Journal of Mediterranean Ecology **vol. 4, No.2, 2003: 5-21**

Patterns of landbird species composition in Italy: A chorological approach focusing on trends and contra-trends along the peninsula

Corrado Battisti (*), Anna Testi (**)

(*) Provincia di Roma – Servizio Pianificazione ambientale, sviluppo parchi, riserve naturali - Via Tiburtina 691, I – 00159 Rome, Italy. (cbattisti@inwind.it)
(**) Orto Botanico di Roma, Dipartimento di Biologia delle Piante – Università degli Studi di Roma "La Sapienza", L.go Cristina di Svezia 24, I – 00165 Rome, Italy. (anna.testi@uniroma1.it)

Keywords: Chorology, Italy, landbirds, peninsula effect.

Abstract

The aim of this study was to analyse chorological patterns of breeding landbirds to find ecogeographical factors responsible for trends, contra-trends and discontinuities along the Italian peninsula. The study was conducted in continental (northern) and peninsular (central-southern) Italy. Italy was subdivided into 27 latitude bands from North to South. For each band, the proportions among the breeding landbird species belonging to different chorotypes was calculated and correlated with the latitude, the maximum altitude and the area of Mediterranean climate. The Cluster Analysis and the Correspondence Analysis performed on the chorotypes matrix showed a clear subdivision into two groups, *i.e.* the two main Italian bioclimatic regions (Eurosiberian and Mediterranean). Along the Italian peninsula, the proportion of northern chorotypes (Holarctic, Eurasiatic, Eurosiberian, Eurocentral-asiatic, European) was positively correlated with latitude and maximum altitude, and negatively with the area of Mediterranean climate. The southern chorotypes (Eastern-Palearctic, Olopalearctic, Eurocentralasiatic-Mediterranean, Euroturanic-Mediterranean, Mediterranean) behave in specular fashion. The European species represent the intermediate chorotype between the northern group and the southern one.
The two main chorological groups divide Italy into two sectors: One continental, north of the bioclimatic boundary between Mediterranean and Eurosiberian regions, and the other peninsular, to the south. Calabrian subpeninsula is chorologically separate from the rest of the Italian peninsula. Furthermore, areas with large changes in bird community composition emerged both in the Correspondence Analysis and in the Diversity Indices: 1) at the level of the bioclimatic boundary; 2) at the Southern tip of the Abruzzo Apennines; and 3) at the border of the Calabrian subpeninsula.

Introduction

Spatial diversity patterns (Whittaker, 1977; Begon *et al.,* 1986), including latitude and altitude related patterns of species richness, are of particular interest in biogeography (*e.g.* Fischer, 1959; Schall & Pianka, 1978; Rosenzweig, 1992).

The factors determining these patterns are complex and differ according to the scale of analysis, the context and the taxa investigated (Kathleen Lyons & Willig, 1999; Cotgreave & Harvey, 1994; Blackburn & Gaston, 1996).

In the peninsular patterns there is a generally trend of progressive reduction in species richness, along the peninsulas from mainland to the tip. According to Simpson (1964) this could be interpreted as extinction-recolonisation dynamics (MacArthur & Wilson; 1967): However the shape of peninsulas could influence these processes and consequently the species richness, expecially in the distal portions of peninsulas (peninsula effect according to Taylor & Regal 1978).

It was observed that several factors (*e.g.*, orogeographic, climatic, anthropic), often interacting together and independent from the "Simpsonian" dynamics could affect the peninsular patterns (Kathleen Lyons & Willig, 1999). Furthermore, these patterns are not universal and a number of exceptions occur: In fact, a progressive increase of species diversity towards the tip ("contra-trends") was observed in some peninsulas (*e.g.* Baja California, Florida), for a number of taxa (Seib, 1980; Due & Polis, 1986; Schwartz, 1988; Brown & Opler, 1990; see also Lawlor, 1983; Busack & Hedges, 1984; Parenzan, 1991; for a review see Wiggins, 1999).

