Bird Conservation International (2006) 16:317–323. © BirdLife International 2006
doi: 10.1017/S0959270906000505 Printed in the United Kingdom

The non-breeding distribution of Dupont's Lark *Chersophilus duponti* in Spain

FRANCISCO SUÁREZ, JESÚS T. GARCÍA, FRANCISCO J. SAMPIETRO and VICENTE GARZA

Summary

In this paper, we analyse the non-breeding distribution of Dupont's Lark, one of Europe's most threatened and least known passerines, using breeding and wintering censuses, published and unpublished records of individuals outside their breeding areas, and data on radio-tagged individuals and field observations. Results suggest that most breeding Dupont's Larks remain around the breeding sites during the non-breeding season, including those populations from areas with harsh winter weather conditions. The probability of winter presence of Dupont's Larks in breeding areas was significantly correlated with population size, but the altitude of the locality studied did not influence winter presence. Records outside breeding areas indicate that part of the population moves some distance after breeding, occupying lower sites and principally those with agrarian substrates. We also found several records far from well-known breeding areas during the breeding period. Our results suggest that Dupont's Lark seems to be a partial migrant, wintering in breeding areas in large numbers (probably the adult fraction of the population) but with some part of the populations moving to other areas. The movements are short-distance in most cases, although medium- and long-distance dispersive movements were also detected. We discuss the implications of these results for the design of specific conservation measures for the species.

Introduction

Dupont's Lark *Chersophilus duponti* is one of Europe's least known and most endangered passerines (De Juana and Suárez 2004, Garza *et al.* 2005, Tella *et al.* 2005). Given that the Spanish and European breeding population has recently been estimated in the range of 1,300 to 1,900 territories (Garza *et al.* 2003a, 2005, Tella *et al.* 2005), the conservation status has been upgraded to Endangered in the Red Book of the Birds of Spain (Garza *et al.* 2004). Nevertheless, the species in Europe remains as SPEC 3 (Status = Depleted; BirdLife International 2004) based on previous breeding estimates (13,000–15,000 pairs), although the species complies with all the IUCN criteria to be included as Critically Endangered in Europe. Furthermore, most studies have been carried out during the breeding period (De Juana and Suárez 2004), while non-breeding ecology has received much less attention. The non-breeding period is crucial for population dynamics in birds because it influences both adult and juvenile survival and subsequent reproductive success (Newton 1998), and movements after breeding allow species to colonize new breeding areas (Rappole and McDonald 1994) and maintain gene flow among different populations (see Pérez-Tris and Tellería 2002 for a review). However, whether the Spanish Dupont's Lark population is largely resident

or migratory is unknown. The aim of this study was to examine for the first time the distribution and habitat use of the species during the non-breeding period, factors that we consider essential to allow the implementation of conservation measures. Specifically, we try to shed light on two questions of major interest: First, it is known that in the Iberian Peninsula, environmental conditions vary greatly due to latitude, altitude and continentality. Most of the breeding population of Dupont's Lark (nearly 70%) occurs in high-altitude sites (> 1,000 m a.s.l.) with harsh winter conditions and 10–15 snow-fall days per year (Garza and Suárez 1990, and climatic data in IGN 1992). Therefore, we investigate whether individuals remain during winter in all the breeding areas or whether they abandon sites with less favourable (harder) winter climate conditions. Second, previous studies (Suárez and Garza 1989) have reported some records of birds found long distances from the main breeding areas. Taking into account all observations published (Suárez and Garza 1989) as well as new ones (from 1988 to date), we assess the pattern of dispersion of Dupont's Lark in relation to the well-known breeding areas to determine whether these long-distance movements are a common feature of the European population of the species.

Material and methods

We evaluated the seasonal changes in the presence of Dupont's Lark by using censuses in 32 localities across the Iberian Peninsula: 1988 spring and 1988–1989 winter (14 localities), and 1990 spring and 1990–1991 winter (19 localities; Figure1), repeated by the same authors in both periods. We only considered censuses performed in habitats where the species may occur throughout the year. All data were obtained by means of line-transect counts (Suárez and Garza 1989), and all counts were repeated in spring and winter by the same authors. These localities cover the main breeding areas for the species in Spain.

