Zoology and Ecology, 2025, Volume 35, Number 1
Online ISSN: 2165-8013
https://doi.org/10.35513/21658005.2025.1.9

RECENT RANGE EXPANSION OF THE HOUSE BUNTING (*EMBERIZA SAHARI SAHARI*) IN ALGERIA AND PROSPECTS FOR FUTURE EXPANSION

Abdelwahab Chedad[a]*, Djamel Bendjoudi[b], Walid Dahmani[c], Mayssara El Bouhissi[d,e], Haféda Benmammar-Hasnaoui[f], Abdelkader Bekkouche[g], Azeddine Si Bachir[h], Hayat Djeziri[i], Fares Zoutal[j], Abdelkarim Zitouni[k], Ghania Touchene[l], Fayçal Seddiki[m], Djalila Rabie[n], Salah Eddine Sadine[o], Mohamed Ait Hammou[c], Brahim Beladis[p], Brahim Babali[r], Omar Guezoul[s] and Haroun Chenchouni[t,u]

[a]Laboratoire de Recherche Agronomie Environnement (LRAE), Université Ahmed Ben Yahia El Wancharissi, Tissemsilt, Algérie; [b]Department of Biology, Laboratory of Biotechnology, Environment and Health, University of Blida 1, 09000 Blida, Algeria; [c]Department and Faculty of Nature and Life Sciences, Laboratory of Agro Biotechnology and Nutrition in Semi-Arid Areas, Ibn Khaldoun University of Tiaret, 14000 Tiaret, Algeria;[d]Laboratory Ecodevelopment of Spaces, University of Djillali Liabes Sidi Bel Abbes, 22000 Sidi Bel Abbes, Algeria; [e]Directorate of Forest Conservation of Sidi Bel Abbes, 22000 Sidi Bel Abbes, Algeria; [f]Tlemcen National Park, 130000 Tlemcen, Algeria; [g]Independent Naturalist, El Hamadna, 48000 Relizane, Algeria; [h]Directorate of Forest Conservation of Tissemsilt, 38000 Tissemsilt, Algeria; [i]Abou Bekr Belkaid University of Tlemcen, 13000 Tlemcen, Algeria; [j]Independent Naturalist, 09000 Blida, Algeria; [k]Independent Naturalist, 20000 Saida, Algeria; [l]Independent Naturalist, 31000 Oran, Algeria; [m]Association for the protection of wildlife, 37000 Tindouf, Algeria; [n]Laboratory the Diversity of Ecosystems and Dynamics of Agricultural Production Systems in Drylands, University of Biskra, 07000 Biskra, Algeria; [o]Faculty of Nature and Life Sciences and Earth Sciences, University of Ghardaïa, 47000 Ghardaïa, Algeria; [p]Laboratory of Saharan Bio-Ressources: Preservation and Valorization, University of Ouargla, 30000 Ouargla, Algeria; [r]Laboratoire d'Ecologie et Gestion des Ecosystèmes Naturels, Department of Biology and Environment, University of Tlemcen, 130000 Tlemcen, Algeria;[s]Department of Forest Management, Higher National School of Forests, 40000 Khenchela, Algeria; [t]Laboratory of Natural Resources and Management of Sensitive Environments 'RNAMS', University of Oum-El-Bouaghi, 04000 Oum-El-Bouaghi, Algeria

*Corresponding author. Email: agrochedad@yahoo.fr

Abdelwahab Chedad: https://orcid.org/0000-0001-8098-1803
Djamel Bendjoudi: https://orcid.org/0000-0002-5029-5498
Walid Dahmani: https://orcid.org/0000-0002-1058-4084
Mayssara El Bouhissi: https://orcid.org/0000-0002-4772-4976
Djalila Rabie: https://orcid.org/0000-0002-1336-372X
Salah Eddine Sadine: https://orcid.org/0000-0002-0026-8280
Mohamed Ait Hammou: https://orcid.org/0000-0002-8463-6107
Brahim Beladis: https://orcid.org/0000-0003-1854-3110
Brahim Babali: https://orcid.org/0000-0001-6788-2069
Omar Guezoul: https://orcid.org/0000-0003-2784-3115
Haroun Chenchouni: https://orcid.org/0000-0001-9077-2706

Chedad, A., Bendjoudi, D., Dahmani, W., El Bouhissi, M., Benmammar-Hasnaoui, H., Bekkouche, A., Si Bachir, A., Djeziri, H., Zoutal, F., Zitouni, A., Touchene, Gh., Seddiki, F., Rabie, D., Sadine, S.E., Ait Hammou, M., Beladis, B., Babali, B., Guezoul, O., Chenchouni, H. 2025. Recent range expansion of the House Bunting (*Emberiza sahari sahari*) in Algeria and prospects for future expansion. *Zoology and Ecology* 35(1), 77–86. https://doi.org/10.35513/21658005.2025.1.9

Article history
Received: 26 March 2025; accepted: 10 June 2025

Keywords:
Climate change; *Emberiza sahari*; new location; range expansion

Abstract. The availability of trophic resources and climate change are two factors that affect the expansion of a species' distribution range. The distribution of the House Bunting (*Emberiza sahari sahari*) was previously limited to the desert and sub-desert areas of North Africa (Algeria, Morocco, and Tunisia). However, the species was recently recorded at several new localities in north-western Algeria, including Tlemcen (Maghnia, Beni Bahdel, and Sebdou), Aïn Témouchent (Aïn Témouchent city and Rechgoun), Oran and Saïda city, Sidi Bel Abbès (Oued Sefioun and Marhoum), Tiaret (Kef Esbaa at Oued Lili, Mecheraa Sfa, Ksar Chellala, Beni Hamad at Serguine, Djbel Goudjila at Mahdia, and Zmalet El Emir Abdelkader), Bordj Bounaama at Tissemsilt, between Relizane and Chlef (El Hamadna and Oued Rhiou), and the El-Aissaouia city in Medea (central Algeria). While the presence of the species has been confirmed in its original hot-arid range, recent expansions are likely driven by climate change and variations in food availability. These shifts are probably linked to the species' nutritional needs, as it finds more stable food resources and foraging opportunities in northern habitats, where the climate is semi-arid to humid. Forecasts suggest that future expansion may occur in the north-eastern regions of Algeria, including Oum El Bouaghi, Souk Ahras, Constantine, Guelma, and Mila, as well as in coastal areas to the west, such as Mostaganem and Tipaza.

