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Brief report

Habitat use by Moltoni's Warbler *Sylvia cantillans moltonii* in Italy

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Moltoni's Warbler *Sylvia cantillans moltonii* is a poorly studied bird endemic to a restricted area in the central-western Mediterranean. We analysed selection of different vegetation structural types by Moltoni's Warblers for singing and foraging in two hilly areas in the northern Apennines (Italy) with low-intensity farming. We related habitat use by the species to 13 habitat categories, defined mainly on the basis of vegetation structure, accounting for vegetation height and presence of broadleaved and/or coniferous plants. We assessed significant differences in the use of habitat categories with respect to their availability, analysing singing and foraging data separately. The most selected categories included medium (1.5–3 m) and/or low (<1.5 m) shrubs. A shift in habitat use according to the different behaviours was quite evident: singing males showed a tendency toward using higher vegetation, while foraging birds relied mainly on lower layers. Additionally, our study highlights the importance of marginal features such as shrub patches in agricultural systems to allow the presence of non-grassland birds in farmland landscapes.

1. Introduction

Sylvia warblers are one of the most representative bird genera for the Western Palearctic and in particular for the Mediterranean region, where several species are endemic (Blondel *et al.* 1996, Shirihai *et al.* 2001). The Subalpine Warbler *Sylvia cantillans* is strictly a Mediterranean bird and a little studied member of its genus (as often occurs with Mediterranean birds: see Bautista & Pantoja 2000, Moreno 2004). The Moltoni's Warbler *Sylvia* (*cantillans*) *moltonii* is a well-differentiated race of *S. cantillans*, and endemic to a restricted area in the central-western Mediterranean (Gargallo 1994, Shirihai *et al.* 2001, Brambilla *et al.* 2006). This race has been very poorly studied. Virtually the only studies that deal with the ecology of Moltoni's Warblers were carried out in Mediterra-

nean islands such as Corsica and Sardinia (e.g. Cody & Walter 1976, Martin & Thibault 1996), but they focused on a guild of *Sylvia* species, often including only a few individuals of Subalpine Warbler (e.g. Martin & Thibault 1996).

Moltoni's Warblers have only recently been shown to breed in mainland Italy (Festari *et al.* 2002), but are very abundant in some central and northern Italian regions (Brambilla *et al.* 2006). Therefore, we study the habitat use of this race in central-northern mainland Italy, where it is a widespread (but poorly studied) breeder. Here, we analyse the selection of different vegetation assemblages for singing and foraging. We study Moltoni's Warblers in a low-intensity agricultural landscape, a particular habitat where the ecology of Mediterranean warblers has received little investigation. Given the peculiar ecology of the genus *Sylvia* (and especially of the Mediterranean species) we expect the occurrence of this species to be linked to shrub patches (Cramp 1992, Shirihai *et al.* 2001).

However, the importance of vegetation height or composition (coniferous and/or broadleaved plants) has – to our knowledge – not been studied before, especially for non-insular populations. We here relate the habitat use of Moltoni's Warblers to vegetation structure, aiming at identifying the height and composition of plant assemblages selected by the species.

2. Material and methods

The study was carried out in the northern Apennines, in the river Trebbia valley (Emilia-Romagna, province of Piacenza, 44°54'N–09°34'E), roughly at the northern boundary of the Mediterranean regions. In spring 2004, eight study plots were located in a gently-sloping mountainside, covered by small-sized fields (mainly *Medicago sativa*), meadows, pastures, shrubland (including *Rosa* spp., *Crataegus* spp., *Juniperus* spp., *Salix* spp. and young *Quercus* spp., *Fraxinus* spp. and *Pinus* spp.), woodland (mainly natural woodland of *Quercus* spp. and plantations of *Pinus* spp.) and rocky habitats, with elevation ranges between 350 and 700 m a.s.l. The different habitats are interspersed with each other, and the landscape is commonly dominated by small cultivated fields, flanked by broadleaved natural or semi-natural woodlands or coniferous plantations, with small calanques (areas with sandy or rocky soil strongly subjected to erosion) and some abandoned fields and pastures progressively covered by shrubs and trees. The eight sample areas (264 ha in total) were scattered on the mountainside in order to cover all the major types of habitats potentially suitable for the species. In the successive spring (2005), we worked in a second area of 71.8 ha, located in another portion of the Trebbia valley; we selected a more northerly site with a very different landscape, more rugged, with more conifers and fewer broadleaved plants with respect to the first area, without cultivated fields, and with more calanques and abandoned pastures.

Each sample plot was surveyed four times, twice in early (5.30–9.00) and twice in late morning (9.00–12.30). We reported on very detailed maps (approximate scale 1:1,000) derived from aerial photographs (1:2,000) the position and behaviour of all the Moltoni's Warblers we contacted (bird mapping). We estimated the number of territories from simultaneous contacts between neighbouring pairs. Subsequent contacts with the same bird were considered as different records; it should be noted that an analysis carried out on a data subset including only the first record of each sequence provided qualitatively nearly identical results (details not shown), as found also by Martin & Thibault (1996). Moreover, our observation sequences were very short (the mean number of contacts per territory in a single mapping session was only 1.86) because of the different field methods, further lowering the risk of biases due to non-independent observations.

