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Breeding bird community of the Montagne della Duchessa (Latium, central Italy)

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Abstract – During 2014 spring we studied the breeding bird community of 'Montagne della Duchessa' Regional Nature Reserve (Latium, Italy). In the study area (5870 ha; altitude range: 800-2239 m a.s.l.) we performed 127 point counts (10 min long) among four macro-habitat types (arable crop, oak wood, beech wood, bushes and alpine meadow) distributed proportionally to their respective area. We found 88 breeding species (79 detected during point counts). Most abundant species were: *Erithacus rubecula*, *Sylvia atricapilla* and *Corvus cornix*. Most widespread species were *Erithacus rubecula*, *Fringilla coelebs*, *Sylvia atricapilla*, *Turdus merula*, *Phylloscopus collybita* and *Cyanistes caeruleus*. In arable crops we detected a total of 54 species (*Passer italiae*, *Sturnus vulgaris*, *Corvus cornix* and *Passer montanus* the most abundant); in oak woods 34 species (*Erithacus rubecula*, *Turdus merula*, *Cyanistes caeruleus*, *Sylvia atricapilla*, *Parus major*, *Phylloscopus collybita*, *Poecile palustris* and *Fringilla coelebs* the most abundant); in beech woods 37 species (*Erithacus rubecula*, *Fringilla coelebs*, *Sylvia atricapilla*, *Poecile palustris*, *Cyanistes caeruleus*, *Sitta europaea* and *Phylloscopus collybita* the most abundant); in bushes and alpine meadows 33 species (*Oenanthe oenanthe*, *Anthus spinoletta*, *Alauda arvensis*, *Carduelis cannabina* and *Anthus campestris* the most abundant). In bushes and alpine meadows Richness, Abundance and Diversity were lowest. The collected data showed the important role of this Protected Area for some species of conservation concern.

Key-words: birds community, richness, abundance, dominance, diversity, evenness, central Italy.

INTRODUCTION

The present contribution was carried out for a wider project aimed at the realization of the Atlas of breeding birds in the Montagne della Duchessa Regional Nature Reserve and surrounding areas. Bird atlases are an useful tool to obtain data on distribution and local ecology of the species (e.g. Sutherland *et al.* 2004, Devictor & Robert 2009, Sorace & Gustin 2010, Belmaker *et al.* 2012). Therefore, several regional protected areas have accomplished or undertaken similar projects (Taffon *et al*. 2008, De Santis *et al*. 2009, Ukmar *et al*. 2009, Papi *et al*. 2010, Battisti & Guidi 2012, Quatrini *et al*. 2012).

The management of a natural protected area needs basic cognitive tools that on one side can help to address the planning of the activities and on the other side can constitute the elements of successive monitoring to assess the effectiveness of the conservation and management actions that were previously undertaken (Primack & Carotenuto 2003, Apollonio *et al*. 2004).

Besides its role as management tool, this work, represents also an important contribution to the knowledge of the breeding avifauna in this area of central Apennines. Excluding the information at regional scale of the recent Atlas of Latium breeding birds (Brunelli *et al*. 2011), studies on local birds are scarce, often dated or focused on single bird group or species (Rossi 1947, Di Carlo 1980, Spinetti 1997, Allavena *et al*. 1999, Allavena & Panella 2000, D.R.E.AM. Italia 2003, AA.VV. 2004, Bernoni *et al*. 2009, Sorace *et al*. 2011). In addition, few investigations deal with composition and structure of breeding bird communities of massifs and mountain chains of central and southern Italy, often referring to a single environment (De Filippo & Kalby 1985, De Filippo *et al*. 1985, Mingozzi 1994, Brandmayr *et al*. 1996, Vuerich *et al*. 2006, Fulco & Tellini Florenzano 2008, Mancinelli *et al*. 2009, Battisti *et al*. 2010, Sorace 2011, Strinella *et al*. 2011).

STUDY AREA

The study area, placed in the Borgorose district (RI) in the eastern Latium at the border of Abruzzo region (Fig. 1), extends over about 5870 ha including 3547 ha inside