To ascertain the distribution of Dupont's Larks outside breeding areas and document the habitat exploited we used available published and unpublished records ($n = 96$; references are available upon request to the authors), including personal communications, captured birds, dead birds and museum specimens, but excluding those with scarce reliability from field observations. It is necessary to bear in mind that the breeding distribution of the species was unknown until after 1988 (Garza and Suárez 1990). For this reason, we analysed only records subsequent to this date ($n = 29$), found more than 10 km away from their current breeding sites (according to the breeding atlas of the birds of Spain; Garza *et al.* 2003b), and/or that occur in habitats dissimilar to those selected for Dupont's Lark during the breeding period (Garza and Suárez 1990, Garza *et al.* 2005). We consider observations as 'breeding' (from early February to the end of July; $n = 23$) and 'non-breeding' (August to the end of January; $n = 6$) according to Dupont's Lark phenology (Herranz *et al.* 1994, Garza *et al.* 2005). To examine the habitat used by individuals outside their breeding areas we considered all data, including those prior to 1988 found more than 50 km from the current breeding places or that occur in habitats dissimilar to those selected during the breeding period ($n = 27$). We categorized habitat use as 'shrubs' (with similar structure to those selected for birds during breeding period), 'agrarian substrates' (stubbles, fallow and long-term fallow land) or 'other' (not included in the above categories).

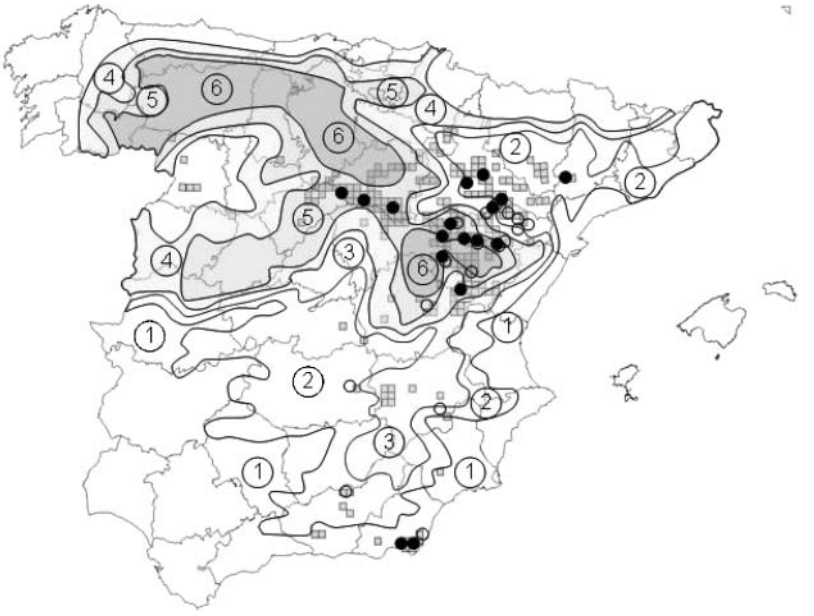

Figure 1. Localities with presence of Dupont's Larks during both winter and breeding period (filled dots) and just breeding presence (unfilled dots). Grey squares show the current breeding distribution of the species according to Garza *et al.* (2003b). Grey curves and numbers (1 to 6) join Mediterranean areas with same mean annual days with snowfall (class 1, 0–1 days with snowfall; class 2, 2–3 days; class 3, 4–5 days; class 4, 6–10 days; class 5, 11–15 days; class 6, 16–20 days). Data from IGN (1992).

To identify the factors that determine the probability of the presence of Dupont's Larks in winter at each locality we fitted a binomial logistic model. There is a chance of increased bird detection with increasing population size, and thus population size was included in the analyses as a categorical factor (very small populations, <10 singing males; small populations, 11–50 males; medium-size populations, 51–100 males; and large populations, >100 males). We also included the altitude of the locality as a continuous predictor (as a surrogate for the winter hardness due to climatic conditions). Descriptive data are expressed as the mean $\pm$ 1 SD. Analyses were made with the Statistica 6.0 package (StatSoft 2001).

Results and discussion

Over half (51.5%) of breeding localities held Dupont's Larks during the winter, including those situated at high altitude (>1,000 m a.s.l.) and with 10–15 snow-fall days (Figure 1). The probability of winter presence of Dupont's Larks in breeding areas was significantly determined by the size of the breeding population (Table 1), the probability of presence increasing with the density of the breeding population (logistic regression model, $\chi^2 = 14.6$, d.f. = 3, $P = 0.002$). In contrast, the altitude of the locality did not influence winter presence ($\chi^2 = 0.75$, d.f. = 1, $P = 0.386$).