INTRODUCTION

The ranges of species have spatially varied throughout evolutionary history in response to changing environmental circumstances (Van der Jeugd et al. 2009). But generally, species distribution limits often coincide with niche limits and, as a consequence, are shifting in response to environmental change (Reed et al. 2021). Over the last several decades, there has been compelling evidence indicating a worldwide trend of increasing temperatures (Rohde and Hausfather 2020). Many authors reported that temperature is a key driver of species distributions, which are expected to shift poleward and upward in response to global warming (Thomas and Lennon 1999; Parmesan and Yohe 2003). Despite this, human activities are increasingly transporting animals outside of their native ranges (Clavero and Garcia-Berthou 2005; Simberloff et al. 2013; Blackburn et al. 2014). As a result, changes in species distributions are predicted to cause range contractions, alterations in community composition, and increased extinction risk (Thomas et al. 2006; Bellard et al. 2012).

Buntings belong to the Emberizidae, a family of passerine birds containing a single genus *Emberiza*, which in turn comprises 44 species (Cai et al. 2021; Gill et al. 2023) distributed throughout the Old World (Europe, Asia, the Middle East, and Africa). In Algeria, 12 bunting species have been recorded, of which 11 species are described in 'Birds of Algeria' (Isenmann and Moali 2000). It should be noted that four bunting species of the avifauna of Algeria have not been observed for a long time, including the Snow Bunting (*Plectrophenax nivalis*), the Yellowhammer (*Emberiza citrinella*), the Cretzschmar's Bunting (*Emberiza caesia*), and the Black-headed Bunting (*Emberiza melanocephala*). Finally, a new species has been observed in Annaba (northeast Algeria), the Rustic Bunting (*Emberiza rustica*), cited in Djemadi et al. (2018). The seven other species were observed during our field surveys: the Cirl Bunting (*Emberiza cirlus*), the Rock Bunting (*Emberiza cia*), the House Bunting (*Emberiza sahari*), the Ortolan Bunting (*Emberiza hortulana*), the Common Reed Bunting (*Emberiza schoeniclus*), the Corn Bunting (*Emberiza calandra*), and the Little Bunting (*Emberiza pusilla*) that was also observed in Touggourt (Northern Sahara) (Adamou 2021).

Two similar bunting species occur in North Africa: (i) the House Bunting, which is endemic to the northwest with two subspecies: *E. sahari sahari* and *E. sahari sanghae*; and (ii) the Striolated Bunting *Emberiza striolata,* with three subspecies: *E. s. saturiator*, *E. s. jebelmarrae,* and *E. s. striolata*, which are distributed from Northeast Africa to Asia (Kirwan and Shirihai 2007; Svensson et al. 2009; Sangster et al. 2013; Schweizer et al. 2017; Gill et al. 2023). The House Bunting is synanthropic and is considered locally a noble, sacred, and daring species. It has several appellations in Arabic and Berber, for example: Bou-Oud, Bou-Hommir, and Bou-Bechir (Chedad 2021; Chedad et al. 2021a).

In Algeria, the House Bunting originally had a narrow distribution range (Chedad et al. 2021a). The northern limits include the Saharan limits of the Aurès Mountains and oases around the Ziban region (M'Chouneche, Ghoufi, T'kout, Ghassira, Belhiourt, Arris, M'Doukal, Oued Abiod, El Kantra, Outaya, Tolga, and Chetma) and of the Saharan Atlas (Ouled Djellal city, Bousaâda, Messaad, Aflou, El Hadjeb, Sidi Makhlouf, Laghouat city, Ain Sefra, Beni Ounif, and Bechar). The southern boundary passes through Biskra, Ghardaïa, M'Zab, Touggourt, Megarine, the oasis of Taghit, and Beni Abbès. The distribution of this species also includes Hoggar, Tassili (extreme Algerian Sahara) and extreme south-east in Tindouf, and at Kalaa-Beni-Hammad (Setif), Bordj Bou-Arreridj, El Bayadh (El Abiod Sidi Cheikh and Ain Larak), Djelfa city, Tissemsilt northwest, Bouhmam in Tlemcen, and also in Algiers (El Casbah) (Heim de Balsac and Mayaud 1962; Ledant et al. 1981; Isenmann and Moali 2000; Chenchouni 2010; Moulaï 2019; Chedad 2021; Chedad et al. 2021a; El Bouhissi et al. 2021). The present study aimed to update the known range of the House Bunting in Algeria, draw a global map following the remarkable expansion of this species, in particular in the north and, in addition, consider its expected range expansion.

MATERIALS AND METHODS

Study area

Algeria biogeographically belongs to the Western Palearctic and is characterized by a diverse climate (subtropical, Mediterranean, semi-arid, and arid) that shapes an important diversity of life forms (fauna and flora), ecological, genetic, landscape, and cultural entities. It is also home to many endangered species (Chedad et al. 2020a).

Data analysis

The field survey and bird observation campaigns were carried out from 2019 to 2024. The occurrence data of the species were obtained by the Progressive Frequency Sampling (EFP) method, a point-sampling technique (Blondel 1975) that has already been used in several passerine bird studies in Algeria (Moali 1999; Benyacoub and Chabi 2000; Bendjoudi et al. 2013; Chedad 2021; Chedad et al. 2021a, 2023).

To construct a map of the current distribution of the House Bunting in Algeria and to update the geographical distribution of this species, we added new locations

that were discovered outside its previously known areas, according to BirdLife International (2016), Shirihai and Svensson (2018), and Chedad et al. (2021a). We used ArcGIS (version 10.8.1 for Desktop: Desktop: Esri®) to produce distribution maps.

To assess the climatic conditions in the species' range at both previously known locations and in sites where the species was newly recorded, the drought severity was analyzed using the Standardized Precipitation-Evapotranspiration Index (SPEI). The SPEI is a drought assessment tool that relies on climatic data and operates at various spatial scales (Beguería et al. 2014). Using monthly weather data from 1970–2022, the six-month SPEI was computed and compared for two regions: Ain Sefra (32°45'32.1" N, 00°35'7.7" W) as a proxy of the historical range, and Ain Temouchent (35°18'7.3" N, 01°08'24.5" W) representing a newly discovered locality from the north of Algeria. The SPEI was employed to ascertain when droughts begin, how long they last, and their severity across the study period in both selected regions.

A regression analysis was conducted to examine the relationship between bird distribution and environmental variables. Model selection was based on AIC, and predictor significance was assessed using *p*-values (< 0.05). All analyses were performed using R software.

RESULTS

The distribution of the House Bunting is mainly located in urban areas and their surroundings. This study shows the presence of this species in several regions of Algeria, with eighteen (19) new records outside its known range proving its expansion to the north (Figure 1). Almost all new records were in north-western Algeria, including the region of Tlemcen (Maghnia, Beni Bahdel, and Sebdou), Aïn Témouchent (Aïn Témouchent city and Rechgoun), Oran and Saïda city, Sidi Bel Abbès (Oued Sefioun and Marhoum), Tiaret (Kef Esbaa in Oued Lili, Mecheraa Sfa, Ksar Chellala, Beni Hamad in Serguine, Djbel Goudjila in Mahdia, and Zmalet El Emir Abdelkader), Bordj Bounaama at Tissemsilt, and the border area between Relizane and Chlef (El Hamadna and Oued Rhiou). Recently, this bird was observed in the central northern Algeria at El-Aissaouia city in Medea (Figure 2).