In Italy, peninsular patterns of species richness, density and composition of species were observed, and associated with, such as: Climate, orography, ecology, as well as biogeographical, historical and anthropic isolation (Massa, 1982; Lebreton & Ledant, 1981).

The present climate may have strong influence on the species richness and composition patterns of species. The extensive latitudinal range of the Italian peninsula can favour species turnover, depending on the ecological and bioclimatic preferences of different species. Analogously to Italy, other peninsulas (*e.g.* Baja California and Florida) show a north-south pattern that influences richness and composition of different taxa. This may be in relation, even indirectly, to vegetational and ecological *sensu latu* variations along the latitudinal climatic gradient (Raivio, 1988; Schwartz, 1988; Brown & Opler, 1990).

The concept of discontinuity dynamics is a common theme in modern ecology (Wiens, 1989; Dale & Powell, 2001) and in conservation biology (Scott & Csuti, 1997). At the community level the size of discontinuities may be one of the main factors responsible for the species turnover (for the birds at the landscape scale, see Cody, 1993). Since a large part of the Italian peninsula consists of a complex and fragmented mosaic of orogeographic and climatic units, they provide excellent opportunities for the study of turnover dynamics along gradients at meso- and macro-scale level.

Studies on the chorology of the Italian fauna have suggested the existence of non-random distribution patterns of different species (La Greca, 1963, 1975; Contoli, 1986b; Boano, 1988; Boano & Brichetti, 1989; Boano *et al.,* 1990; Vigna Taglianti *et al.,* 1992; Parenzan, 1994; Brichetti, 1997; Contoli, 2000; see also Ruffo, 1959). These patterns provide indications on events that have determined origin and distribution of the faunas of a region (La Greca, 1963; 1975; 1984), at both macrogeographical level (linked to earlier historical-biogeographical factors), and microgeographical level (linked to present ecological factors) (Vigna Taglianti *et al.,* 1992). However, species range variations due to anthropic impact can occasionally distort the main chorological pattern (Boano & Brichetti, 1989; La Greca, 1975).

Italy's high biogeographical diversity, due to its complex geologic history and to its geographical position, explains the presence of faunas of different origins, belonging to various chorotypes (La Greca, 1963).

The aim of this paper is to analyse the chorological patterns of Italian breeding landbirds to investigate the factors responsible for trends, contra-trends and discontinuities observed and to provide indications on the "peninsula effect".

Study area and methods

The territory of the continental (northern) and peninsular (central-southern) Italy was subdivided from north to south into 27 latitudinal bands (LB), each one comprising a 20' latitudinal range and formed by a set of 1:100,000 IGMI (Italian Military Geographic Institute) map sheets of the same latitude (LAT) (Fig. 1). For each of these, the number of breeding landbird species (Columbiformes to Passeriformes; Vaurie, 1959 and 1965 in Massa, 1982) was obtained from the Atlas of Italian breeding birds (Meschini & Frugis, 1993). The breeding landbird species in Italy comprise some 30% of the total number of species (Brichetti & Massa, 1998; see also Tramer, 1974).

For *Bubo bubo* (distribution not published in Meschini & Frugis, 1993) data were obtained from Snow and Perrins (1998). The two subspecies of *Corvus corone*, although treated separately in the Atlas, were regarded as a single taxon.

The use of atlases for biogeographical analyses was recently emphasised (*e.g.* Spellerberg & Sawyer, 1999; Sutherland, 2000). They do however have some limits: The Atlas data, cumulative over a number of years, sometimes overestimate the number of species (*e.g.* Diamond & May, 1977; Minelli, 1990). Moreover, the data refer to presence/absence, and do not take into account the abun-

Fig. 1. Mediterranean (white) and Eurosiberian (grey) Bioclimatic regions of Italy according to (a) Tomaselli *et al.* (1973) and (b) Pedrotti (1996); (c) Latitudinal bands (LB) along Italy.

dance of the individual species and of their distribution within each LB.

Each species was considered separately according to the classification of the chorotypes and subchorotypes described for Italy (Boano & Brichetti, 1989; Boano *et al.,* 1990: see Fig. 2 for abbreviations).

