976, Belik & Moskalenko 1993, Bokotey 1995, 2004, Guziy 1996, Kogut *et al.* 1996, Mistryukova 1996, Godovanets 1997, Knyazev 1997, Bashta 1999, Lugovoi *et al.* 2001, Nadtochiy 2002, Grischenko 2003, Senyk & Hornyak 2003, Gavriilyuk 2004, Gavriilyuk *et al.* 2005, Lugovoi 2005, Sizhko 2006, Gavrys *et al.* 2007, Domashevskiy 2008, Matveev 2008, Peklo 2008, 2018, Matviychuk & Serebryakov 2010, Knyish, 2011, Materials of ornithological observations 2011, Nankinov 2011, Skilskyi *et al.* 2014, Knysh & Malyshok 2015, Novak 2015, Yakovlev 2015, Yanenko *et al.* 2015, Pisulinska *et al.* 2016, Biletska 2017, Charlemagne 2020, Ghryb 2022), in addition to 83 author's registration points and data from databases, namely UaBirds, iNaturalist, UkrBIN, were used. In the absence of the coordinates of the sightings in the literature source, GIS coordinates were determined by searching on the map for the indicated locality and the distance from it to the place of bird registration. All the bird sightings described in the literature were divided into four GIS map layers. The first layer comprises records of the species during the first century of ornithological research in Ukraine before the beginning of bird expansion in Ukraine (1840–1939). The second layer represents the beginning of expansion in Ukraine and includes the distribution of the European Serin in the first half of the 20th century (1940–1950). The third layer encompasses the range of the European Serin by the end of the 20th century (1951–1999), and the fourth layer represents the distribution of the species at the beginning of the 21st century (2000–2022). A total of 399 GIS coordinates were utilised in the construction of the maps.

Results

Analyses of European Serin records during the breeding period revealed that in the late 19th and early 20th centuries, the species inhabited the western and south-western regions of the territory that is part of modern Ukraine (*Figure 1a*). By the middle of the 20th century, the number of nestings in the south-west increased, and the boundaries of the breeding range shifted to the centre of the country, reaching Kiev (*Figure 1b*). By the end of the 20th century, the European Serin had established a breeding population in Central and Northeastern Ukraine, with a possible expansion into the Odessa region (*Figure 1c*).

In the territories developed in the 20th century, the density of European Serin records during the breeding season increased. In the 21st century, the boundary of the breeding range of the species shifted further to the south and east (*Figure 1d*).