The majority of these new sites are located in a semi-arid bioclimatic zone except for the Medea region, which falls within a subhumid bioclimate; Oran and Aïn Témouchent have humid bioclimates. These localities have a large elevation range varying between 0 and 1128 m and are mostly urban environments with modern or traditional structures or adjacent farmlands,

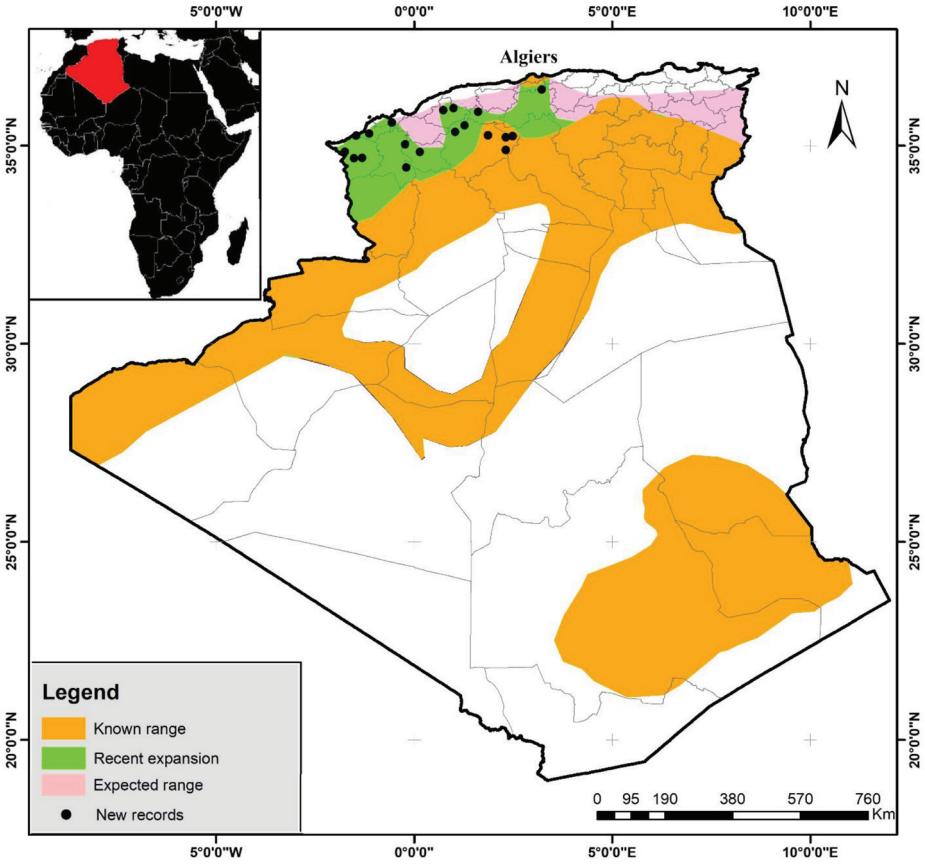

Figure 1. Map showing previous and updated distributions of the House Bunting (*Emberiza sahari*) in Algeria. The previously known range (orange colour) follows BirdLife International (2016) and Chedad et al. (2021a).

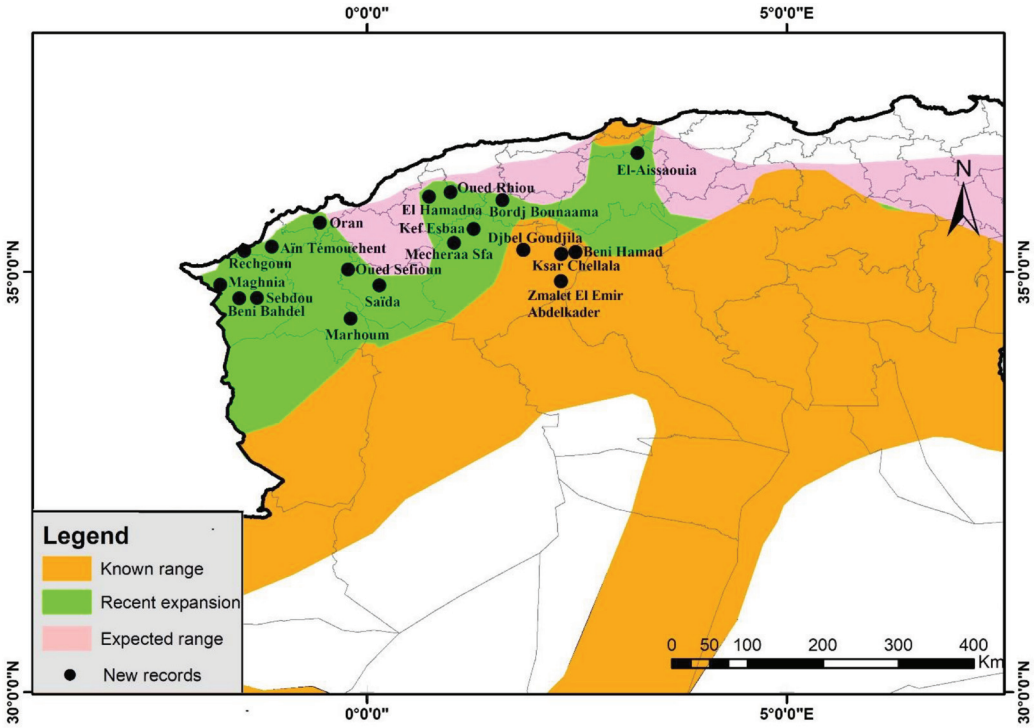

Figure 2. Locations of sites where the House Bunting (*Emberiza sahari*) has newly been recorded in Algeria.

Table 1. Descriptions of the newly occupied locations of the House Bunting *Emberiza sahari* in Algeria.