We also recorded on the maps the extent of 13 habitat categories, which were identified mainly on the basis of vegetation structure; such categories accounted for vegetation height and presence of broadleaved and/or coniferous plants, while all the herbaceous vegetation, including cultivated fields, grasslands and meadows, were grouped into a single category (see Table 1 for variables definition). The maps we obtained were then digitized and uploaded into a Geographic Information System (GIS); each warbler record was therefore associated with a given habitat category.

We studied the selection of different habitat categories with the use of contingency tables to as-

Table 1. Definition of habitat categories adopted in the study of habitat use by Moltoni's Warblers. Height categories of non-herbaceous plants are defined as "high" (> 3 m), "medium" (between 1.5 and 3 m), and "low" (< 1.5 m).

Acronym	Definition	Description
ALL	All mixed height	Plant species of all height classes: young or open woodlands
TM	Tall and medium	High and medium plants: mainly woodland
TL	Tall and low	High and low plants: managed woodland
MLMIX	Mixed	Shrubland comprising both coniferous and broadleaved plants (low to medium height)
MLBRO	Broadleaved	Shrubland of broadleaved plants of medium and low height
MLCOG	Coniferous and *Genista*	Shrubland comprising coniferous and/or *Genista* spp. (low to medium height)
T	Tall plants	High plants: trees
M	Medium plants	Plants of medium height: mainly young plantations
LMIX	Low mixed shrubs	Low shrubland consisting of mixed broadleaved and coniferous plants
LBRO	Low broadleaved shrubs	Low shrubland consisting of broadleaved plants
LCON	Low coniferous shrubs	Low shrubland consisting of conifers
BARE	Areas without vegetation cover	Rocky and sandy soils and other areas without vegetation
GRASS	Grasslands, pastures and fields	Herbaceous, semi-natural, mainly managed for agriculture

sess significant differences in the use of habitat types with respect to their availability (cf. Martin & Thibault 1996). We considered all the records we collected and a measure of habitat availability by randomly scattering 1,138 random points through a GIS procedure over the two areas (833 in the first and 305 in the second, which was approximately 1.2 times the number of contacts collected per area). In this way, non-random use of habitat categories should be pointed out by different frequencies of records and random points among vegetation types.

In order to identify significant selection or avoidance of different habitat categories as revealed by the respective observation and random point frequencies, we analysed their adjusted residuals. Assuming that the variables forming the tables are independent, residuals are approximately normally distributed with mean 0 and standard deviation 1. Statistical significance at the 5% (or at the 1%) level of residuals values can then be estimated by comparing their values with the 5% (1%) standard normal deviate, equal to 1.96 (2.58) (Everitt 1977, Martin & Thibault 1996, Fowler & Cohen 2002). Overall statistical significance of differences in habitat use among vegetation types was assessed by means of a χ^2 test (likelihood-ratio χ^2; see Brambilla *et al.* 2004; test carried out without low-frequencies categories, so that no cells have expected counts less than 5).

In order to discrimate between vegetation use for singing and for other behaviors (mainly foraging; hereafter referred to as foraging, which was the behavior involved in most of these cases), after considering all the records together, we analysed singing and foraging records separately.

Finally, to assess if the differences in habitat use performed by singing and foraging individuals (see Results) were statistically significant, we directly compared the two categories of records, according to the same method (see above).

3. Results

We collected 960 Moltoni's Warbler records (696 from the first and 264 from the second study area/season; 448 records of singing birds and 512 of foraging individuals), obtained from an estimated 129 territories (97 in the first study area/season and 32 in the second), corresponding to an overall breeding density of 3.84 pairs/10 ha.

Patterns of habitat use are summarized in Table 2. Overall, out of 13 measured categories, 5 were selected and one (grasslands) avoided; in detail, 6 were selected and 2 avoided by singing birds,

Table 2. Pattern of overall, singing and foraging habitat use for Moltoni's Warblers. See Table 1 for the coding of habitat variables. Missing values are coded as "m.v.", and all χ^2 tests were carried out after removing cells with expected frequencies lower than 5.

Acronym	All records (residuals)	Singing (residuals)	Foraging (residuals)	Interpretation
ALL	309 (+7.6)	155 (+7.1)	154 (+5.5)	always selected
TM	12 (+2.1)	8 (+2.7)	4 (+0.9)	selected for singing
TL	17 (–0.6)	10 (+0.2)	7 (–1.0)	
MLMIX	199 (+3.5)	92 (+2.7)	107 (+3.0)	always selected
MLBRO	134 (+7.6)	59 (+6.1)	75 (+7.2)	always selected
MLCOG	4 (–0.6)	2 (–0.4)	2 (–0.6)	
T	54 (+1.5)	30 (+2.1)	24 (+0.4)	selected for singing
M	2 (+0.7)	m.v.	2 (+1.3)	
LMIX	37 (–0.3)	18 (–0.1)	19 (–0.4)	
LBRO	79 (+1.4)	28 (–0.3)	51 (+2.3)	selected for foraging
LCON	18 (+3.7)	5 (+2.2)	13 (+4.4)	always selected
BARE	13 (–1.0)	2 (–2.2)	11 (+0.3)	avoided for singing
GRASS	82 (–17.4)	39 (–12.8)	43 (–13.7)	always avoided
Likelihood ratio χ^2	380.91 (d.f. = 10, p < 0.001)	224.08 (d.f. = 8, p < 0.001)	240.08 (d.f. = 8, p < 0.001)	
N Tot	960	448	512	

while foraging individuals selected 5 categories (of which 4 were selected also by singing males) and avoided one other (see Table 2).