From our sample of Dupont's Lark records outside the breeding areas, those corresponding to non-breeding period were scarce ($n = 6$), representing nearly a fifth

https://doi.org/10.1017/S0959270906000505 Published online by Cambridge University Press

Table 1. Percentage (%) of localities with presence of Dupont's Lark during winter (data from censuses, see Material and Methods) in relation to breeding population size.

	Winter presence	
	%	*N*
Very small populations	11.1	9
Small populations	57.1	7
Medium-size populations	42.9	7
Large populations	90.0	10

of total observations. All were in places located at lower altitudes than the main breeding areas (mean altitude for observations: 235 ± 239 m a.s.l.; mean altitude for core breeding areas 880 ± 260 m a.s.l.), and isolated 80.2 ± 93.3 km (range 1.2–293 km) from the nearest known breeding area (Figure 2). Four of six observations were in 'agrarian substrates', whereas only one was in 'shrubs' and one in the 'other' land-use type. Individuals observed far from known breeding areas during the breeding period were more abundant (79.3% of all observations). Most were recorded at 79.2 ± 64.5 km from any current breeding settlement (Figure 2). This set of samples tended to occur also in sites with lower altitude than the core breeding places (mean altitude for observations 672 ± 316 m) and were concentrated in the middle part and at the end of the breeding cycle (February–March: $n = 2$; April–May: $n = 8$; June–July: $n = 6$). From the 17 observations during breeding season with habitat

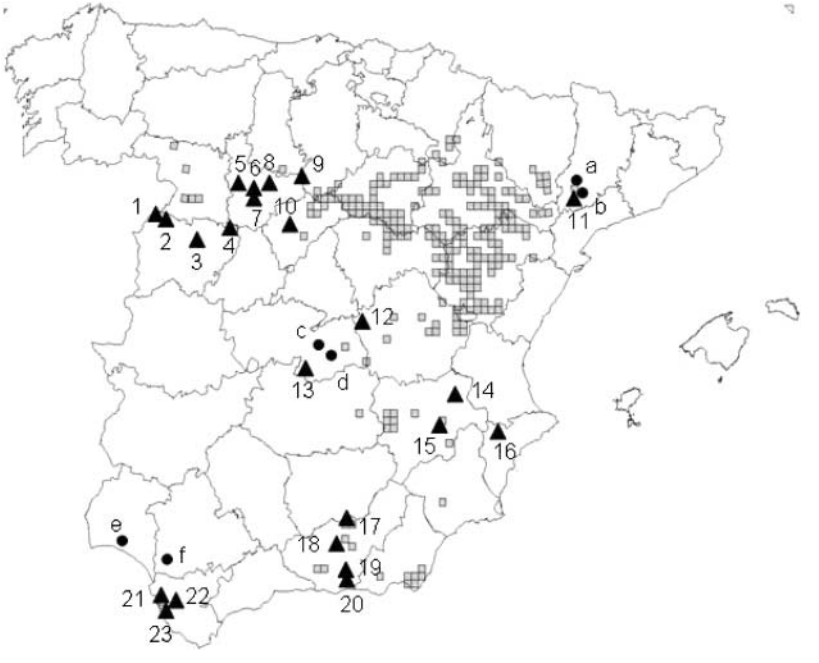

Figure 2. Spatial dispersion of Dupont's Lark records outside breeding areas (grey squares) used in this study (post-1988). Black triangles show records from the breeding season; black circles, records from the non-breeding period.

https://doi.org/10.1017/S0959270906000505 Published online by Cambridge University Press

description, 29.4% correspond to 'agrarian substrates', 47.1% to 'shrubs' and 23.5% to 'other' land-use types.

Results from this study suggest that most breeding Dupont's Larks remain on their breeding sites during the non-breeding season. Indeed, because the probability of winter presence in breeding areas was significantly correlated with breeding population size, presence in areas with few territorial males (like those categorized in this study as very small, <10 territorial males), winter presence would most probably be unnoticed. In contrast, we have confirmed the presence of the species in most of the areas with the largest populations (90%). Furthermore, data from captures in the winters following this study (2004–2005) in breeding sites (authors' unpublished data) corroborate the results obtained by censuses. All these data suggest that the species is principally resident in the Iberian Peninsula, including those populations from areas with harsh winter climate conditions.