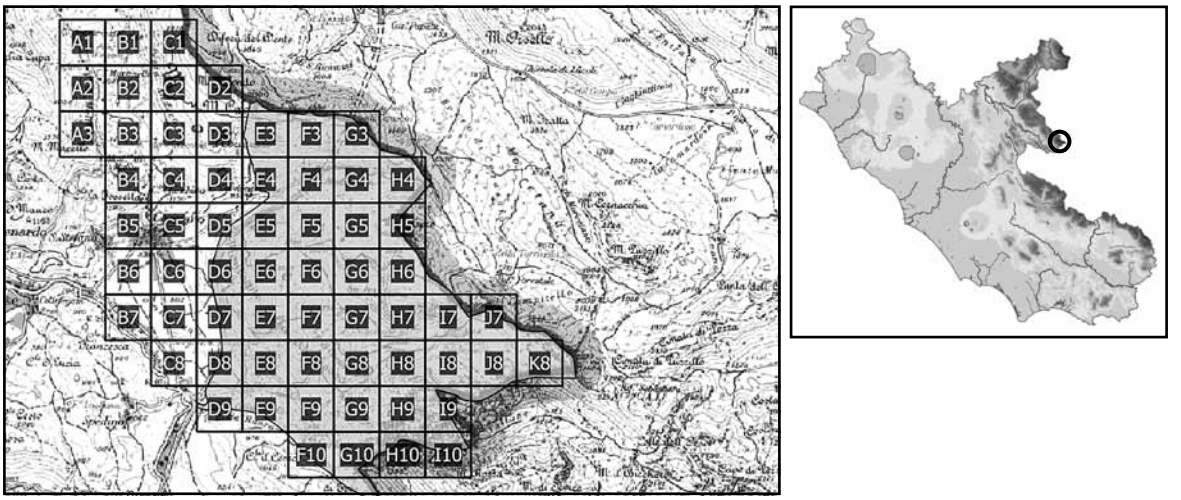

Figure 1. Study area with the overlapped 1-km square grid. In grey, the Regional Nature Reserve "Montagne della Duchessa".

the Montagne della Duchessa Regional Nature Reserve and 2323 ha in the adjoining areas with higher naturalistic value, in particular the Corvaro plain and the slopes of Cava Mountain towards Malito Valley. Altitude ranges between 800 m a.s.l. of Corvaro plain and 2239 m of Costone Mountain.

Due to the presence of species and habitat of European Community interest, Montagne della Duchessa district includes three sites of Natura 2000 network: two SCI, instituted according to Habitat Directive (92/43/CEE), named "Monti della Duchessa (area sommitale)" (IT6020020) and "Monte Duchessa-Vallone Cieco e Bosco Cartore" (IT 6020021); the two SCI are included in ZSP "Riserva Naturale Montagne della Duchessa" (IT3020046), established according to Birds Directive (2009/147/CEE) and overlapping with the Nature Reserve that was instituted by Latium Regional Law in 1990. The nearby areas of Cava Mountain, Malito Valley and Corvaro plain are not protected.

At the lower altitude (800-1100 m a.s.l.) the vegetation of study area is characterized by the presence of farmland and meadows/pastures, in particular in Corvaro plain and, partially, in Ruara Valley and Malito Valley, and by large areas covered by bushes (mainly with *Rosa canina*, *Prunus spinosa*, *Cornus mas*) and oak woods (with *Quercus cerris* and *Quercus pubescens* dominants). Moreover, wide chestnut groves with *Castanea sativa* are present in Malito Valley while *Salix alba* e *Populus nigra* are common along Apa stream. At the higher altitude (1200-1900 m) oak woods are gradually replaced by mixed woods with *Fagus sylvatica*. Pure beech woods prevail between 1500 and 1800 m and above them extensive bushes with *Juniperus communis* alternate with alpine xeric meadows (for a more detailed description of the study area see Russo *et al*. 2010).

METHODS

In order to make the investigation replicable for future monitoring and to obtain representative data, we used a standardized methodology widely experimented in analogous ornithological investigations (see Fornasari *et al*. 2010). We overlapped a 1-km square grid, originated from UTM coordinate system, on the map of the study area obtaining 63 recording units (RU) identified by an univocal alpha-numeric denomination (Fig. 1).

We investigated the structure of breeding bird communities by means of point count method (Blondel *et al*. 1970, Bibby *et al*. 2000, Fornasari *et al*. 2010). Individuals of more rare or less detectable species might be not sampled with this method, nevertheless collected data with point counts can well describe bird communities, characterizing their variation throughout the environmental mosaic (Sutherland et al. 2004, Battisti et al. 2010).

We carried out 127 point counts, not less than two per each of the 63 RU, spaced at least 200 m apart. Point counts were located by means of stratifying sampling using the Software Quantum Gis 2.2 and the CORINE Land Cover categories (Regione Lazio 2010). We selected four main habitat types:

- arable crops (23 point counts);
- oak wood (22 point counts);
- beech wood (46 point counts);
- bushes and alpine meadow (36 point counts).

Some scarcely represented habitats, such as urban areas (continuous and discontinuous urban fabric, road network, etc) and chestnut groves, were incorporated with the main four habitats. When a point count was not achievable, due to the uneven morphology of the study area, it was replaced by a new point in the same habitat and RU.

In 2014 breeding season, each point count (10-min long), was double visited recording the species of all birds identifiable by sight or song inside and outside a 100-m radius from the observer. The first visit was carried out between 15 March and 18 May, the second one between 20 May and 1 July; time lag between two visits in each point count was at least 35 days. One point was assigned to each recorded individual. For each species, the maximum score obtained between the two visits was considered the number of individuals present per point count.