N°	Province	Site	Longitude	Latitude	Elevation (m a.s.l.)	Climate	Habitat type	Phenological status
1	Tlemcen	Maghnia	1°44'43.23"W	34°50'54.25"N	409	Semi-arid	Modern urban habitat	Resident breeder
2	Tlemcen	Beni Bahdel	1°31'9.51"W	34°41'8.44"N	718	Semi-arid	Semi-modern urban environment	Resident breeder
3	Tlemcen	Sebdou	1°18'39.00"W	34°41'25.32"N	1091	Semi-arid	Rocky plateau, close to an agricultural area	Resident breeder
4	Aïn Témouchent	A. Témouchent city	1° 7'57.09"W	35°18'9.39"N	233	Humid	Modern urban environment	Breeding unconfirmed
5	Aïn Témouchent	Rechgoun	1°28'6.53"W	35°17'44.26"N	0	Humid	Modern urban environment	Breeding unconfirmed
6	Oran	Oran city	0°37'16.88"W	35°40'7.38"N	92	Humid	Modern urban environment	Breeding unconfirmed
7	Sidi Bel Abbès	Marhoum	0°11'40.00"W	34°26'44.00"N	1128	Semi-arid	Modern urban environment	Breeding unconfirmed
8	Sidi Bel Abbès	Oued Sefioun	0°13'23.00"W	35° 1'46.00"N	706	Semi-arid	Abandoned habitats in the middle of a forest	Resident breeder
9	Tiaret	Kef Esbaa	1°16'13.55"E	35°30'43.49"N	576	Semi-arid	Modern urban habitat	Resident breeder
10	Tiaret	Mecheraa Sfa	1°2'16.49"E	35°20'46.62"N	596	Semi-arid	Traditional urban site near a water dam	Resident breeder
11	Tiaret	Ksar Chellala	2°18'53.80"E	35°12'46.01"N	840	Semi-arid	Modern urban habitat	Resident breeder
12	Tiaret	Beni Hamad	2°29'3.69"E	35°15'15.41"N	782	Semi-arid	Urban area adjacent to the agricultural area	Resident breeder
13	Tiaret	Djbel Goudjila	1°51'43.46"E	35°15'57.34"N	931	Semi-arid	Urban area surrounded by agricultural fields	Resident breeder
14	Tiaret	Zmalet El Emir Abdelkader	2°18'40.76"E	34°53'29.65"N	843	Semi-arid	Urban area adjacent to agricultural area	Resident breeder
15	Tissemsilt	Bordj Bounaama	1°36'44.59"E	35°51'13.31"N	1030	Semi-arid	Urban are	Breeding unconfirmed
16	Saïda	Saïda city	0° 8'48.84"E	34°50'31.78"N	803	Semi-arid	Modern urban environment	Resident breeder
17	Medea	El-Aissaouia	3°13'8.85"E	36°25'5.88"N	744	Sub-humid	Farm in the middle of a pine forest and near an agricultural area	Breeding unconfirmed
18	Relizane	El Hamadna	0°57'41.91"E	35°57'42.43"N	114	Semi-arid	Farm near a water dam	Resident breeder
19	Relizane	Oued Rhiou	0°44'19.80"E	35°53'43.80"N	81	Semi-arid	Modern urban habitat	Resident breeder

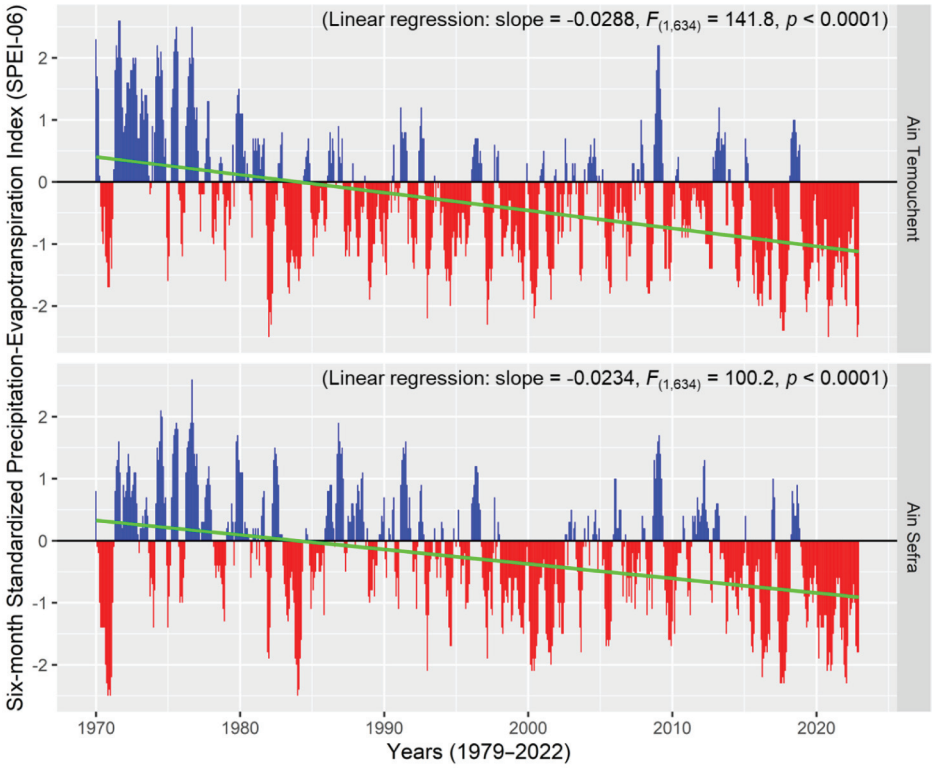

Figure 3. Amplification time series of six-month standardized precipitation-evapotranspiration index (SPEI) in Ain Temouchent (representing the newly expanded range) and Ain Sefra (representing the historical range) between 1970 and 2022. Red reflects episodes of drought, and blue reflects wet episodes. The green solid line represents a linear regression with a linear model fit; linear regression statistics include the slope, F: F-statistics (with degrees of freedom in brackets) and p: *p*-values.

fields, orchards, water sources, and rocky areas (Table 1). Among the important results of these results are the confirmation of breeding of the House Bunting in many regions, except in Medea, Sidi Bel Abbès, Oran, and Aïn Témouchent.

The analysis of six-month SPEI data suggests that the historical range of the species (represented by Ain Sefra) likely had harsher and more arid climatic conditions, whereas the newly occupied sites (such as Ain Temouchent) appear to have milder and potentially more favourable climate conditions for the House Bunting, which could explain its recent expansion into this area (Figure 3). When considering the historical and previously known distribution locations of the species, such as Ain Sefra, the SPEI analysis revealed climate conditions that were likely characteristic of the species' traditional habitat. These regions likely experienced a combination of relatively low precipitation and high evapotranspiration rates, indicative of a hot and arid environment. Drought events may have been common, but they were within the species' historical range of adaptability. On the other hand, at newly recorded sites in the northern part of the country, such as Ain Temouchent, the SPEI analysis indicates different climate conditions. Compared to Ain Sefra, Ain Temouchent has exhibited higher and more consistent precipitation levels and lower evapotranspiration rates, with a clear shift towards drought conditions in the last two decades. These conditions indicate that the species was extending its range into a climate initially characterized as semi-arid to mesic but subsequently transitioning towards aridity and reduced moisture, potentially creating a more stable and accommodating environment for the House Bunting. It is worth emphasizing that the pattern of drought events in Ain Temouchent was more severe and developed at a faster pace when compared to Ain Sefra, as evidenced by the linear regression analyses (Figure 3).