For each LB the number of breeding landbird species belonging to each of the chorotypes listed was calculated and expressed as percentage of the total number of breeding landbird species in the LB.

For each LB the following variables have also been calculated:

- percentage area of Mediterranean climate (MED TOM in 5 % intervals data from Tomaselli *et al.* (1973); and the area of the Eurosiberian and Mediterranean bioclimatic region (MED PED, data from Pedrotti, 1996);

- maximum altitude (ALT MAX) of the LB (indicative of the altimetric range only in the peninsular LBs) taken from general geographical atlases. The maximum altitude values indicate the altimetric range and provide indirect information on environmental potentials: This concerns only those LBs including the coastline, where the maximum altitude corresponds to the altitudinal range.

The percentage proportions of each chorotype (dependent variables), lastly, were correlated with the independent variables obtained for each LB: LAT (latitudinal mid-point of each LB), MAX ALT, MED TOM, MED PED. A preliminary correlation analysis was performed with simple Spearman test to recognize the effects of geographical-environmental factors on chorotypes; multiple regression analysis was also performed to estimate the weight of the individual environmental variables (SPSS Statistic software).

The chorotypes C, PP, OAb, EUT, EN, because of the small total number of species have not been considered in the statistical analysis (see Annex 1).

To assess the similarity between LBs, the landbird species-turnover along the North-South direction was calculated using Whittaker's b statistic (cited in Gregory *et al.* 1998) between each LB and the LB immediately to the south of it:

$$\beta = (N_1 + N_2) / (N_1 + N_2 + 2 N_{12}) \quad (1)$$

where N_1 and N_2 are the number of species found only in the first and in the second LB, respectively; and N_{12} is the number of species in common (on the β diversity see, *e.g.* Tramer, 1974; Wilson & Shmida, 1984; for Italy, Zilli & Racheli, 1985).

From the set of data, a matrix of 14 chorotypes x 27 LBs was obtained and subjected to Multivariate Statistical Analyses (Cluster Analysis with complete link Euclidean distance procedure and Correspondence Analysis) with the Biodiversity Pro32 programme (McAleece, 1997).

Berger & Parker's dominance index (1970) and Pielou's evenness index (1969) were analysed for geographical patterns.

Results

Total breeding landbird species proportions subdivided into chorotypes are reported in Table 1.

Latitude and altitude

Significant and direct individual correlations among indipendent variables (LAT and ALT MAX) and following chorotypes: OA (including OAb), EU, EUS, EUC, EUR have been found; while significant and inverse individual correlations for PO, O, EUCm, EUTm and MED exist.

The palaearctic species (PAL) as a whole, were directly correlated with latitude and maximum altitude.

The correlations with OA, excluding OAb, were not significant (Fig. 2; Table 2).

Results of multiple regression showed a greater influence of LAT on OA, EUS, EUCm and MED, while ALT MAX is a major responsible factor for EUTm (P<.05) (Annex 2).

Climate

According to Spearman test, with increasing area of Mediterranean climate, the proportions of PO, O, EUCm, EUTm and MED significantly increase, while the OA (including OAb), EU, EUS, EUC, EUR and PAL decrease.

The correlations with OA (excluding OAb) were not significant.

Considering both the Tomaselli *et al.* (1973) and the Pedrotti (1996) maps, no substantial differences emerge in the significance of the individual correlations (Fig. 2; Table 2).

According to multiple regression results (Annex 2), indipendent variable MED PED is the most important factor explaining trends of PO; while O are better explained by MED TOM. EUS are dependent by MED TOM (and, secondarily, also by LAT and ALT MAX).

Whittaker Index Turnover

The β - turnover index (Whittaker, 1960) showed marked oscillations at the LB pairs 8-9, 17-18 and 21-22 and in the southernmost LBs of the peninsula (Fig. 3).

Multivariate Analysis

Chorotypes

Cluster Analysis (Fig. 4) showed a subdivision of chorotypes into three groups: The first (I°) and the second (II°) can be distinguished by their greater (PO, O, EUCm, EUTm, EUR, MED) or lesser (OA, EU, EUS, EUC) affinity with climatic Mediterranean conditions ("Mediterranean-ness"). The third group (III°) which refers to chorotypes C, PP, OAb, EUT, EN was not considered in the analysis as already explained in the methods.