To characterize the structure of breeding bird communities, we calculated the following parameters:

- Richness (S): total number of recorded species;
- Richness mean (Smean): mean number of recorded species per point count;
- Abundance (A): mean number of individuals per point count;
- Dominance (p_i): where pi is the relative frequency of each species; species with $p_i \geq 0.050$ and $p_i \geq 0.020$ were considered respectively dominant and subdominant (Turcek 1956);
- Diversity (H): $H = - Sp_i \ln p_i$ (Shannon & Weaver 1963);
- Evenness (J): $J = H/\ln S$ (Lloyd & Ghelardi 1964, Pielou 1966);
- Non-Passeriformes percentage (Ferry & Frochot 1970).

To analyze data concerning the community parameters and the frequencies of species in the whole study area, we summed data collected in each point count both inside and outside the 100-m radius from the observer. In the analysis in which bird communities of different habitats were separately considered, only data collected inside the 100-m radius were taken into account.

Since data considered in statistical analysis were not normally distributed (Kolmogorov-Smirnov test), we used non-parametric tests: the non-Passeriformes percentages were compared with χ^2 test; the differences of Richness e Abundance values per point count among the four habitats were evaluated by means of Kruskal-Wallis ANOVA rank Test with Mann-Whitney U Test for pairwise comparisons; the differences of Dominance of recorded species among the four habitats were tested by means of Friedman test with Wilcoxon test for pairwise comparisons.

Besides collected data with point counts, we carried out some not standardized field researches to obtain information about less detectable breeding species. We did not take into account the information collected for these species in the computation of the community parameters.

RESULTS

On the whole we recorded 88 breeding species, including 23 non Passerines (26.1%) and 65 Passerines (73.9%); 79 out of 88 species were observed with the 127 point counts, including 20 non Passerines (25.3%) and 59 Passerines (74.7%) (Tab. 1). The dominant species resulted in decreasing order *Erithacus rubecula*, *Sylvia atricapilla* and *Corvus cornix*; 17 were the subdominant species (Tab. 1). The most widespread species in the study area, i.e. recorded at least in 50% of point counts, resulted in decreasing order *Erithacus rubecula*, *Fringilla coelebs*, *Sylvia atricapilla*, *Turdus merula*, *Phylloscopus collybita* and *Cyanistes caeruleus* (Tab. 1).

In Table 2 the values of breeding bird community parameters of the study area are shown.

In Table 3, data on Abundance and Dominance of the 73 species recorded inside the 100-m radius in the four habitat types are reported (see Methods).

In the arable crops we observed 54 species, among them *Passer italiae*, *Sturnus vulgaris*, *Corvus cornix* and *Passer montanus*, species typical of man-made environments, resulted dominant. Other ten species were subdominant, including mainly ecotonal species, but also *Pica pica*, *Galerida cristata* and *Emberiza calandra*, which are linked to agricultural environments.

In the oak wood we found 34 species, among them *Erithacus rubecula*, *Turdus merula*, *Cyanistes caeruleus*, *Sylvia atricapilla*, *Parus major*, *Phylloscopus collybita*, *Poecile palustris* and *Fringilla coelebs* resulted dominant in decreasing order. These eight species are typical of not particularly old forests. Species exclusive of this habitat were not observed.

In the beech wood we recorded 37 species, among them *Erithacus rubecula, Fringilla coelebs*, *Sylvia atricapilla*, *Poecile palustris*, *Cyanistes caeruleus*, *Sitta europaea* and *Phylloscopus collybita* resulted dominant. Four species were only found in this habitat: *Emberiza cia* (in edge zone), *Phylloscopus sibilatrix*, *Certhia familiaris* and *Ficedula albicollis*. The recording of the last three species and the observations of three Picidae species indicate the availability of mature wood sectors.

In bushes and alpine meadows we found 33 species, among them *Oenanthe oenanthe*, *Anthus spinoletta*, *Alauda arvensis*, *Carduelis cannabina* and *Anthus campestris*, typical of open habitats, were dominant in decreas-

Table 1. Number of point counts in which each species has been detected and mean number of individuals per point count (± SD) in spring 2014. In bold, dominant species (pi > 0.05); in italic, sub-dominant species (pi > 0.02). Threat categories are evaluated on the basis of Bird Directive Annex I (2009/147/CEE), SPEC classification (BirdLife International 2004), National Red List (Peronace *et al.* 2012) and Regional Red List (Calvario *et al*. 2011) categories. Specie marked with * were found only outside point counts.