However, winter observations outside the known breeding areas indicate that some individuals or a part of the population could move to distant areas. Some additional evidence suggests that juveniles could disperse more than adults. Aymí *et al.* (1994), using data from recaptured birds in Lleida (north-east Spain; *c.* 300 m a.s.l.), found higher capture rates during the non-breeding season for adults than for juveniles (42% vs 12%, respectively; Aymí *et al.* 1994). Indeed, local post-breeding movements were reported for juveniles in that area (Calvet *et al.* 2004). Furthermore, data from radio-tagged individuals in Layna (central Spain; 1,200 m a.sl.), showed local movements by juveniles to suboptimal habitat (Garza *et al.* 2005). Thus, at least juveniles seem to perform local movements more often than adult birds, and it is likely that most records of wintering birds far from breeding areas correspond to juveniles. However, we cannot rule out that the whole population in a given area could carry out temporal movements at a local scale in the case of exceptional weather conditions, such as heavy snowfall.

More intriguing are the observations of males singing during the breeding season but outside the known breeding areas. As breeding distribution is relatively well known, there are three possible non-exclusive explanations: (1) observations are linked to sporadic breeding areas in which individuals did not breed every year; (2) observations are of birds temporarily settled in suboptimal habitats; (3) observations correspond to dispersed birds, especially the latter ones. The first explanation is supported by spring observations of individuals in alfa grass shrub-like habitat restricted to perimeters of lagoons, where the species breeds some years depending on the water level (V. Garza, unpubl. data). The second and third explanations are supported by a large proportion of records obtained far from well-known breeding areas of the species, which would indicate vagrant movements (observations 13, 16 and 19–23 in Figure 2). Furthermore, most of the latter observations (52.9% of the total set of observations) occur in habitat different from those selected by Dupont's Lark during the breeding season.

Three aspects of our results could be used to develop sustainable and efficient conservation plans for this species in the European Union, and to improve its conservation. The first is the sedentary character of most individuals. These results imply that conservation measures applied to a breeding area affect a large proportion of birds all year round. Therefore, if resources are limited and they do not allow full protection of all areas within the species' distribution, it would be more efficient to concentrate conservation efforts in the main breeding areas, making sure that most

birds are protected there, rather than working in other suboptimal areas. This conclusion is particularly important when considering that most of the Dupont's Lark breeding areas remain unprotected, and several threats related to habitat changes (i.e. ploughing of natural suitable habitat), reforestation, and more recently the expected construction of several wind farms, are actually taking place in the main breeding areas of Dupont's Lark (Garza *et al.* 2004). Therefore, the legal protection of the breeding areas of the species is our priority.

The second aspect is the recorded presence of some birds outside the breeding areas. Dupont's Lark seems to carry out partial population migrations at the Iberian Peninsula scale, and the existence of birds outside breeding areas could be used to increase the connectivity between populations. The distribution of Dupont's Lark in Spain is highly fragmented, with small isolated and dispersed populations containing fewer than 10 breeding territories. In other avian species, simulation analyses showed that connectivity between populations through natal dispersal could allow persistence of threatened populations even in the absence of conservation measures (Arroyo *et al.* 2002). Thus, promoting and managing large extents of natural vegetation in flat areas could help individuals to move and rest, act as a link between different populations and increase the viability of the species in the medium and long term (Arroyo *et al.* 2002).

Finally, the third important issue is the use of marginal areas and habitats by a part of the population during the non-breeding period. The importance of these marginal habitats for the conservation of birds was highlighted by Rivera *et al.* (1999) and by Garza *et al.* (2005) for Dupont's Lark. The marginal habitats used by individuals after breeding comprise long-term fallow land, stubbles and pastures, all of which are rapidly decreasing in Spain due to agricultural intensification (Suárez *et al.* 1997). This process may have a major impact on the recruitment of first-year birds in breeding areas, and the protection of these habitats within the framework of the Common Agricultural Policy should be prioritized, because they are also important for most of the endangered steppe bird species at a European scale (Suárez 2004).

Acknowledgements

We thank all the ornithologists who, through their observations, allowed us to produce this paper. This study was funded by the Spanish Ministerio de Medio Ambiente. J. J. Areces kindly provided enthusiasm and institutional support where necessary. We also thank Manuel B. Morales and two anonymous referees for their comments.

References

Arroyo, B., García, J. T. and Bretagnolle, V. (2002) Conservation of the Montagu's harrier (*Circus pygargus*) in agricultural areas. *Anim. Conserv.* 5: 283–290.

Aymí, R., Elliot, A. and Martínez, I. (1994) Els Ocells. Pp. 32–35 in *La Timoneda dAlfés*. Lleida: Monografies de DEPANA.

Birdlife International (2004) Birds in Europe: population estimates, trends and conservation status. Cambridge, UK: Birdlife International.

