HABITAT OF THE ORTOLAN BUNTING EMBERIZA HORTULANA ON A CAUSSE IN SOUTHERN FRANCE

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ABSTRACT. – We studied the habitat requirement of the ortolan bunting Emberiza hortulana on the Causse Méjean (Lozère, France) during the breeding season by point counts, using a paired-point design (i.e., points with vs. without ortolan), and describing the habitat within a 100 m radius. We compared variable by variable, by mean of Chi² tests, the point counts where the ortolan bunting was present (N = 98) with the points where it was absent (N = 94). Most of the ortolan buntings breed in steppe-like grasslands with scattered bushes, and in open shrublands where the mean height of the shrub layer is between 0.5 and 1.75 m. This bird is particularly frequent in Buxus sempervirens shrublands (cover ranging between 10 to 40%). In such open and low habitats, song posts are needed. They mainly consist in scattered trees or tall shrubs higher than 1.8 m, but wires and rocks are also used. On the Causse Méjean, the ortolan bunting clearly prefers slopes to flat areas. Certain environmental variables regarded as important elsewhere in Europe (such as orientation, cover of bare soil, or proximity of farmland) are not relevant on the Causse. Using a vegetation map drawn for the purpose of this study, we estimated at 15 222 ha the area of suitable habitat available to the species, of a total area of 21 314 ha for the bare part of the Causse Méjean. A discriminant analysis performed on the two sets of census points (i.e., with and without ortolan bunting) reveal a good, although incomplete, discrimination, and led us to assume that the present ortolan bunting population on the Causse Méjean does not occupy the entire area of favourable habitat. As a result, possible variations of habitat availability cannot explain alone the present decline of this population.
INTRODUCTION

The greatest threats to birds in Europe, and to biodiversity in general, lie in the continuing erosion of the quality and extent of habitats (Tucker & Evans 1997). In the hilly or mountainous areas of the north Mediterranean basin, open landscapes are particularly threatened due to a decline of breeding and agricultural activities that leads to the encroachment of the former fields and pastures by woody vegetation (Lepart & Debussche 1992, Marty et al. 2003). This trend represents a threat for the bird species of the open landscapes. Among the 100 priority birds species that occur in Mediterranean habitats in Europe (Tucker & Evans 1997), more than half are more or less dependent from open landscape for breeding or foraging. The ortolan bunting is particularly representative of these species. Since the sixties, the ortolan bunting has suffered a noticeable reduction of its distribution area and a decrease of its populations in most European countries (Kutzenberger 1994a, Stolt 1997), and in particular in France (Claessens 1992, Claessens & Rocamora 1999). Three possible reasons for this decline have been suggested:

– Alteration and loss of breeding habitats as a result of changes in agricultural practices, in France (Claessens 1992) and in other European countries (Bülow 1997, Steiner 1994),
– Traditional hunting of the species in southwestern France (Claessens 1992, 1994b, Stolt 1994),
– Alteration of wintering conditions in West Africa (Bülow 1990, Stolt 1993).

The habitats used by the ortolan bunting in Europe are very diverse (Cramp & Perrins 1994, Tucker & Heath 1994). They are generally characterised by dry and sunny climates, by the presence of scattered trees, poles, rocks, or other song posts, by sparse herbaceous vegetation, and by well drained soils leaving sectors of bare soil for ground feeding. Two main categories of habitat can be distinguished:

(i) Natural and semi-natural habitats with low human impact. In southern Europe, the ortolan inhabits open shrublands such as Mediterranean matorrals (Villarán Adánez 1997), degraded garrigues (Valera & Rey 1994, Olioso 1996), dry montane pasture scrublands (Zamora 1991), and grasslands scattered with bushes on rocky slopes or plateaux (Mestre 1984, Lovaty 1991). In Scandinavia, meadows or rocky grasslands with isolated tree forest edges and clearings, and to a lesser extent peat bogs, are the main habitats (Stolt 1994, Väisänen 1994, Dale & Hagen 1997). The ortolan bunting can also be found in recently burned areas (Dale & Hagen 1997, Prodon 2000). More generally, the species occurs in early successional formations.