Species	Occupied points		Ind./point counts			Bird Directive	SPEC	National Red List	Regional Red List
	N	%	Mean	SD	pi				
Anas platyrhynchos	1	0.79	0.024	0.266	0.001		Non-SPEC	LC	
Alectoris graeca *	-	-	-	-	-	I	SPEC2	VU	VU
Coturnix coturnix	2	1.57	0.016	0.125	0.001	II B	SPEC3	DD	
Pernis apivorus	2	1.57	0.016	0.125	0.001	I	Non-SPEC[E]	LC	VU
Gyps fulvus	13	10.24	0.417	1.725	0.018	I	Non-SPEC	CR	CR
Circaetus gallicus *	-	-	-	-	-	I	SPEC3	VU	EN
Accipiter nisus	2	1.57	0.016	0.125	0.001		Non-SPEC	LC	
Buteo buteo	15	11.81	0.181	0.583	0.008		Non-SPEC	LC	
Falco tinnunculus	12	9.45	0.094	0.294	0.004		SPEC3	LC	
Falco peregrinus	3	2.36	0.024	0.152	0.001	I	Non-SPEC	LC	NT
Columba livia f. domestica	2	1.57	0.016	0.125	0.001		Non-SPEC	-	
Columba palumbus	55	43.31	0.606	0.828	*0.026*	II A	Non-SPEC[E]	LC	
Streptopelia decaocto	1	0.79	0.016	0.177	0.001		Non-SPEC	LC	
Streptopelia turtur	5	3.94	0.039	0.195	0.002	II B	SPEC3	LC	
Cuculus canorus	41	32.28	0.378	0.603	0.016		Non-SPEC	LC	
Strix aluco	2	1.57	0.016	0.125	0.001		Non-SPEC[E]	LC	
Caprimulgus europaeus *	-	-	-	-	-	I	SPEC2	LC	DD
Apus apus	1	0.79	0.039	0.444	0.002		Non-SPEC	LC	
Upupa epops	7	5.51	0.063	0.275	0.003		SPEC3	LC	
Jynx torquilla	3	2.36	0.024	0.152	0.001		SPEC3	EN	
Picus viridis	37	29.13	0.339	0.567	0.015		SPEC2	LC	
Dendrocopos major	17	13.39	0.142	0.372	0.006		Non-SPEC	LC	
Dendrocopos minor	2	1.57	0.016	0.125	0.001		Non-SPEC	LC	DD
Galerida cristata	8	6.30	0.126	0.563	0.005		SPEC3	LC	
Lullula arborea	10	7.87	0.110	0.422	0.005	I	SPEC2	LC	
Alauda arvensis	32	25.20	0.866	3.105	*0.037*	II B	SPEC3	VU	
Ptyonoprogne rupestris *	-	-	-	-	-		Non-SPEC	LC	
Hirundo rustica	3	2.36	0.079	0.543	0.003		SPEC3	NT	
Delichon urbicum	6	4.72	0.205	1.197	0.009		SPEC3	NT	
Anthus campestris	16	12.60	0.228	0.657	0.010	I	SPEC3	LC	DD
Anthus trivialis	28	22.05	0.346	0.770	0.015		Non-SPEC	VU	
Anthus spinoletta	28	22.05	0.496	1.076	*0.021*		Non-SPEC	LC	
Motacilla cinerea	1	0.79	0.008	0.089	0		Non-SPEC	LC	
Motacilla alba	6	4.72	0.063	0.327	0.003		Non-SPEC	LC	
Troglodytes troglodytes	45	35.43	0.480	0.754	*0.021*		Non-SPEC	LC	
Prunella collaris *	-	-	-	-	-		Non-SPEC	LC	DD
Erithacus rubecula	84	66.14	1.646	1.551	**0.071**		Non-SPEC[E]	LC	
Luscinia megarhynchos	22	17.32	0.260	0.693	0.011		Non-SPEC[E]	LC	
Phoenicurus ochruros	13	10.24	0.142	0.483	0.006		Non-SPEC	LC	
Phoenicurus phoenicurus	9	7.09	0.110	0.422	0.005		SPEC2	LC	VU
Saxicola torquatus	7	5.51	0.071	0.313	0.003		Non-SPEC	VU	
Oenanthe oenanthe	29	22.83	0.567	1.288	*0.024*		SPEC3	NT	
Monticola saxatilis	5	3.94	0.047	0.247	0.002		SPEC3	VU	EN