Calvet, J., Estrada, J., Mañosa, S., Moncasí, F. and Solans, J., eds. (2004) *Els ocells de la plana de Lleida*. Lleida: Pagés editors.

De Juana, E. and Suárez, F. (2004) Dupont's Lark *Chersophilus duponti*. Pp. 586 in J. del Hoyo, A. Elliott and D. Christie, eds. *Handbook of the birds of the world*. Volume 9. Barcelona: Lynx Edicions.

Garza, V. and Suárez, F. (1990) Distribución, población y selección de hábitat de la Alondra de Dupont, *Chersophilus duponti*, en la Península Ibérica. *Ardeola* 37: 3–12.

Garza, V., Traba, J. and Suárez, F. (2003a) Is the European population of Dupont's Lark *Chersophilus duponti* adequately estimated? *Bird Study* 50: 309–311.

Garza, V., Suárez, F. and Tella, J. L. (2003b) Alondra de Dupont *Chersophilus duponti*. Pp. 364–365 in R. Martí and J. C. del Moral, eds. *Atlas de las aves reproductoras de España*. Madrid: Dirección General de Conservación de la Naturaleza-Sociedad Española de Ornitología.

Garza, V., Suárez, F. and Tella, J. L. (2004) Alondra de Dupont, *Chersophilus duponti*. Pp. 309–312 in A. Madroño, C. González and J. C. Atienza, eds. *Libro Rojo de las aves de España*. Madrid: Dirección General para la Biodiversidad-SEO/BirdLife.

Garza, V., Suárez, F., Herranz, J. Traba, J., García de la Morena, E. L., Morales, M. B., González, R. and Castañeda, M. (2005) Home range, territoriality and habitat selection of the endangered Dupont's Lark (*Chersophilus duponti*): the breeding and postbreeding periods. *Ardeola* 52: 133–146.

Herranz, J., Manrique, J., Yanes, M. and Suárez, F. (1994) The breeding biology of Dupont's Lark, *Chersophilus duponti*, in Europe. *Avocetta* 18: 141–146.

IGN, Instituto Geográfico Nacional (1992) *Atlas nacional de España. Sección II: climatología*. Madrid: Ministerio de Obras Públicas y Transporte.

Newton, I. (1998) *Population limitation in birds*. London: Academic Press.

Pérez-Tris, J. and Tellería, J. L. (2002) Regional variation in seasonality affects migratory behaviour and life-history traits of two Mediterranean passerines. *Acta Oecol.* 23: 13–21.

Rappole, J. H. and McDonald, M. V. (1994) Cause and effect in population declines of migratory birds. *Auk* 111: 652–660.

Rivera, J. H. V., McShea, W. J., Rappole, J. H. and Haas, C. A. (1999) Postbreeding movements and habitat use of adult wood thrushes in northern Virginia. *Auk* 116: 458–466.

StatSoft (2001) *STATISTICA (data analysis software system), 6.0*. Tulsa, Oklahoma: StatSoft Inc.

Suárez, F. (2004) Aves y agricultura en España peninsular: una revisión sobre el estado actual de conocimiento y una previsión sobre su futuro. Pp. 223–265 in J. L. Tellería, ed. *Libro homenaje a Francisco Bernis*. Madrid: Editorial Complutense.

Suárez, F. and Garza, V. (1989) La invernada de la Alondra de Dupont, *Chersophilus duponti*, en la Península Ibérica. *Ardeola* 36: 107–110.

Suárez, F., Naveso, M. A. and De Juana, E. (1997) Farming in the drylands of Spain: birds of pseudosteppes. Pp. 297–230 in D. Pain and M. Pienkowski, eds. *Farming and birds in Europe: the Common Agricultural Policy and its implication for bird conservation*. Cambridge, U.K: Academic Press.

Tella, J. L., Vögeli, M., Serrano, D. and Carrete, M. (2005) Status of the threatened Dupont's Lark in Spain: overestimation, decline and extinction of local populations. *Oryx* 39: 1–5.

FRANCISCO SUÁREZ*, VICENTE GARZA
Dpto. de Ecología, Facultad de Ciencias, Universidad Autónoma, 28049 Madrid, Spain.

JESÚS T. GARCÍA
Instituto de Investigación en Recursos Cinegéticos (IREC), Ronda de Toledo s/n, 13005 Ciudad Real, Spain.

FRANCISCO J. SAMPIETRO
C/ San Viator, 45, 50000 Zaragoza, Spain.

*Author for correspondence; E-mail: francisco.suarez@uam.es

Received 31 May 2005; Accepted 6 February 2006