The results of Correspondence Analysis, showed EUS and MED at the extremes of the main axis (Fig. 5).

Latitudinal bands

Correspondence Analysis (Fig. 6) showed affinities among LBs, distributed according to geographical patterns:

I° - LB 1-8 (Northern Italy), divided into a more northerly, typically Alpine, cluster (LB 1-3) and one including the Po Valley (LB 4-8);

II° - LB 9-21 (Central-Southern Italy, corresponding to Peninsula, excluding Calabria);

III° - LB 22-27 (Calabrian subpeninsula).

Also the Cluster Analysis (Fig. 7) show three groups of LBs: The LBs 23 and 24 (Northern Calabrian subpeninsula) are clustered in the II° LBs group (Peninsula) (together with LB 18), showing a transition geographical character.

By the clusters of chorotypes (Fig. 4) and of the LBs (Fig. 7), a table of three groups of chorotypes and of three groups of LBs was drawn up (Annex 3).

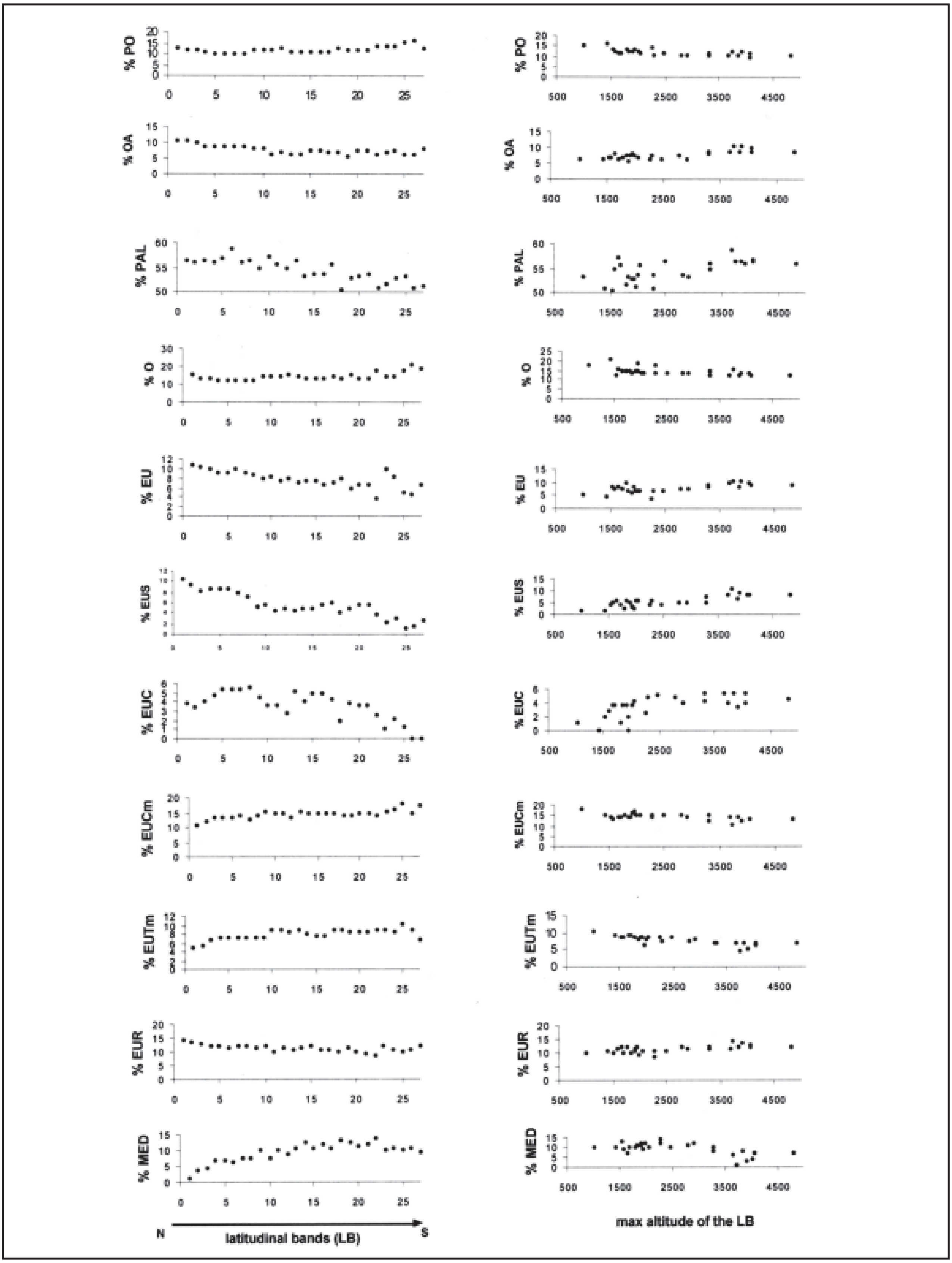

Fig. 2. Latitudinal (a) and altitudinal (b) trends of chorotypes (OAb are included in OA).