DISCUSSION

The range expansion of a deserticolous bird species like the House Bunting into semi-arid and mesic regions of North Africa is a multifaceted phenomenon shaped by various ecological and climatic factors. Climate change plays a pivotal role, as rising temperatures and intensified aridity in its native desert habitat might render these areas less hospitable, driving the species to explore new territories. Notably, the use of the SPEI has revealed that the newly colonized sites are experiencing more severe and prolonged drought events, which makes these sites suitable as compared to the previously known distribution areas. This shift could be a survival strategy, as prolonged droughts in its historical range may

compel individuals to seek regions with more reliable water sources and food availability. A prior study on the spread of this species in Algeria came to the same conclusion as did a subsequent study on its expansion in northern Morocco and also in Europe, into southernmost Spain (Chedad et al. 2021a; López-Ramírez et al. 2023). Moreover, behavioural adaptations and modified dispersal patterns may facilitate this range expansion, enabling the House Bunting to thrive in varying ecological conditions.

Since the 1960s, the House Bunting has been observed mainly in the south of Algeria (Heim de Balsac and Mayaud 1962; Chenchouni 2010), but it has spread progressively both towards the south to the great Central Sahara and to the north (Chedad et al. 2021a). More recently, this species has expanded its distribution range towards the north in Tissemsilt city, Tlemcen (Bouhmam), and also in Algiers (El Casbah) (Moulaï 2019; Chedad 2021; Chedad et al. 2021a; El Bouhissi et al. 2021). Our observations reported new range expansions in several areas at Tlemcen (Maghnia, Beni Bahdel, and Sebdou), Aïn Témouchent (Aïn Témouchent city and Rechgoun), Oran and Saïda city, Sidi Bel Abbès (Oued Sefioun and Marhoum), Tiaret (Kef Esbaa in Oued Lili, Mecheraa Sfa, Ksar Chellala, Beni Hamad in Serguine, Djbel Goudjila in Mahdia, and Zmalet El Emir Abdelkader), Bordj Bounaama at Tissemsilt, Chlef city also to El Hamadna and Oued Rhiou in the border area between Relizane and Chlef, and finally to El-Aissaouia (Medea) in the mount of Titteri.

The recent expansion seems localized in the north-western regions of Algeria, which supports the hypothesis that the expansion of this species will be to the west of Algeria (Moulaï 2019), but we also recorded an expansion in the central northern region at El-Aissaouia, Médéa. In Morocco, new range expansion has been reported northward and southward (Amezian et al. 2006; Azaouaghe et al. 2020). In Morocco, the species has also spread to Tetouan and Tangiers, along with Ceuta, in the Tangier Peninsula (SEO-CEUTA 2016; Bergier et al. 2022). A recent study suggests that the climatic conditions of southern Iberia have become sufficient to host this typical African species, as it has been regularly recorded there over the past few years (López-Ramírez et al. 2023). Its first breeding in Europe was recorded in 2023 in southernmost Spain (Jesús Sepúlveda and Ortega 2023).

Climate change has already had an impact on the geographic range of several species. In the last several decades, Heim de Balsac (1979) identified alterations in the geographical ranges of many landbird and waterbird species in Algeria. Invasive species like the Eurasian Collared Dove (*Streptopelia decaocto*), reported in Tamanrasset, have seen their ranges move south. Moali and Isenmann (2007) found evidence of the dove's spread and breeding activities. Several finch species such as the Eurasian Siskin (*Spinus spinus*), European Serin (*Serinus serinus*), European Greenfinch (*Chloris chloris*), Common Linnet (*Linaria cannabina*), and Hawfinch (*Coccothraustes coccothraustes*) (Chedad et al. 2020a), as well as some wheatear species, such as White-crowned Wheatear (*Oenanthe leucopyga*), Desert Wheatear (*Oenanthe deserti*), Isabelline Wheatear (*Oenanthe isabelline*), Northern Wheatear (*Oenanthe oenanthe*) (Chedad et al. 2021b), and House Sparrow (*Passer domesticus*) (Haddad et al. 2021), have also been recorded in the south of the country, as were the Maghreb Magpie *Pica mauritanica* and the Common Starling *Sturnus vulgaris* from the north of the Algerian Sahara (Chedad et al. 2022a; Bouletif et al. 2022). A range expansion from the Sahara to the north (Hauts Plateaux) has been recorded for two species, Greater Hoopoe-Lark *Alaemon alaudipes* and Dupont's Lark *Chersophilus duponti* (Dahmani et al. 2023 a,b). Southward range expansion has also been seen in some waterbird species, such as the European Golden Plover (*Pluvialis apricaria*), the Black Stork (*Ciconia nigra*), the Western Reef Heron (*Egretta gularis*), the Common Crane (*Grus grus*), and the White-headed Duck *Oxyura leucocephala* (Chedad et al. 2021c; Bouzid et al. 2023a). In some cases, the expansion includes not only the overall range but also the nesting areas, as evidenced by the successful breeding of the Little Egret (*Egretta garzette*), Squacco Heron *Ardeola ralloides,* and Black-crowned Night Heron *Nycticorax nycticorax,* which were first recorded in the desert after being confined hitherto to the north of the country (Chedad et al. 2022b; Bouzid et al. 2023b).

Chenchouni (2017) and Chedad et al. (2021a) report that urban-adapted and urban-exploiter species extensively benefit from various resources that the urban environments provide, such as additional and permanent foraging and nesting opportunities. According to Chedad et al. (2021a), there is a close relationship between the presence of species and the trophic resources of the habitat, especially in the House Bunting, a granivorous species feeding mainly on seeds of annual weeds, with trophic preferences for certain plant species such as *Chenopodium murale*, *Cynodon dactylon,* and *Schismus barbatus*. Moreover, the species often picks up the remains of food of plant origin, such as breadcrumbs and seeds, inside houses, which it often frequents and even nests within (Pasteur 1956; Chedad et al. 2021a). This ability may have aided the House Bunting in dispersal (Chedad et al. 2021a). The range expansion in both directions can be explained by the convergence of climatic factors in certain regions, as well as human activities (overexploitation of natural resources, different types of pollution, agricultural expansion, and the

creation of green spaces) and change in building style (urban development), fires, and the appearance of new wetlands (particularly artificial wetlands: oases, dam reservoirs, and irrigation channels) (Clavero and Garcia-Berthou 2005; Simberloff et al. 2013; Blackburn et al. 2014; Chedad et al. 2020a, b; Chedad et al. 2021a, c; Aynalem et al. 2023).

Regarding the nesting of House Bunting that has been confirmed in the new localities, it has a strong adaptation to different biotopes, and this is what Chedad et al. (2021a) addressed where this species breeds and resides in different urban sites (traditional, semi-modern, and modern habitats), which may imply some advantages such as greater availability of resources, less competition, or protection against predators (Chedad et al. 2021a; Stofberg et al. 2022; VanderWand DownWerf and Dawns 2022; Garcia et al. 2025).