(ii) Man-made habitats. In most European countries, and especially in central Europe, the ortolan bunting is associated with cultivated land. It prefers small-scale mixed farming with a combination of cereal fields and root crops, pastures, and meadows, with scattered trees and bushes (Gérout 1980, Lang et al. 1990, Steiner 1994). Nests are often found in cereal fields. Fallow lands, terraces, and vineyards, are also used (Gérout 1980, Geister 1994, Kutzenberger, 1994b).

Most of the extensive surveys on ortolan bunting habitat in Europe have been carried out in cultivated landscapes (Bülow 1990, Steiner 1994). Although steppes, grasslands and open shrublands are often mentioned in European literature as major habitats of the species (Kutzenberger 1994a), they have seldom been surveyed. In France the only study was done by Lovaty (1991, 1992).

In 1995, we began a monitoring of the ortolan bunting and of its habitat near the area studied by Lovaty (op. cit.) – namely the Causse Méjean – where the ortolan population has been estimated at 250-300 singing males (Fonderflick & Thévenot 2002). This area is convenient for such a study because its ortolan population does not suffer direct impacts from shooting practices, unlike in SW France, and because recent changes in land use affect the habitats, in particular the structure of the vegetation. In other papers we have studied the composition of the bird community of the Causse Méjean and its recent evolution (Fonderflick et al. 2001), and the population size and density variation of the ortolan bunting population in the same area during the 1996-2000 period (Fonderflick & Thévenot 2002). The aim of the present study was to answer the following questions: (i) what is the habitat requirement of the ortolan bunting? Is habitat a limiting factor? (ii) Is the species’ habitat under threat? Do landscape dynamics influence the population dynamics of the bird?

STUDY AREA

The Causse Méjean is located in Lozère in the southern part of the Massif Central (Fig. 1). This high limestone plateau of 330 km² is limited by deep gorges and canyons (Tarn, Jonte and Tarnon). The density of human population (446 inhabitants in 1991, i.e., 1.4 inhabitants per km²) is among the lowest in France. Sheep-farming of wide pasturelands is practised on about 85% of the Causse area, although intensive grazing of certain grasslands tends to replace the traditional extensive sheep breeding. In spite of the plateau appearance of the causses, its altitude ranges from 810 m (Montignac) to 1247 m (Mont Gargo). The annual rainfall ranges from 840 to 1160 mm, depending on the year and on the loca-
tion (the western wooded part receives lower rainfall than the eastern open part). Rainfall is especially abundant during the autumn. Summers are generally dry and hot. The warmest months are July and August with average daily temperatures close to 20°C, and the coldest January and February, with average daily temperatures close to 0°C. Minimum temperatures can reach –10°C.

The Causse Méjean can be divided into two large ecological parts (Fig. 2). (i) The ‘open causse’ in the eastern part consists of steppe-like grasslands (*Bromus erectus* Hudson, *Festuca* spp. and *Stippa pennata* L.), scattered with bushes (e.g., *Buxus sempervirens* L.) and small trees (e.g., *Juniperus communis* L.), with a few artificial plantations of *Pinus nigra* (Arnold). It is partly included in the central zone of the Cévennes National Park. (ii) The ‘wooded causse’ in the western part is covered with pine (*Pinus sylvestris* L., *P. nigra*) stands, together with *Buxus sempervirens* and *Juniperus communis*; some clearings remain, especially around hamlets.

**MATERIALS AND METHODS**

*Ortolan census:* The ortolans were counted by single-visit and 100 m radius point counts. Each count lasted 20 minutes. Due to the late arrival of the species in spring, censuses were carried out between the 8th of May and the 28th of June.

*Sampling design:* Our objective was to define the habitat requirements of the species by comparing environmental characteristics of points with and without ortolan. The sampling design results from two constraints: to take into account the whole of the study area on the one hand and to obtain a sufficient number of records of the relatively rare ortolan buntings on the other hand.

A preliminary field survey showed that ortolan buntings was totally absent of the ‘wooded causse’ Méjean, including in the remaining patches of open landscape. Thus, we restricted the sampling to the ‘open causse’. In 1995, we first sampled 75 sites in a priori suitable habitats, i.e., in sites where the ligneous cover (shrub or shrub-and-tree cover) was lower than 50%. These points were taken at random on a 400-square grid (750 m × 750 m), on a map covering the whole open Causse Méjean. After discarding the squares where unsuitable habitat was predominant, the points were chosen within the squares (according to accessibility constraints) in a priori suitable habitats. We also measured the habitat characteristics on 17 supplementary points where we found ortolan buntings while moving from one site to the other.