In abscissa, (a): LBs are reported (LB1: 46° 50’ N; LB27: 38° 10’ N). (b): maximum altitude is reported in m a.s.l.. Chorotypes and subchorotypes (from Boano & Brichetti, 1989 and Boano *et al*., 1990): Cosmopolitan (and Subcosmopolitan) (C); Palaearctic-palaeotropical (PP); Eastern-Palaearctic (PO); Holarctic (OA; calculating separately also the Boreoalpine-Holarctic, OAb); Palaearctic (PAL; including the following O, EU, EUS, EUC, EUCm, EUT, EUTm, calculated separately); Olopalaearctic (O); Euroasiatic (EU); Eurosiberian (EUS); Eurocentralasiatic (EUC; these including the Eurocentralasiatic-Mediterranean, EUCm, calculated separately); Euroturanic (EUT; these including the Euroturanic-Mediterranean, EUTm, calculated separately); European (EUR); Mediterranean (MED); Endemic Italian (EN); Chorotypes C, PP, EUT and EN are not reported (see Methods).

Table 1. Percentage of chorotypes. For each LB the values of the latitude North (LAT), the maximum altitude (ALT MAX), and the percentage of the Mediterranean area according to Tomaselli *et al*. (1973) (MED TOM) and to Pedrotti (1996) (MED PED) are shown. Min-max values are reported. (For the abbreviations, see Methods and Fig. 2).