Predicting range shifts is a current challenge for biogeography because bird ranges are predicted to move in response to changes in temperature and precipitation (Thomas and Lennon 1999; Böhning-Gaese and Lemoine 2004; Massimino et al. 2015). Regardless, it is expected that if the species continues its progressive spread to the north, our findings forecast a future in the north-east of the country in Oum El Bouaghi, Souk Ahras, Constantine, Guelma, and Mila, as well as in the coastal areas to the west in Mostaganem, Chlef, and Tipaza.

In conclusion, many bird species in Algeria have experienced range expansions. They include the House Bunting, whose habitats now span the humid northern coastal belt, the semi-arid Hauts Plateaux, and the hyper-arid Sahara in the south, with the possibility of extending in the near future to the northeast of the country at Oum El Bouaghi, Souk Ahras, Constantine, Guelma, and Mila. The study of the bioecology of the House Bunting in northern Algeria after the confirmation of its breeding is in prospect, not to mention the continuation of monitoring populations throughout the national territory to record new expansions and update its geographical distribution and understand its population dynamics. Conservation efforts should consider the changing dynamics and conservation implications associated with this expansion, focusing on preserving both the established and newly colonized habitats and monitoring climate projections to ensure the species' long-term survival amidst evolving environmental challenges.

ACKNOWLEDGMENTS

We are most grateful to an anonymous reviewer for helpful comments and suggestions. We would like to thank the General Directorate of Forests and the members of the National Network of Algerian Ornithologist Watchers "R.N.O.O.A." We also thank the Algerian Ministry of Higher Education and all Algerian naturalists for their field assistance during birdwatching.

Author Contribution

Abdelwahab Chedad: Conceptualization; Formal Analysis Supervision; Visualization; Writing – Original Draft Preparation. Djamel Bendjoudi: Conceptualization; Methodology; Validation; Writing – Original Draft Preparation; Writing – Review & Editing. Walid Dahmani: Investigation. Haféda Benmammar-Hasnaoui: Investigation. Abdelkader Bekkouche: Investigation. Mayssara El Bouhissi: Conceptualization; Investigation. Azeddine Si Bachir: Investigation. Hayat Djeziri: Investigation. Fares Zoutal: Investigation. Abdelkarim Zitouni: Investigation. Ghania Touchene: Investigation. Fayçal Seddiki: Investigation. Djalila Rabie: Investigation. Salah Eddine Sadine: Conceptualization; Writing – Original Draft Preparation. Mohamed Ait Hammou: Investigation; Writing – Original Draft Preparation. Brahim Beladis: Investigation. Brahim Babali: Investigation. Omar Guezoul: Conceptualization; Validation. Haroun Chenchouni: Validation; Writing-Original Draft; Writing-Review & Editing.

Conflict of interests

The co-authors report no conflicts of interest.

Funding

This research did not receive any financial support.

Data availability

The data used to support the findings of this study are included within the article.

REFERENCES

Adamou, N. 2021. Première observation du Bruant Nain *Emberiza pusilla* en Algérie [First observation of the Little bunting *Emberiza pusilla* in Algeria]. *Alauda* 89(1), 75.

Amezian, M., Bensusan, K., Perez, C., & Thompson, I. 2006. Is House Bunting about to colonise Europe? *Birding World* 19(6), 263.

Aynalem, Y., Bekele, A., & Bogale, B.A. 2023. Breeding biology of the helmeted guineafowl (*Numida meleagris meleagris*, Linnaeus 1758) in Western Ethiopia. *Ornithology Research* 31: 173–181. https://doi.org/10.1007/s43388-023-00132-6

Azaouaghe, S., Thevenot, M., & Bergier, P. 2020. Première mention du Bruant du Sahara à Nador et compléments

sur l'historique de l'expansion au Maroc [First mention of the House Bunting in Nador and additional information on the history of expansion in Morocco]. *Go-South Bulletin* 17, 16–19.

Beguería, S., Vicente-Serrano, S.M., Reig, F., & Latorre, B. 2014. Standardized precipitation evapotranspiration index (SPEI) revisited: parameter fitting, evapotranspiration models, tools, datasets and drought monitoring. *International Journal of Climatology* 34(10), 3001–3023. https://doi.org/10.1002/joc.3887

Bellard, C., Bertelsmeier, C., Leadley, P., Thuiller, W., & Courchamp, F. 2012. Impacts of climate change on the future of biodiversity. *Ecology Letters* 15, 365–377. https://doi:10.1111/j.1461-0248.2011.01736.x

Bendjoudi, D., Chenchouni, H., Doumandji, S., & Voisin, J.F. 2013. Bird species diversity of the Mitidja Plain (Northern Algeria) with emphasis on the dynamics of invasive and expanding species. *Acrocephalus* 34, 13–26. https://doi.org/10.2478/acro-2013-0002

Benyacoub, S., & Chabi, Y. 2000. Diagnose écologique de l'avifaune du parc national d'El Kala [Ecological Assessment of the Avifauna of El Kala National Park]. *Synthèse Rev. Sci. Technol.* 7, 1–98.

Bergier, P., Thévenot, M., Qninba, A., & Houllier, J.R. 2022. *Oiseaux du Maroc*. [*Birds of Morocco*]. Paris: Société d'Etudes Ornithologiques de France.

BirdLife International. 2016. *Emberiza sahari*. *The IUCN Red List of Threatened Species*: e.t22734808a104265494. https://doi.org/10.2305/iucn.uk.2016-3.rlts.t22734808a104265494.en Accessed June 20, 2022.

Blackburn, T.M., Essl, F., Evans, T., Hulme, P.E., Jeschke, J.M. et al. 2014. A unified classification of alien species based on the magnitude of their environmental impacts. *PLoS Biology* 12: e1001850. https://doi:10.1371/journal.pbio.1001850

Blondel, J. 1975. L'analyse des peuplements d'oiseaux – éléments d'un diagnostic écologique. La méthode des échantillonnages fréquentiels progressifs (E.F.P) [The analysis of bird stands – elements of an ecological diagnosis. The method of Progressive Frequency Sampling (E.F.P)]. *Rev. Ecol. (Terre et Vie)* 29(4), 533–589.

Böhning-Gaese, K., & Lemoine, N. 2004. Importance of climate change for the ranges, communities and conservation of birds. *Advances in Ecological Research* 35: 211–236. https://doi.org/10.1016/S0065-2504(04)35010-5

Bouletif, H., Chedad, A., & Bendjedidi, A. 2022. Maghreb Magpie *Pica mauritanica* Malherbe, 1845 winters in two oases at Aurès Mountains, Algeria (Aves: Corvidae). *Algerian Journal of biosciences* 03(01), 001–004.