continued

Species	Occupied points		Ind./point counts			Bird Directive	SPEC	National Red List	Regional Red List
	N	%	Mean	SD	pi				
Turdus merula	71	55.91	0.882	1.081	*0.038*	II B	Non-SPEC[E]	LC	
Turdus philomelos	9	7.09	0.094	0.366	0.004	II B	Non-SPEC[E]	LC	
Turdus viscivorus	27	21.26	0.260	0.580	0.011	II B	Non-SPEC[E]	LC	
Sylvia atricapilla	80	62.99	1.339	1.387	**0.058**		Non-SPEC[E]	LC	
Sylvia communis *	-	-	-	-	-		Non-SPEC[E]	LC	
Sylvia cantillans	4	3.15	0.039	0.232	0.002		Non-SPEC[E]	LC	
Phylloscopus bonelli	27	21.26	0.346	0.749	0.015		SPEC2	LC	
Phylloscopus sibilatrix	4	3.15	0.055	0.341	0.002		SPEC2	LC	
Phylloscopus collybita	69	54.33	0.921	1.066	*0.040*		Non-SPEC	LC	
Regulus ignicapilla	6	4.72	0.055	0.261	0.002		Non-SPEC[E]	LC	
Muscicapa striata *	-	-	-	-	-		SPEC3	LC	
Ficedula albicollis	2	1.57	0.024	0.198	0.001	I	Non-SPEC[E]	LC	
Aegithalos caudatus	13	10.24	0.189	0.880	0.008		Non-SPEC	LC	
Cyanistes caeruleus	65	51.18	0.787	1.005	*0.034*		Non-SPEC[E]	LC	
Parus major	62	48.82	0.795	1.079	*0.034*		Non-SPEC	LC	
Periparus ater	26	20.47	0.339	0.857	0.015		Non-SPEC	LC	
Poecile palustris	41	32.28	0.512	0.872	*0.022*		SPEC3	LC	
Sitta europaea	42	33.07	0.567	0.964	*0.024*		Non-SPEC	LC	
Tichodroma muraria *	-	-	-	-	-		Non-SPEC	LC	EN
Certhia familiaris	4	3.15	0.039	0.232	0.002		Non-SPEC	LC	NT
Certhia brachydactyla	7	5.51	0.071	0.313	0.003		Non-SPEC[E]	LC	
Oriolus oriolus	5	3.94	0.047	0.247	0.002		Non-SPEC	LC	
Lanius collurio	5	3.94	0.063	0.351	0.003	I	SPEC3	VU	
Garrulus glandarius	42	33.07	0.528	0.958	*0.023*	II B	Non-SPEC	LC	
Pica pica	13	10.24	0.276	1.152	0.012	II B	Non-SPEC	LC	
Pyrrhocorax pyrrhocorax	13	10.24	0.512	2.836	*0.022*	I	SPEC3	NT	VU
Corvus monedula	3	2.36	0.031	0.216	0.001	II B	Non-SPEC[E]	LC	
Corvus cornix	58	45.67	1.252	2.743	**0.054**		Non-SPEC	LC	
Corvus corax	9	7.09	0.126	0.577	0.005		Non-SPEC	LC	EN
Sturnus vulgaris	11	8.66	0.913	5.947	*0.039*	II B	SPEC3	LC	
Passer italiae	11	8.66	0.717	2.806	*0.031*		SPEC3	VU	
Passer montanus	7	5.51	0.268	1.950	0.012		SPEC3	VU	
Petronia petronia	3	2.36	0.079	0.586	0.003		Non-SPEC	LC	VU
Montifringilla nivalis *	-	-	-	-	-		Non-SPEC	LC	EN
Fringilla coelebs	84	66.14	1.142	1.207	*0.049*		Non-SPEC[E]	LC	
Serinus serinus	12	9.45	0.118	0.391	0.005		Non-SPEC[E]	LC	
Carduelis chloris	9	7.09	0.142	0.614	0.006		Non-SPEC[E]	NT	
Carduelis carduelis	9	7.09	0.102	0.415	0.004		Non-SPEC	NT	
Carduelis cannabina	31	24.41	0.480	1.075	*0.021*		SPEC2	NT	
Pyrrhula pyrrhula	22	17.32	0.197	0.455	0.008		Non-SPEC	VU	
Coccothraustes coccothraustes	1	0.79	0.008	0.089	0		Non-SPEC	LC	EN
Emberiza citrinella	4	3.15	0.031	0.175	0.001		Non-SPEC[E]	LC	
Emberiza cirlus	26	20.47	0.291	0.656	0.013		Non-SPEC[E]	LC	
Emberiza cia	2	1.57	0.016	0.125	0.001		SPEC3	LC	
Emberiza calandra	9	7.09	0.189	0.764	0.008		SPEC2	LC	

Table 2. Breeding bird community parameters: S = Richness, Smean = mean Richness per point count, A = Abundance, H = Diversity, J = Evenness, non Pass = % non-Passeriformes, N dom. = number of dominant species (see Methods).

	Point counts	S	Smean	A	H	J	non Pass.	N dom.
Montagne della Duchessa	127	79	11.99	23.2	3.77	0.86	24.1	3

ing order. The subdominant species were: *Phoenicurus ochruros* (other species characteristic of this habitat), *Anthus trivialis*, *Erithacus rubecula* and *Phylloscopus collybita*. The good abundance of the last three species suggests the influence of ecotonal areas and/or the presence of arboreal elements in this habitat.

The values of bird community parameters of the four habitat types highlight that in the arable crops Richness of species, mean Richness of species per point count, Abundance of individuals and Diversity index reach the highest values (Tab. 4). However, in this habitat the number of dominant species is minimum. The bushes and alpine meadows show the lowest values for all considered parameters. As far as forest environments are concerned, beech wood presents more species than oak wood, but less individuals and a lower value of non-Passeriformes percentage (Tab. 4).