As only 33 points out of these 92 showed the presence of the ortolan buntings, the sampling of the second year of our study (1996) followed a “paired points” design. It involved prospecting a priori suitable areas (outside those already visited in the first year) until we met with the first ortolan buntings; at this first point, the habitat was described within a 100 m radius. Then we walked 250 m in a random direction, but always remaining in an a priori suitable habitat. At this second point, a 20-min ortolan census was coupled with a second habitat description. This distance (250 m) between the two points in the pair was determined in order to minimize the risk of overlap in the double count. It sometimes happened that the species was also recorded on the second point. We sampled in this way 50 pairs of points (100 points in total), 65 with ortolan and 35 without.

The final data set consisted of 192 census points (92 from 1995 and 100 from 1996) carried out in areas a priori suitable for the ortolan buntings, including 98 in which it was present, and 94 in which it was absent.

*Environmental variables:* The environmental variables we measured were selected both from our field experience and from the literature on the habitat requirements of the ortolan (Table I). The habitat description referred to a 100 m radius circle around the observer. Special
attention was paid to landscape structure, including the possible juxtaposition of various vegetal formations within the 100 m radius.

Vegetation map of the Causse Méjean: From the average height of the vegetation, and the covers of the tree, shrub and herbaceous layers, we distinguished seven formations, ranging from low and open to high and dense habitats (codified M1 to M7, see Table II), with reference both to the CNRS code (Godron et al. 1968) and to the results of our preliminary field work.

The corresponding vegetation map (Fig. 2) was drawn using infrared aerial photographs from the 1989 IGN mission. All the vegetal formations were transferred on a 1:25,000 map (“IGN Top 25, Gorges du Tarn et de la Jonte, Causse Méjean”), then digitalized on a GIS (ArcInfo ®). Each of the 2406 polygons obtained was assigned to one of the seven vegetal formations.

Data processing: The point counts with ortolan bunting (N=98) were compared, variable by variable, with the point counts without ortolan bunting (N=94) by a Chi² test with Bonferroni’s correction (software NP-Stat version 2.95, Praxème R&D ®). The same set of 192 observations in two groups was submitted to an ascending incremental discriminant analysis (Statistica software, Statsoft ®).

**RESULTS**

**Repartition and density of the ortolan bunting on the open cause**

The distribution of the ortolan bunting on the open cause seemed loosely aggregative (Fig. 3), due either to the patchy distribution of suitable habitat, or to the gregarious habits of the species (Durango 1948, Conrads 1969), or both. But it may also result from the sampling design used in 1996 (“paired points”) which led to an over-sampling of the suitable habitats. Of the 192 census points carried out in suitable habitats, 94 held no buntings, 77 held only one, 18 held two and 3 held three. This observed distribution was very close to a Poisson distribution (Chi² = 4.16, 3 d.f., P ≈ 0.2), so that we cannot reject the null hypothesis of a random distribution within the suitable habitats.

Breeding density estimated on the whole open cause was about 0.014 singing males per ha. However on two suitable areas of 330 and 190 ha monitored from 1995 to 2000, the bunting densities

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**Table I. – List and notation of the environmental variables selected.**