Bouzid, A., Adamou, N., & Chedad, A. 2023a. Première observation de l'Erismature à tête blanche *Oxyura leucocephala* dans le Sahara Algérien [First observation of the White-headed Duck *Oxyura leucocephala* in the Algerian Sahara]. *Alauda* 91(3), 210–213.

Bouzid, A., Chedad, A., Samraoui, F., & Samraoui, B. 2023b. Range expansion of nesting Squacco Heron *Ardeola ralloides* and Black-crowned Night Heron *Nycticorax nycticorax* in the Sahara. *Wetlands Ecology and Management* 31, 467–478. https://doi.org/10.1007/s11273-023-09928-1

Cai, T., Wu, G., Sun, L., Zhang, Y., Peng, Z., Guo, Y., Liu, X., Pan, T., Chang, J., Sun, Z., & Zhang, B. 2021. Biogeography and diversification of Old-World buntings (Aves: Emberizidae): radiation in open habitats. *Journal of Avian Biology* 52(6), e02672. https://doi.org/10.1111/jav.02672

Chedad, A. 2021. Bio-écologie des espèces aviennes dans quelques écosystèmes sahariens (Ghardaïa): Cas du Bruant du Sahara [Bio-ecology of Avian species in some saharan ecosystems (Ghardaïa): Case of the house bunting]. Doctorat thesis. Algeria: Univ. Ouargla. https://doi.org/10.13140/RG.2.2.32728.21768

Chedad, A., Bendjoudi, D., & Guezoul, O. 2020a. Expansion of some species of the Fringillidae family in the Algerian Northern Sahara. *Current Trends in Natural Sciences* 9(18), 92–99. https://doi.org/10.47068/ctns.2020.v9i18.013

Chedad, A., Bendjoudi, D., & Guezoul, O. 2020b. New data on the wintering and sedentary life of the European turtle dove *Streptopelia turtur* in the Algerian Northern Sahara. *Current Trends in Natural Sciences* 9(17), 65–73. https://doi.org/10.47068/ctns.2020.v9i17.007

Chedad, A., Bendjoudi, D., & Guezoul, O., Chenchouni, H. 2021a. A comprehensive monograph on the ecology and distribution of the house bunting (*Emberiza sahari*) in Algeria. *Frontiers of Biogeography* 13(1), e47727. https://doi.org/10.21425/f5fbg47727202

Chedad, A., Bendjoudi, D., & Guezoul, O. 2021b. Place of Wheatear species within the avifauna of Ghardaïa (Algerian sahara). *Current Trends in Natural Sciences* 10(19), 25–35. https://doi.org/10.47068/ctns.2021.v10i19.003

Chedad, A., Beladis, B., Bouzid, A., Bendjoudi, D., & Guezoul, O. 2021c. Biodiversité avienne dans un milieu artificiel: cas de la bande verte Noumérate (Ghardaïa, Sahara algérien) [Avian biodiversity in an artificial environment: case of Noumérate green band, (Ghardaïa, Algerian Sahara)]. *Revue des Bio Ressources* 11(2), 94–107.

Chedad, A., Adamou, N., Bouzid, A., Bendjoudi, D., & Guezoul, O. 2022a. The Common starling *Sturnus vulgaris* L., 1758 regular wintering species in the Algerian Sahara. *Natural Resources and Sustainable Development* 12(1), 189–197. https://doi.org/10.31924/nrsd.v12i1.099

Chedad, A., Bouzid, A., & Samraoui, B. 2022b. First successful nesting of the Little Egret *Egretta garzetta* in Ghardaïa (Algerian Sahara). *Zoology and Ecology* 32(1), 68–73. https://doi.org/10.35513/21658005.2022.1.8

Chedad, A., Bouzid, A., Bendjoudi, D., & Guezoul, O. 2023. Avifauna of M'Zab region (Ghardaïa, Algerian Sahara): checklist and overview of the current status. *Zoology and Ecology* 33(1), 22–35. https://doi.org/10.35513/21658005.2023.1.4

Chenchouni, H. 2010. Statuts de protection et de conservation des oiseaux recensés dans les Aurès et ses alentours (nord-est algérien) [Status of protection and conservation of birds recorded in the Aurès and its surroundings (north-east Algeria)]. *Proceedings of the international Conference "SIBFA"*. Algeria: Univ. Ouargla, 56–75.

Chenchouni, H. 2017. Variation in white stork (*Ciconia ciconia*) diet along a climatic gradient and across rural-to-urban landscapes in North Africa. *International Journal of Biometeorology* 61(3), 549–564. https://doi.org/10.1007/s00484-016-1232-x

Clavero, M., & Garcia-Berthou, E. 2005. Invasive species area leading cause of animal extinctions. *Trends in Ecology and Evolution* 20(3), 110. https://doi.org/10.1016/j.tree.2005.01.003

Dahmani, W., Chedad, A., & Ait Hammou, M. 2023a. A new locality of Dupont's Lark *Chersophilus duponti* in Algeria. *Zoology and Ecology* 33(1), 1–4. https://doi.org/10.35513/21658005.2023.1.1

Dahmani, W., El Bouhissi, M., Chedad, A., & Ait Hammou, M. 2023b. Données nouvelles sur l'aire de répartition du Sirli du Désert *Alaemon alaudipes* en Algérie [New Data on the Distribution Range of the Greater Hoopoe-Lark *Alaemon alaudipes* in Algeria]. *Alauda* 91(1), 129–132.

Djemadi, I., Draidi, K., & Bouslama, Z. 2018. First record of Rustic Bunting for Algeria. *Bull. ABC* 25, 211–212.

El Bouhissi, M., Babali, B., Sadine, S.E., & Chedad, A. 2021. Expansion du Bruant du Sahara *Emberiza sahari* et nouvelle localité au Nord-Ouest Algérien [Expansion of the House Bunting *Emberiza sahari* and new locality in the North-West of Algeria]. *Alauda* 89(4), 301–302.

Garcia, E., Ryan, P., Pyle, P., Boesman, P.F.D., & Kirwan, G.M. 2025. House Bunting (*Emberiza sahari*), version 2.0. In *Birds of the World,* edited by S.M. Billerman. Ithaca, NY, USA: Cornell Lab. of Ornithology. https://doi.org/10.2173/bow.houbun3.02

Gill, F., Donsker, D., & Rasmussen, P. (eds) 2023. *IOC World Bird List.* Vol. 13.2. https://doi.org/10.14344/ioc.ml.13.2. http://www.worldbirdnames.org/

Haddad, K., Bellatreche, M., Afoutni, L., & Mebarki, M.T. 2021. Données nouvelles sur l'aire de répartition du Moineau domestique – *Passer domesticus* en Algérie [New data on the range of the *House Sparrow – Passer domesticus* in Algeria]. *Alauda* 89(4), 297–300.