Statistical analysis confirmed the majority of these results in particular the differences between alpine meadows/bushes and the other three habitats. The mean richness of species per point count was significantly different among the four habitats ($H_{3\text{-}127} = 52.3$, $P < 0.00001$). In particular the richness resulted significantly lower in the alpine meadows/bushes as compared to oak wood ($Z = 5.48$, $P < 0.00001$), beech wood ($Z = 5.33$, $P < 0.00001$) and arable crops ($Z = 6.11$, $P < 0.00001$). Other pairwise comparisons for this parameter were not significant. Abundance resulted significantly different among the four habitats ($H_{3\text{-}127} = 59.2$, $P < 0.00001$) in particular it was significantly lower in alpine meadows/bushes than in oak wood ($Z = 5.73$, $P < 0.00001$), beech wood ($Z = 4.40$, $P < 0.00006$) and arable crops ($Z = 6.92$, $P < 0.00001$); in addition it resulted lower in beech wood as compared to arable crops ($Z = 3.40$, $P < 0.004$). Other pairwise comparisons for this parameter were not significant.

The Dominance values were significantly different among the four habitats ($\chi^2_{3\text{-}73} = 8.96$, $P < 0.03$), as well as between arable crops and alpine meadows/bushes ($T = 675$, $P < 0.035$). Other pairwise comparisons for this parameter were not significant.

Non-Passeriformes percentage did not result significantly different among the four habitats and in pairwise comparisons.

DISCUSSION

Results highlight that Montagne della Duchessa Regional Nature Reserve and its surrounding areas present a breeding bird community characterized by values of diversity and richness of species among the highest recorded in Apennine regional areas (De Felici & Sorace 2011). This is likely due to the presence of large sectors of the reserve that show high nature conservation status and to the high level of habitat heterogeneity. However, it has to be noticed that local bird community is also clearly affected by environmental changes produced in the past by man; indeed generalist species, which are successful to settle down in environments modified by anthropogenic activities, are dominant and the most widespread in large parts of study area.

Data collected on environmental preferences of the species and, among them, those dominant in the four main habitat types of the study area, agree with the available information in literature for them (Brunelli *et al*. 2011) and with investigations carried out in other montane Apennine areas. In particular, as far as alpine meadows are concerned, it is interesting that the six species dominant in the breeding bird community of Campo Imperatore (Gran Sasso d'Italia, 33 km far away from the study area) included *Pyrrhocorax pyrrhocorax* and the same five species which were dominant in the present study (Strinella *et al*. 2011; for the Simbruini Mts. area, see Vuerich *et al*. 2006). The highest number of species observed in the arable crops has to be likely related to three factors: the availability of environmental enrichments (trees, bushes, buildings) inside this habitat; the patches have reduced surface leading to detect species living in the adjacent woods and bushes; arable crops are placed at the lowest altitude of the Reserve. The recording of a high richness of species in open habitats due to "edge effect" was also reported in other studies (Farina & Martelli 1979, Sorace 1996, Giraudo 2001, Farina 2003, Lorenzetti *et al*. 2004, Sorace 2011, Bernoni *et al*. 2012). Species richness and abundance of individuals tend to decrease with altitude (Begon *et al*. 1986, Sarrocco & Sorace 1997).

Without environmental enrichments and edge effect, breeding bird community of open habitats (meadows, pas-

Table 3. Mean number of individuals per point count (± SD) and dominance values in each habitat type. Dominant (pi > 0.05) and sub-dominant species (pi > 0.02) in bold and italic, respectively.