<table>
<thead>
<tr>
<th>Environmental variables</th>
<th>Measurement modalities</th>
<th>Classes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Altitude</td>
<td>in meters</td>
<td>900-950, 950-1000, 1000-1050, 1050-1100, 1100-1150, 1150-1200</td>
</tr>
<tr>
<td>Aspect</td>
<td>absent/present</td>
<td>north, north-east, east, south-east, south, south-west, west, north-west</td>
</tr>
<tr>
<td>Topography</td>
<td>absent/present</td>
<td>summit, foot slope, half-slope, high-slope, levelling off, depression, flat</td>
</tr>
<tr>
<td>Distance to the nearest farming zone</td>
<td>in meters</td>
<td>0-50, 50-100, 100-150, 150-200, 200-250, 250-300, 300-350, 350-400, 400-450, 450-500, 500-550, 550-600</td>
</tr>
<tr>
<td>Area of farming zone</td>
<td>absent/present</td>
<td>0-1 ha, 1-3 ha, 3-5 ha, + 5 ha</td>
</tr>
<tr>
<td>Nature of farming zones</td>
<td>absent/present</td>
<td>meadow, cereal fields, leguminous crop, various</td>
</tr>
<tr>
<td>Distance to the nearest lavogne</td>
<td>in meters</td>
<td>0-750, 750-1500, 1500-2250, 2250-3000, 3000-3750, 3750-4500</td>
</tr>
<tr>
<td>Presence of particular elements</td>
<td>absent/present</td>
<td>fence, sheep fold house, hedge, electricity and telephone wires, rock, little wall</td>
</tr>
<tr>
<td>Cover of the different vegetal formations within a 100 m radius</td>
<td>percentage</td>
<td>M2, M3, M4 and M1+M2, M3 or M4</td>
</tr>
<tr>
<td>Cover of the herbaceous layer</td>
<td>percentage</td>
<td>10-20%, 20-30%, 30-40%, 40-50%, 50-60%, 60-70%, 70-80%, 80-90%</td>
</tr>
<tr>
<td>Presence of selected plants species in the herbaceous layer</td>
<td>absent/present</td>
<td>Stipa pennata, Lavandula angustifolia, Brachypodium pinnatum</td>
</tr>
<tr>
<td>Cover of the shrub layer</td>
<td>percentage</td>
<td>0-10%, 10-20%, 20-30%, 30-40%, 40-50%</td>
</tr>
<tr>
<td>Mean height of the shrub layer</td>
<td>in meters</td>
<td>0.25-0.5, 0.5-0.75, 0.75-1, 1-1.25, 1.25-1.5, 1.5-1.75, 1.75-2</td>
</tr>
<tr>
<td>Nature of dominant vegetal species of the shrub layer</td>
<td>absent/present</td>
<td>Buxus sempervirens, Crataegus monogina-Rosa sp., Amelanchier vulgaris, Juniperus communis, others</td>
</tr>
<tr>
<td>Cover of the arborescent layer</td>
<td>percentage</td>
<td>0-1%, 1-5%, 5-10%, 10-15%, +15%</td>
</tr>
<tr>
<td>Mean height of the arborescent layer</td>
<td>in meters</td>
<td>2-3, 3-4, 4-5</td>
</tr>
<tr>
<td>Nature of dominant vegetal species of the arborescent layer</td>
<td>absent/present</td>
<td>Pinus sylvestris, Pinus nigra, Fraxinus sp., Ulmus sp.</td>
</tr>
<tr>
<td>Presence of a song-post higher than 1.8 m</td>
<td>absent/present</td>
<td>With, without</td>
</tr>
<tr>
<td>Cover of loose stone</td>
<td>percentage</td>
<td>0-10%, 10-20%, 20-30%, 30-40%, 40-50%, 50-60%</td>
</tr>
<tr>
<td>Cover of bare soil</td>
<td>percentage</td>
<td>1%, 2%, 3%, 4%, 5%, 6%, 7%, 8%, 9%, 10%</td>
</tr>
<tr>
<td>Nature of bedrock</td>
<td>absent/present</td>
<td>limestone, dolomite, dolomie and limestone</td>
</tr>
</tbody>
</table>
Fig. 2. – Vegetation map of the Causse Méjean (according to infrared aerial photographs from the 1989 IGN mission). The separation between the wooded Causse and the open Causse is highlighted.
ranged from 0.015 to 0.11 territories per ha (Fonderflick & Thévenot 2002).

**Factor-by-factor comparison of sites with vs. without ortolan on the open caisse**

**Topography and aspect**

The ortolan bunting showed a significant preference for slopes without any significant preference for aspect, and tended to neglect flat sectors (Fig. 4a).

**Proximity of cultivated areas**

90% of census points with ortolan bunting were located within 400 m from cultivated lands. Nevertheless, the proximity of farmland does not seem to be necessary to the settling of the ortolan as a cartographic analysis showed that the great majority (ca 90%) of the suitable habitats on the open part of the caisse was actually located less than 400 m away from cultivated areas.