Heim de Balsac, H. 1979. A propos de l'article de Burnier et de l'ornithologie de terrain à poursuivre en Algérie [About Burnier's article and the field ornithology to be continued in Algeria]. *Alauda* 47, 103–110.

Heim de Balsac, H., & Mayaud, N. 1962. *Les Oiseaux du Nord-Ouest de l'Afrique* [*Birds of North-West Africa*]. Paris: Éd. Paul Lechevalier.

Isenmann, P., & Moali, A. 2000. *Oiseaux d'Algérie* [*Birds of Algeria*]. Paris: Ed. Société d'études ornithologiques de France, MNHN.

Jesús Sepúlveda, A., & Ortega, J. 2023. First breeding record of the House Bunting (*Emberiza sahari*) in mainland Spain and Europe. *Maghreb Ornithology* 2023. https://magornitho.org/2023/09/first-breeding-house-bunting-europe. Accessed September 5, 2023.

Kirwan, G.M., & Shirihai, H. 2007. Species limits in the House Bunting complex. *Dutch Birding* 29, 1–19.

Ledant, J.P., Jacob, J.P., Jacobs, P., Malher, F., Ochando, B., & Roche, J. 1981. Mise à jour de l'avifaune Algérienne [Update of the Algerian avifauna]. *Gerfaut* 71, 295–394.

López-Ramírez, S., Chamorro, D., & Real, R. et al. 2023. Southern Europe is becoming climatically favourable for African birds: anticipating the establishment of a new species. *Frontiers in Zoology* 20, 18. https://doi.org/10.1186/s12983-023-00496-x

Massimino, D., Johnston, A., & Pearce-Higgins, J.W. 2015. The geographical range of British birds expands during 15 years of warming. *Bird Study* 62, 523–34. https://doi.org/10.1080/00063657.2015.1089835

Moali, A. 1999. Déterminisme écologique de la répartition des oiseaux le long d'un transect altitudinal en Kabylie (Algérie) [Ecological determinism of the distribution of birds along an altitudinal transect in Kabylie (Algeria)]. Doctoral thesis. Algeria: Univ.Tizi-Ouzou.

Moali, A., & Isenmann, P. 2007. La Tourterelle turque *Streptopelia decaocto* nicheuse en 2007 à Tamanrasset (Sahara central, Algérie) et son expansion au Sahara [The European turtle dove *Streptopelia decaocto* nesting in 2007 in Tamanrasset (Central Sahara, Algeria) and its expansion in the Sahara]. *Alauda* 75(3), 247–248.

Moulaï, R. 2019. Expansion du Bruant du Sahara *Emberiza sahari* dans le Nord de l'Algérie [Expansion of the House Bunting *Emberiza sahari* in Northern Algeria]. *Alauda* 87(3), 170–171.

Parmesan, C., & Yohe, G. 2003. A globally coherent fingerprint of climate change impacts across natural systems. *Nature* 421, 37–42. https://doi.org/10.1038/nature01286

Pasteur, G. 1956. Premières observations sur le Traquet, le Bruant et l'Ammomane du poste d'Aouinet-Torkoz (Bas Draa) [First observations on the wheatear, the Bunting and the Ammomanes of the post of Aouinet Torkoz (Bas Draa)]. *Bull. Soc. Scr. nat. Maroc* 36, 165–183.

Reed, P.B., Peterson, M.L., Pfeifer-Meister, L.E., Morris, W.F., Doak, D.F., Roy, B.A. Johnson, B.R., Bailes, G.T., Nelson, A.A., & Bridgham, S.D. 2021. Climate manipulations differentially affect plant population dynamics within versus beyond north-

ern range limits. *Journal of Ecology* 109, 664–675. https://doi.org/10.1111/1365-2745.13494

Rohde, R.A., & Hausfather, Z. 2020. The Berkeley Earth Land/Ocean Temperature Record. *Earth System Science Data* 12(4), 3469–3479. https://doi.org/10.5194/essd-12-3469-2020

Sangster, G., Collinson, J.M., Crochet, P.A., Knox, A.G., Parkin, D.T., & Votier, S.C. 2013. Taxonomic recommendations for Western Palearctic birds: ninth report. *Ibis* 155, 898–907. https://doi.org/10.1111/ibi.12091

Schweizer, M., Shirihai, H., Schmaljohann, H., & Kirwan, G.M. 2017. Phylogeography of the House Bunting complex: discordance between species limits and genetic markers. *Journal of Ornithology* 159(1), 47–61. https://doi.org/10.1007/s10336-017-1501-4

SEO-CEUTA. 2016. *House Bunting (Emberiza sahari), Ceuta, 14 November 2016*. SEO-Ceuta/Sociedad De Estudios Ornitologicos de Ceuta.

Shirihai, H., & Svensson, L. 2018. *Handbook of Western Palearctic Birds: Passerines: Larks to Warblers*. Vol. II. London: HELM Bloomsbury Publishing.

Simberloff, D., Martin, J.L., Genovesi, P., Maris, V., Wardle, D.A., & Aronson, J. 2013. Impacts of biological invasions: what's what and the way forward. *Trends of Ecology and Evolution* 28, 58–66. https://doi.org/10.1016/j.tree.2012.07.013

Stofberg, M., Amar, A., Sumasgutner, P., & Cunningham, S.J. 2022. Staying cool and eating junk: Influence of heat dissipation and anthropogenic food on foraging and body condition in an urban passerine. *Landscape and Urban Planning* 226, 104465. https://doi.org/10.1016/j.landurbplan.2022.104465

Svensson, L., Mullarney, K., & Zetterstrom, D. 2009. *Collins Bird Guide*, 2nd edition. London: Harper Collins.

Thomas, C.D., & Lennon, J.J. 1999. Birds extend their ranges northwards. *Nature* 399, 213. https://doi.org/10.1038/20335

Thomas, C.D., Franco, A.M.A., & Hill, J.K. 2006. Range retractions and extinction in the face of climate warming. *Trends of Ecology and Evolution* 21, 415–416. https://doi.org/10.1016/j.tree.2006.05.012

Van Der Jeugd, H.P., Eichhorn, G., Litvin, K.E., Stahl, J., Larsson, K., Van Der Graaf, A.J., & Drent, R.H. 2009. Keeping up with early springs: rapid range expansion in an avian herbivore incurs a mismatch between reproductive timing and food supply. *Global Change Biology* 15(5), 1057–1071. https://doi.org/10.1111/j.1365-2486.2008.01804.x

Vander Werf, E.A., & Downs, R.E. 2022. Factors Affecting Breeding Success of White Terns (*Gygis alba*; Aves: Laridae) in Urban Environments of Honolulu, Hawaii. *Pacific Science* 76, 33–41. https://doi.org/10.2984/76.1.3