Species	Arable crops			Oak wood			Beech wood			Bushes and meadows		
	Mean	SD	pi	Mean	SD	pi	Mean	SD	pi	Mean	SD	pi
Coturnix coturnix	0.087	0.288	0.004	-	-	-	-	-	-	-	-	-
Pernis apivorus	-	-	-	0.045	0.213	0.003	-	-	-	-	-	-
Gyps fulvus	-	-	-	-	-	-	-	-	-	0.028	0.167	0.005
Accipiter nisus	0.043	0.209	0.002	-	-	-	0.022	0.147	0.002	-	-	-
Buteo buteo	-	-	-	0.091	0.294	0.006	0.109	0.482	0.010	-	-	-
Falco tinnunculus	0.087	0.288	0.004	-	-	-	-	-	-	0.028	0.167	0.005
Columba livia f. domestica	0.087	0.288	0.004	-	-	-	-	-	-	-	-	-
Columba palumbus	0.304	0.765	0.013	0.273	0.456	0.019	0.217	0.554	0.020	0.028	0.167	0.005
Streptopelia decaocto	0.087	0.417	0.004	-	-	-	-	-	-	-	-	-
Streptopelia turtur	-	-	-	0.045	0.213	0.003	-	-	-	-	-	-
Cuculus canorus	-	-	-	0.136	0.468	0.010	0.043	0.206	0.004	-	-	-
Apus apus	0.043	0.209	0.002	-	-	-	-	-	-	-	-	-
Jynx torquilla	0.087	0.288	0.004	-	-	-	-	-	-	-	-	-
Picus viridis	0.087	0.288	0.004	0.182	0.395	0.013	0.065	0.250	0.006	-	-	-
Dendrocopos major	0.130	0.344	0.006	0.136	0.351	0.010	0.065	0.327	0.006	-	-	-
Dendrocopos minor	0.043	0.209	0.002	-	-	-	0.022	0.147	0.002	-	-	-
Galerida cristata	0.478	0.947	*0.021*	-	-	-	-	-	-	-	-	-
Lullula arborea	0.087	0.417	0.004	-	-	-	-	-	-	0.028	0.167	0.005
Alauda arvensis	0.174	0.491	0.008	-	-	-	-	-	-	0.861	1.073	**0.142**
Hirundo rustica	0.304	1.105	0.013	-	-	-	-	-	-	-	-	-
Delichon urbicum	0.174	0.650	0.008	0.045	0.213	0.003	-	-	-	-	-	-
Anthus campestris	-	-	-	-	-	-	-	-	-	0.417	0.649	**0.068**
Anthus trivialis	-	-	-	0.045	0.213	0.003	0.109	0.315	0.010	0.167	0.447	*0.027*
Anthus spinoletta	-	-	-	-	-	-	-	-	-	0.889	0.854	**0.146**
Motacilla alba	0.174	0.388	0.008	-	-	-	-	-	-	0.056	0.232	0.009
Troglodytes troglodytes	0.130	0.458	0.006	0.227	0.429	0.016	0.543	0.657	*0.049*	0.083	0.28	0.014
Erithacus rubecula	1.000	1.206	*0.043*	1.955	0.950	**0.139**	1.630	0.853	**0.146**	0.139	0.487	*0.023*
Luscinia megarhynchos	0.478	0.593	*0.021*	0.091	0.294	0.006	-	-	-	0.083	0.368	0.014
Phoenicurus ochruros	0.087	0.288	0.004	-	-	-	0.022	0.147	0.002	0.194	0.467	*0.032*
Phoenicurus phoenicurus	0.348	0.647	0.015	0.045	0.213	0.003	0.065	0.327	0.006	-	-	-
Saxicola torquatus	0.087	0.288	0.004	-	-	-	-	-	-	0.083	0.368	0.014
Oenanthe oenanthe	-	-	-	-	-	-	-	-	-	1.167	1.028	**0.192**
Monticola saxatilis	-	-	-	-	-	-	-	-	-	0.083	0.368	0.014
Turdus merula	0.565	0.788	*0.025*	1.364	1.590	**0.097**	0.457	0.504	*0.041*	0.028	0.167	0.005
Turdus philomelos	0.043	0.209	0.002	-	-	-	0.022	0.147	0.002	-	-	-
Turdus viscivorus	-	-	-	0.045	0.213	0.003	0.239	0.480	*0.021*	-	-	-
Sylvia atricapilla	1.087	1.240	*0.047*	1.182	1.006	**0.084**	0.978	0.802	**0.088**	0.083	0.280	0.014
Sylvia cantillans	0.130	0.458	0.006	-	-	-	-	-	-	0.056	0.232	0.009
Phylloscopus bonelli	0.087	0.288	0.004	0.500	0.802	*0.035*	0.283	0.544	*0.025*	-	-	-
Phylloscopus sibilatrix	-	-	-	-	-	-	0.130	0.542	0.012	-	-	-
Phylloscopus collybita	0.261	0.541	0.011	0.909	0.868	**0.065**	0.674	0.790	**0.061**	0.167	0.447	*0.027*
Regulus ignicapilla	-	-	-	0.182	0.501	0.013	0.065	0.250	0.006	-	-	-
Ficedula albicollis	-	-	-	-	-	-	0.043	0.206	0.004	-	-	-
Aegithalos caudatus	0.087	0.288	0.004	0.318	0.568	*0.023*	0.109	0.434	0.010	-	-	-
Cyanistes caeruleus	0.739	0.964	*0.032*	1.273	1.032	**0.090**	0.717	0.750	**0.064**	0.111	0.398	0.018
Parus major	0.913	1.083	*0.040*	1.091	1.192	**0.077**	0.522	0.752	*0.047*	0.028	0.167	0.005