**Landscape composition**

To find whether the presence of the ortolan bunting is dependant on the nature of vegetal formations or not, we considered not only relatively homogeneous vegetal formations *a priori* favourable to the ortolan bunting (M2, M3 and M4), but also heterogeneous patchy habitats found in farming zones (M1) associated with one or more of these suitable formations.

The ortolan bunting occurred more than expected in the M3 and M4 vegetal formations and less than expected in M2 as well as in mixed formations (Fig. 4b). Chi² tests show significant difference between the formations as long as the M4 formation is enclosed in the analysis (*P* = 0.08).

**Height of shrub layer**

The Ortolan bunting mainly occupied habitats in which the average height of the shrub layer ranged from 0.5 to 1.75 m, with a significant preference for the class 0.5-0.75 m (Fig. 4c).

The Ortolan bunting significantly selected vegetal formations in which the shrub layer was dominated by *Buxus sempervirens* (Fig. 4d).

**Cover of tree layer**

The majority (92%) of the census points occupied by the ortolan bunting had a tree cover lower than 5% (Fig. 4e). The Chi² test showed significant differences regarding this habitat variable, mainly due to the 0-1% class. Despite the fact that habitats with very low tree cover were selected, those completely devoid of trees were less favourable to the ortolan.
Presence of song posts

On the Causse Méjean, trees (Pinus nigra or P. sylvestris, and less frequently Fraxinus sp. or Ulmus sp) offer song posts which are essential for territorial males, but trees were not the only song posts used by the ortolan bunting. In their absence, singing males often perched on high shrubs, on telegraph poles or wires, or on rocks. Within our data set, the presence of song posts more than 1.8 m high is highly significant (Fig. 4f).

Area of favorable habitat on the open causse

The ortolan bunting was present in three vegetation types only, namely the M2, M3 and M4 formations (Fig.4b). The M3 formation, where the ligneous cover (bushes or bushes and trees) ranged between 5 and 25%, was entirely occupied, but the two other formations were only partly occupied. Within M2 (ligneous cover < 5%) and M4 (ligneous cover 25-50%), the ortolan bunting was only encountered in areas where the ligneous cover was > 2% (in M2) and < 46% (in M4). It was particularly frequent where the ligneous cover ranged between 10 and 40%.

From a vegetation map on a G.I.S., we calculated the surface area of habitat suitable for the ortolan bunting in the open part of the Causse Méjean. In 1989, when the aerial photographs used to draw the vegetation map were taken, these favourable habitats represented 15 222 ha out of a total area of 21 314 ha for the open causse (Table II). Looking for possible vegetation changes between 1989 (date of the aerial photographs) and 1995-96...
(date of our field sampling) we compared the vegetation at each point count with the vegetation map. We recorded very few differences, and thus are confident that our area estimations are accurate.

**Discriminant analysis of sites with vs. without ortolan in a priori suitable areas**

The choice of a breeding site may result from a combination of several environmental variables rather than from a single characteristic. The two sets of samples ("with" and "without" ortolan bunting, respectively) were submitted to a discriminant analysis for which we selected 15 environmental variables that proved to be significantly different (at, or close to, the 0.05 level) in sites with vs. without buntings (Table III). Seven variables were found to be particularly discriminative between the two set of samples (Table III). The hierarchy of variables obtained in this way is consistent with the one derived from Chi² analyses, especially as

<table>
<thead>
<tr>
<th>Environmental variables</th>
<th>Variables retained by analysis</th>
<th>Variables excluded by analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Topography</td>
<td></td>
<td>F Values</td>
</tr>
<tr>
<td>Half-slope</td>
<td>Flat</td>
<td>4.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.66</td>
</tr>
<tr>
<td>Vegetal formations</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M3</td>
<td></td>
<td></td>
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<tr>
<td>M4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presence of selected species in the herbaceous and shrub layer</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lavandula angustifolia</td>
<td></td>
<td>5.77</td>
</tr>
<tr>
<td>Brachypodium pinnatum</td>
<td></td>
<td>0.01</td>
</tr>
<tr>
<td>Buxus sempervirens</td>
<td></td>
<td>0.54</td>
</tr>
<tr>
<td>Cover of the herbaceous layer</td>
<td></td>
<td>0.04</td>
</tr>
<tr>
<td>Cover of the arborescent layer</td>
<td></td>
<td>0.05</td>
</tr>
<tr>
<td>Mean height of the shrub layer</td>
<td>6.23</td>
<td></td>
</tr>
<tr>
<td>Presence of a song-post higher than 1.8 m</td>
<td>11.20</td>
<td></td>
</tr>
</tbody>
</table>