For singing males, a shift towards higher vegetation was evident. Singing warblers selected habitat categories including high or medium plants (with the exception of low coniferous shrubs) and avoided grasslands and bare soil (the latter was not truly avoided by foraging birds).

When dealing with foraging behavior, a shift towards lower vegetation layers was observed. All the selected categories included (exclusively or not) low shrubs. Grasslands were still avoided.

The comparison between singing and foraging records revealed a general different pattern of habitat use (Likelihood ratio $\chi^2 = 19.14$, d.f. = 10, p = 0.039), and subtler differences in the selection of single habitat categories, with adjusted residuals pointing out a higher frequency of foraging birds in low broadleaved shrubs (+2.1) and bare ground (+2.3) with respect to singing males.

4. Discussion

A shift in habitat use according to the different behaviors considered here emerged from our results. Some habitat categories were always subjected to selection or avoidance. All-height patches, medium and low mixed shrubs, medium and low broadleaved shrubs and low coniferous shrubs were preferred according to all analyses, while grasslands were always avoided. Probably, these vegetation types are the main determinant of habitat exploitation by Moltoni's Warbler.

Even though Cramp (1992) reported singing from low cover as being usual, Subalpine Warblers very often sing from trees or the top of tall shrubs (Shirihai *et al.* 2001). We here find this latter behaviour reflected in the habitat choice of singing Moltoni's Warblers, which was mainly associated with categories comprising high and/or medium plants, including tall and tall and medium vegetation, which were not used either for foraging (see Table 2) or nesting, both in this (authors, unpubl. data) and in other areas (Shirihai *et al.* 2001).

Foraging warblers mainly select lower vegetation. All the habitat categories selected included low shrubs, and low broadleaved shrubs were not selected for singing but actively sought out for foraging. Grasslands were still avoided, as typically reported for *Sylvia* warblers (Cramp 1992). Our results are consistent with some previous findings (Cody & Walter 1976), which reported low or medium vegetation as the main foraging habitat for

Subalpine Warbler. In contrast, other studies describe the species as feeding almost exclusively in higher layers or in the tree canopy (Blondel 1969, Zbinden & Blondel 1981). Note that the report of Cody & Walter (1976) referred to Moltoni's Warbler, while the other cited work considers the nominate race. This difference in (sub)species could contribute to (along with regional differences) the observed difference in habitat use. However, according to Martin & Thibault (1996), Moltoni's Warblers selected vegetation higher than 1.5 m (on Spargi, Sardinia) or than 2 m (on Scandola, Corse) and avoided the lowest layers, preferring the higher portions of matorral. Nevertheless, these authors lumped all plants above 2 meters into a single category, and so detailed comparisons with our results are difficult. More important, they did not compare selected with unselected vegetation, but with that selected by the other species. Moreover, their work was carried out in island habitats in typical Mediterranean scrub, hosting also other Mediterranean *Sylvia* species, while our study referred to a very different agricultural landscape in mainland areas, where Moltoni's Warbler is the only abundant 'matorral' species.

Our study further highlights the importance of shrub patches in agricultural systems (see also Brambilla *et al.* 2007) to allow the presence of non-grassland birds in farmland landscapes. Therefore, the maintenance of suitable shrub patches should be promoted for the conservation of this endemic taxon and of several other European birds of conservation importance (see also Tucker & Evans 1997).

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Rusorintakertun maastonkäyttö laulannan ja ruokailun yhteydessä

Rusorintakertun (*Sylvia cantillans moltonii*) maastonkäyttöä ruokailun ja laulannan yhteydessä tutkittiin kevyesti viljellyillä alueilla Pohjois-Apenniineilla Italiassa. Maasto jaettiin 13 kategoriaan pääasiassa kasvillisuuden rakenteen mukaan huomioiden kasvillisuuden korkeus ja lehti-/havupuuvaltaisuus alueella. Rusorintakertut suosivat selvästi tiettyjä maastotyyppejä ruokaillessaan ja toisia laulaessaan. Kaikkein suosituimpia maastotyyppejä olivat pusikkoiset alueet, joilla kasvillisuuden korkeus oli joko 1.5 m–3 m tai < 1.5 m. Laulavat koiraat suosivat korkeampia pusikoita laulantapaikkoinaan, kun taas ruokailevat yksilöt pysyttelivät matalamman kasvillisuuden seassa. Tutkimuksemme alleviivaa pienimuotoisuuden, kuten pensaiden ym. kasvillisuuslaikkujen tärkeyttä maatalousympäristöjen lintulajeille.

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