continued

Species	Arable crops			Oak wood			Beech wood			Bushes and meadows		
	Mean	SD	pi	Mean	SD	pi	Mean	SD	pi	Mean	SD	pi
Periparus ater	0.217	0.736	0.009	0.136	0.468	0.010	0.543	1.048	*0.049*	0.028	0.167	0.005
Poecile palustris	0.261	0.689	0.011	0.864	1.167	**0.061**	0.804	0.885	**0.072**	-	-	-
Sitta europaea	0.304	0.635	0.013	0.682	1.129	*0.048*	0.717	0.911	**0.064**	-	-	-
Certhia familiaris	-	-	-	-	-	-	0.087	0.285	0.008	-	-	-
Certhia brachydactyla	0.087	0.288	0.004	0.045	0.213	0.003	0.065	0.327	0.006	-	-	-
Oriolus oriolus	0.043	0.209	0.002	0.045	0.213	0.003	-	-	-	-	-	-
Lanius collurio	0.174	0.491	0.008	-	-	-	-	-	-	0.028	0.167	0.005
Garrulus glandarius	0.478	0.994	*0.021*	0.636	0.902	*0.045*	0.261	0.612	*0.023*	0.028	0.167	0.005
Pica pica	0.696	1.295	*0.030*	-	-	-	-	-	-	-	-	-
Pyrrhocorax pyrrhocorax	-	-	-	-	-	-	-	-	-	0.056	0.232	0.009
Corvus monedula	0.130	0.458	0.006	-	-	-	-	-	-	-	-	-
Corvus cornix	1.478	2.391	**0.064**	0.227	0.685	0.016	0.022	0.147	0.002	0.056	0.232	0.009
Corvus corax	-	-	-	-	-	-	-	-	-	0.111	0.523	0.018
Sturnus vulgaris	3.087	8.404	**0.134**	-	-	-	-	-	-	-	-	-
Passer italiae	3.391	5.168	**0.147**	-	-	-	-	-	-	-	-	-
Passer montanus	1.435	4.470	**0.062**	-	-	-	-	-	-	-	-	-
Petronia petronia	0.174	0.576	0.008	-	-	-	-	-	-	-	-	-
Fringilla coelebs	0.304	0.559	0.013	0.727	0.935	**0.052**	1.022	1.064	**0.092**	0.111	0.398	0.018
Serinus serinus	0.304	0.635	0.013	-	-	-	-	-	-	0.056	0.232	0.009
Carduelis chloris	0.304	0.876	0.013	-	-	-	0.043	0.295	0.004	-	-	-
Carduelis carduelis	0.348	0.714	0.015	0.091	0.294	0.006	-	-	-	0.028	0.167	0.005
Carduelis cannabina	0.348	0.935	0.015	0.136	0.351	0.010	-	-	-	0.722	1.446	**0.119**
Pyrrhula pyrrhula	-	-	-	0.182	0.395	0.013	0.304	0.511	*0.027*	-	-	-
Emberiza citrinella	0.043	0.209	0.002	-	-	-	0.043	0.206	0.004	-	-	-
Emberiza cirlus	0.304	0.559	0.013	0.136	0.351	0.010	0.022	0.147	0.002	0.056	0.232	0.009
Emberiza cia	-	-	-	-	-	-	0.043	0.206	0.004	-	-	-
Emberiza calandra	0.522	0.846	*0.023*	-	-	-	-	-	-	-	-	-

tures, bushes) are usually characterized by a low number of species and individuals, with few dominant species yielding to low values of Diversity and Evenness indices (Farina 1982, Sorace 1996; for the negative relation between degree of vegetation cover and Evenness, see for example Symonds & Johnson 2008). Conversely, non-Passeriformes percentage usually increases in the ecological succession toward climax community (Ferry & Frochot 1970).

Regarding species of conservation interest, the Montagne della Duchessa Reserve may play a role of great importance for *Alectoris graeca* and *Gyps fulvus*. In this area, the former species achieves density values among the highest of Apennines (Sorace *et al*. 2011, 2013); the latter is present with a colony of 10 breeding pairs, that established following a reintroduction project started in 1994 (Allavena & Panella 2000, Allavena 2012).

In spite of its reduced surface, the study area has a great value at regional scale, since some of the most localized species are breeding inside it. In fact, besides the two above quoted species, *Tichodroma muraria*, *Pyrrhocorax pyrrhocorax*, *Petronia petronia*, *Montifringilla nivalis* and *Coccothraustes coccothraustes* are found (Brunelli *et al*. 2011).

In order to protect local species of conservation concern (see Tab. 1) in a more effective manner, an enlargement of Montagne della Duchessa Regional Nature Reserve would be appropriate. In particular the inclusion of the whole massif of Cava Mountain should benefit, for example, species such as *Alectoris graeca* and *Anthus campestris* as well as *Aquila chrysaetos* that nests in areas very proximate to the study area and regularly uses alpine meadows of the massif for feeding activities. Moreover, the insertion of Corvaro plain should favour species such as *Lullula arborea*, *Anthus campestris* and *Lanius collurio* as well as *Pyrrhocorax pyrrhocorax*, that feeds in this area during the winter period.

Table 4. Breeding bird community parameters for each habitat type: S = Richness, Smean = Mean Richness per point count, A = Abundance, H = Diversity, J = Evenness, non Pass = % non-Passeriformes; N dom. = number of dominant species (see Methods).

Habitat	Point counts	S	Smean	A	H	J	non Pass.	N dom.
Arable crops	23	54	10.65	22.96	3.31	0.83	20.37	4
Oak wood	22	34	9.36	14.09	2.96	0.84	20.59	8
Beech wood	46	37	8.20	11.13	2.99	0.83	18.92	7
Bushes and Meadows	36	33	4.22	6.08	2.72	0.78	9.10	5

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