**After analysis classification**

<table>
<thead>
<tr>
<th>Data before analysis</th>
<th>Without Ortolan p = 0.49</th>
<th>With Ortolan p ≤ 0.01</th>
<th>% of well classified points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Census points with Ortolan</td>
<td>94</td>
<td>58</td>
<td>36</td>
</tr>
<tr>
<td>Census points without Ortolan</td>
<td>98</td>
<td>24</td>
<td>74</td>
</tr>
<tr>
<td>Total</td>
<td>192</td>
<td>82</td>
<td>110</td>
</tr>
</tbody>
</table>

Numbers of well-classified points appear in bold on grey background.
regards the prominent role of the availability of a song post. The discriminant analysis allowed a correct characterisation of 75.5% of points with ortolan, and of 61.7% of points without ortolan (Table III), with a high level of significance (Wilks’ Lambda = 0.799; p < 10^{-4}).

DISCUSSION
Criteria of habitat Selection by the ortolan bunting

Our study confirms the influence of vegetation structure in habitat selection by the ortolan bunting, pointing out the importance of certain characteristics such as song post availability. Compared with other studies carried out on this bird in other European countries, our results show some distinctive features. Certain environmental variables, elsewhere regarded as important (orientation, cultivated areas), apparently do not play any role on the Causse Méjean, whereas some others, though seldom mentioned (topography), seem to be active.

Aspect and climate

Aspect often plays a role in habitat selection by the ortolan in European countries, such as Sweden (Durango 1948), Finland (Väisänen 1994), Switzerland (Géroudet 1954), France (Claessens 1994a), northern Spain (Villarán Adánez 1997) and Italy (Bordignon & Torreggiani 1988). The ortolan bunting generally chooses southern sunny orientations with relatively dry and hot summers. In contrast, our study shows that orientation does not explain the ortolan’s distribution on the Causse Méjean. This result may be explained by a lack of variation in aspect and in microclimates on the Causse Méjean. The Causse Méjean receives relatively high annual rainfall (slightly over 1000 mm per year). In Europe, if the ortolan bunting generally prefers areas receiving low rainfall (often < 600 mm per year), it can tolerate up to 900-1000 mm, as in Austria (Kutzenberger 1994b, Lentner 1994), Switzerland (Géroudet 1954), Germany (Meier-Peithmann 1994, Lang et al. 1990, Schubert 1994), and Scandinavia. On the Causse Méjean, strong rains with cold weather are not uncommon in spring until mid-June. They probably represent a cause of breeding failure, affecting the population dynamics of the bird, as it has been demonstrated in Germany by Lang (1994).

Topography

On the Causse Méjean, the ortolan bunting clearly prefers mid-slopes to flat areas. The determinism of this preference might be ethological (song range, anti-predator strategy). So far, topography has seldom been mentioned to explain the ortolan microdistribution, and the rare data are contradictory. Lang et al. (1990) in Germany, and Géroudet (1954) in Switzerland say that the ortolan prefers flat lands. Contrarily, Nikiforov & Gritshik (1997) in Bielorussia mention that the species avoids flat areas.

Cultivated areas

Our study shows that the proximity of cultivated lands does not explain the location of territories on the open Causse Méjean where farmlands are scattered everywhere. This conclusion is at variance with most of the surveys carried out elsewhere in Europe, where the ortolan bunting breeds more often in (or in the vicinity of) open mixed farmland with sparse bushes and trees than in natural habitats (Peero 1988, Conrads 1969, Steiner 1994, Bülow 1997). In Norway the majority of the ortolan population breeds on peat bogs, provided that there is a farmland in close proximity (Dale 2000). A preference for cultivated lands has also been pointed out in France (Claessens 1994a, Boitier 2001). In an area close to the Causse Méjean, Lovaty (1991) observed that ortolan bunting densities were higher in zones that included farmland.