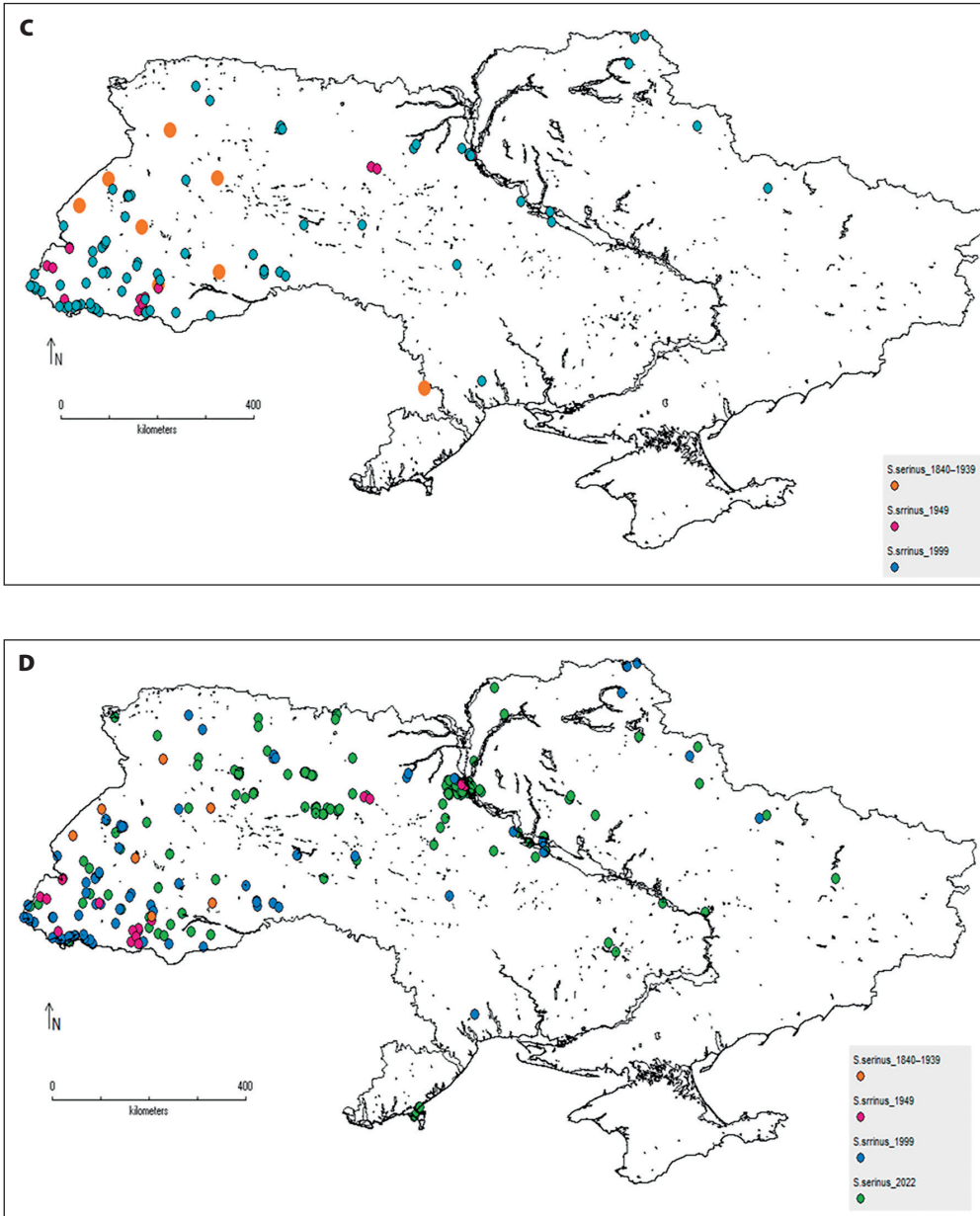


Figure 1. The changes in the breeding range of the European Serin in Ukraine during the period 1840–1939 (a), 1940–1949 (b), 1950–1999 (c) and 2000–2022 (d): stable area: 1840–1939 (orange); new nesting sites in 1940–1949 (pink), and in 1950–1999 (blue); area of European Serin in Ukraine in 2000–2022 (green)

1. ábra A csicsörke fészkelőterületeinek változása Ukrajnában az 1840–1939 (a), 1940–1949 (b), 1950–1999 (c) és a 2000–2022 (d) közötti időszakban

Discussion

The study of the European Serin in Ukraine commenced in the mid-20th century. The initial description of the species was provided by Charlemagne (2020), who indicated that the bird was not previously documented until 1939. From 1939 onwards, the species was observed in Volyn, and in Kiev, it was first recorded as breeding in 1948 (Parkhomenko 1950, Charlemagne 2020). However, the information provided by Charlemagne (2020) is contradicted by the data presented by Strautman (1963), who indicates that the species was common in Galicia between 1840 and 1880 and was distributed in Galicia, Romania, the vicinity of Tiraspol, Bukovina, the upper Prut river, and the northern foothills of the Carpathians. Additionally, records indicate the birds' dispersal in western Ukraine (in Volyn, Lviv, Zakarpattia, and Ivano-Frankivsk regions) (Strautman 1963, Pisulinska *et al.* 2016). Subsequently, the European Serin continues to expand its breeding range in an eastern direction. The birds establish new regions through the formation of focal settlements, from which they subsequently disperse. This process was observed in the Baltics, where the European Serin initially distributed in small, scattered groups in new areas (Kumari 1958). A similar pattern can be observed in Central and Eastern Ukraine, where the species has penetrated in the last two decades and currently inhabits localised subpopulations. In the western region, where the species has been breeding for over a century, the frequency of observations is evenly distributed across the entire territory (*Figure 1*).

In established populations of the species in Ukraine, an increase in numbers has been observed since the middle of the 20th century (Bashta 1999, Knaus 2020). At the same time, decreasing population size has been observed in Europe since 1982 (BirdLife International 2024). Bird abundance have declined particularly significantly in Portugal, although in some regions of Europe, for example in Slovenia, it has increased (Knaus 2020). This intriguing discrepancy in the species' population trends across different regions necessitates a comprehensive investigation.

In Ukraine, the area inhabited by the European Serin continues to expand. The modern breeding range of the species encompasses the entirety of the west and north of Ukraine, with its southern border traversing the Cherkassy, Dnepropetrovsk, and Donetsk oblasts. The status of the species in Odessa oblast requires further clarification. The species has already been documented in the Black Sea region, and although birds were first observed in the Odessa region in 1990 (Yakovlev 2015), the status of the species remains uncertain, as all descriptions of the species in this region pertain to the migratory period. Nevertheless, adult birds and fledglings are regularly recorded in the region (Yakovlev 2015). In Poltava (Nankinov 2011, UaBirds), Dnepropetrovsk (Sizhko 2006, author's data) and Donetsk (author's data) regions, European Serin appeared already in the 21st century.