We suppose that the choice of cultivated areas, especially cereals and root crops, in Northern and Eastern Europe as nest sites, is a palliative for the lack of natural open habitats. When both cultivated and non-cultivated areas are available, as it is the case on the Causse Méjean, the ortolan actually prefers to build its nest in the latter, generally at the foot of shrubs or small trees (e.g., Juniperus communis). However, the presence of cultivated areas might be important as feeding areas, but we were unable to locate census points sufficiently far from farmlands.

Shrub layer cover and patchiness

On the causses, the ortolan bunting selected areas with a low ligneous cover (< 46%). Nevertheless, we never encountered the species in areas completely devoid of ligneous cover, or in area with a ligneous cover higher than 45% (but these areas are fairly scarce on the open causses).

These results are consistent with those obtained in similar habitats in southern Europe (Lovaty 1991, Zamora 1991). The ortolan also seems to have a marked preference for the box Buxus sempervirens, one of the most common shrubs on the Causse Méjean. The ortolan seems to favour heterogeneous formations that include a mosaic of open and closed areas where the box dominates. Such patchy habitats are also selected in many other European countries (Steiner 1994, Bülow 1997). Although ground accessibility is fundamental for this ground-feeding species (Claessens 1994a), it does not represent a limiting factor on the Causse Méjean.
Song posts and trees

Song posts are important for open country passerines that do not sing in flight, such as the ortolan bunting. On the open causses, these posts mainly consist of Pinus nigra and P. sylvestris, or high bushes, or even electricity or telephone wires. However, we have never seen any ortolan bunting at forest edges, as it is often the case in Europe, e.g. in Germany (Conrads 1969, Bülow 1990, Lang et al. 1990), Russia (Nikiforov & Grishik 1997), Sweden (Stolt 1994), Lithuania (Izdzelis 1994), and Poland (Kupczyk 1997), where forest edges are used as song sites as well as feeding zones.

Evolution of ortolan’s habitat on the Causse Méjean

The discriminant analysis carried out in a priori suitable habitats provides a significant, but not complete, segregation between sites with vs. without ortolan bunting. It is possible that we did not survey all important habitat variables, or that the spatial scale of the sampling was not appropriate. Another possibility is that part of the numerous unpaired males (e.g. 42% of the singing males in 1997, Fonderflick & Thévenot 2002) occupies less favourable habitat. But it is more likely that the present ortolan population of the Causse Méjean does not entirely occupy the available habitat, and leaves many suitable sites unoccupied.

Since the mid 20th century, many grasslands or open shrublands of the causses, a priori suitable for the ortolan, have been gradually replaced by heath and forest due to the decrease of grazing. Even if the potentially suitable areas still represented 15 222 ha (out of a total area of 21 314 ha of open causses) in 1989, 5 613 ha of meadows have disappeared on the open causses between 1948 and 1989 (Duguépéroux 1999), and this landscape change is still going on (Lardon et al. 1995). Some 70 years ago, according to Meylan (1934), the ortolan bunting was common on a slope, adjacent to the Causse Méjean, that was a scree covered with scattered shrubs mixed with vineyards and dry meadows. Vineyards have now completely disappeared from the site. The sparsely vegetated areas have been replaced by pine woodland, leaving only small fragments of dry meadows where we failed to locate any ortolan bunting in spite of frequent visits.

However, the semi-open formations sustained by traditional grazing and used by the ortolan still cover a great extent of the open part of the causses. We assume that the suitable habitat is not fully saturated by the species. Furthermore, current vegetation dynamics, i.e., the evolution of bare grasslands, formerly grazed, into Buxus sempervirens open shrublands, appear to be a priori favourable to the ortolan in the short term. In a longer term, however, these dynamics are unfavourable to the bird as the shrublands become dense and are overgrown by pines, especially on the slopes which are favoured by ortolan bunting but are more subject to natural reforestation (Lepart pers. com).

Nevertheless, we have observed a continuous decline of the ortolan bunting breeding population on two monitored areas on the open causses since 1995 (Fonderflick & Thévenot 2002). This decline cannot be explained by habitat loss. The ortolan is known to be subject to local colonisation or desertion with no apparent change in habitat (Cramp & Perrins 1994).

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