The primary factor driving the range expansion of numerous species, including the European Serin, is the shift in the European climate towards less continental (Huntley *et al.* 2008). The range of the European Serin has been expanding northwards in a gradual manner (Kinzelbach 2004). It is postulated that, having crossed the Alps, the birds encountered optimal conditions devoid of competitors. Further northward dispersal was attributed by Mayr (1926) to the emergence of mutants with an increased desire for expansion, with

the number of dispersing individuals accounting for approximately 20% of the population. The introduction of European Serin into the northwest occurred in a broad front and at a greater rate than into the southeast (Mal'chevskii & Pukinskii 1983). Over the course of 170 years, the European Serin expanded its range by 2.5 million km², with an average rate of 14,300 km² per year. This expansion was punctuated by shifts in the habitat boundary, which occurred at a distance of 100–270 km from previous records (Payevsky 2015). By the end of the 20th century, the species was observed in almost all of continental Europe during the summer period. The subsequent slowdown in dispersal rate is attributed to the challenging climatic conditions of northern regions (Alimova & Bogutskaya 2004). We posit that the slow dispersal of European Serin in the eastern direction is due to the necessity for the birds to develop the Carpathian region and to settle mountainous terrain. The total area of mountain valleys and uplands requires a larger number of individuals than the flat areas of Central and Northern Europe. For example, European Serin inhabited the Ukrainian Carpathians for approximately 100 years, first appearing in 1840 in Bukovina and only in 1939 in Volyn and Kremenets (Strautman 1963). Subsequently, the birds migrated to the plains, occupying Transcarpathia in a southern direction within 10 years and reaching Kiev in an eastern direction (Peklo 2008, Pisulinska *et al.* 2016, Charlemagne 2020). Over the consecutive 50 years, its range expanded to encompass the middle reaches of the Dnieper river (*Figure 1*) along both its banks. By 2022, only the southern and south-eastern regions of Left-Bank Ukraine remained uninhabited. It can be predicted that by the middle of this century, the European Serin's breeding range may extend to the northern coasts of the Black and Azov Seas. It is also important to recognise that military actions in this region may both accelerate and slow down the process of bird dispersal.

The occupation of new territories by a species is most often initiated by young individuals during the 'prolongation of migration', who then nest further away from the former range boundary with each spring (Payevsky 2015). It is believed that the dispersal of the European Serin was a completely natural process, without any influence of random introductions, and accompanied by a change in attachment to specific biotopes (Payevsky 2015). From a preference for forest edges, clearings and small groups of trees among open landscapes, the species migrated to urbanised biotopes, including parks, cemeteries, gardens and suburban areas with sparse vegetation. As a native of the Mediterranean, it found in European settlements a habitat that was highly similar to its original environment (Belik 1977).

It is also important to consider the impact of human activity on the landscape when analysing the factors influencing the dispersal of the species. Urban biotopes, which occupy more and more living space every year, represent a mosaic landscape of islands of green areas in buildings (Croci *et al.* 2008, Miroshnyk *et al.* 2021). European Serin have become well adapted to living in these urbanised green areas. Thanks to their presence in steppe areas that have always been deficient in tree plantations, the birds have been able to populate regions rich in food resources for grain-eating birds but previously unsuitable for dendrophiles.

In conjunction with the expansion of the breeding range, the wintering grounds of birds are undergoing a transformation. Traditionally, most populations of European Serin gather in flocks and migrate in September (Knysh & Malyshok 2015). In Europe, the species winters in suburban areas with ruderal herbaceous communities, often in vineyards, olive

or almond groves and other non-irrigated lands, where its average density reaches from 100 to 240 birds/km² and it is less often found in urban parks. Some populations of birds from different regions of Europe winter in the southern regions of the continent, while 10% of populations are sedentary (Senar *et al.* 2011). They leave Ukraine for the winter in October. However, in western Ukraine, European Serin was already recorded in small numbers in winter during the 20th century (Mistryukova 1996, Skilsky 1998). These birds are kept in winter in botanical gardens and arboretums. In the 21st century, the species was described wintering in Armenia too (Ananyan & Boyadzhyan 2016). It is believed that since European Serin has been hunted to extinction, there are no threats to the species in Europe. Its numbers are negatively affected only by shortcomings in agricultural policy (Senar *et al.* 2011). It is proposed that fallow lands and wastelands be developed to provide the birds with food during the winter months.

Conclusion

The European Serin continues to disperse southwards and eastwards in Europe. The current breeding range of the species encompasses the entirety of the west and north of Ukraine, with the southern border of the species traversing Central and Eastern Ukraine, extending to the right bank of the Dnieper river and the Black Sea regions. However, the status of this population in this region requires further clarification. It is similarly important to examine the comparative dynamics of bird populations in old habitats and in newly developed areas. This can help identify new wintering grounds and populations that have shifted to a sedentary lifestyle.

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