LB	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**	
LAT	**46°50'**	**46°30'**	**46°10'**	**45°50'**	**45°30'**	**45°10'**	**44°50'**	**44°30'**	**44°10'**	**43°50'**	**43°30'**	**43°10'**	**42°50'**	**42°30'**	**42°10'**	**41°50'**	**41°30'**	**41°10'**	**40°50'**	**40°30'**	**40°10'**	**39°50'**	**39°30'**	**39°10'**	**38°50'**	**38°30'**	**38°10'**	
ALT MAX	**3738**	**3905**	**4049**	**4810**	**4061**	**3676**	**3303**	**3841**	**3297**	**1654**	**1701**	**1576**	**2478**	**2912**	**2795**	**2283**	**2050**	**1533**	**1899**	**1836**	**2005**	**2267**	**1785**	**1928**	**1013**	**1423**	**1956**	
MED TOM	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**20**	**10**	**10**	**10**	**10**	**35**	**75**	**90**	**100**	**95**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**	
MED PED	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**5**	**10**	**5**	**15**	**10**	**10**	**10**	**20**	**25**	**35**	**45**	**65**	**70**	**55**	**50**	**40**	**65**	**75**	**70**	min-max values
C	1.94	1.72	1.64	2.31	2.31	1.55	1.55	0.78	0.89	0.91	1.82	1.92	1.74	1.64	1.65	1.65	1.74	1.98	1.89	1.83	1.85	2.53	2.20	1.05	1.27	1.49	1.32	0.78-2.53
PP	1.94	1.72	2.46	2.31	2.31	2.33	3.10	3.13	2.66	1.82	3.64	2.86	2.61	3.28	2.48	3.31	2.61	3.96	2.83	3.67	2.78	2.53	3.30	3.16	2.53	2.99	3.95	1.72-3.96
PO	12.62	12.07	11.48	10.77	10.00	10.08	10.08	10.16	11.50	11.82	11.82	12.50	11.30	10.66	10.74	10.74	11.30	12.87	12.26	11.93	12.04	13.92	13.19	13.68	15.19	16.42	13.16	10.00-16.42
OA	10.68	10.34	9.84	8.46	8.46	8.53	8.53	8.59	7.97	8.18	6.36	6.73	6.09	6.56	7.44	7.44	6.96	6.93	5.66	7.34	7.41	6.33	6.59	7.37	6.33	5.97	7.90	5.66-10.68
OAb	2.91	2.59	2.46	1.54	1.54	1.55	1.55	1.56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0-2.91
O	15.53	13.79	13.11	12.31	12.31	12.40	12.40	12.50	14.16	14.55	14.55	15.38	13.91	13.11	13.22	13.22	13.91	12.87	15.09	13.76	13.89	17.72	14.29	14.74	17.72	20.90	18.42	12.31-20.90
EU	10.68	10.34	9.84	9.23	9.23	10.08	9.30	8.59	7.97	8.18	7.27	7.69	6.96	7.38	7.44	6.61	6.96	7.92	5.66	6.42	6.48	3.80	9.89	8.42	5.06	4.48	6.58	3.80-10.68
EUS	10.68	9.48	8.20	8.46	8.46	8.53	7.75	7.03	5.31	5.46	4.55	4.81	4.35	4.92	4.96	5.79	6.09	3.96	4.72	5.50	5.56	3.80	2.20	3.16	1.27	1.49	2.63	1.27-10.68
EUC	3.88	3.45	4.10	4.62	5.38	5.43	5.43	5.47	4.43	3.64	3.64	2.89	5.22	4.10	4.96	4.96	4.35	1.98	3.77	3.67	3.70	2.53	1.10	2.10	1.27	0	0	0-5.47
EUCm	10.68	12.07	13.11	13.08	13.08	13.95	12.40	14.06	15.04	14.55	14.55	13.46	15.65	14.75	14.88	14.88	14.78	13.86	14.15	14.68	14.81	13.92	15.38	15.79	17.72	14.93	17.11	10.68-17.72
EUT	0	1.72	1.64	1.54	1.54	1.55	1.55	1.56	0.89	1.82	1.82	1.92	1.74	0.82	0.83	0.83	0.87	0.99	0.94	0.92	0.93	0	0	0	0	0	0	0-1.92
EUTm	4.85	5.17	6.56	6.92	6.92	6.98	6.98	7.03	7.08	9.09	9.09	8.65	8.70	8.20	7.44	7.44	8.70	8.91	8.49	8.26	8.33	8.86	8.79	8.42	10.13	8.96	6.58	4.85-10.13
EUR	14.56	13.79	13.11	12.31	12.31	11.63	12.40	12.50	11.50	11.82	10.00	11.54	10.43	11.48	12.40	10.74	10.43	9.90	11.32	10.09	9.26	8.86	12.09	10.53	10.13	10.45	11.84	8.86-14.56
PAL (total)	56.31	56.03	56.56	56.15	56.92	58.91	55.81	56.25	54.87	57.27	55.45	54.81	56.52	53.28	53.72	53.72	55.65	50.50	52.83	53.21	53.70	50.63	51.65	52.63	53.16	50.75	51.32	50.50-58.91
MED	0.97	3.45	4.10	6.92	6.92	6.20	7.75	7.81	9.74	7.27	10.00	8.65	10.43	12.30	10.74	11.57	10.43	12.87	12.26	11.01	12.04	13.92	9.89	10.53	10.13	10.45	9.21	0.97-13.92
EN	0.97	0.86	0.82	0.77	0.77	0.78	0.78	0.78	0.89	0.91	0.91	0.96	0.87	0.82	0.83	0.83	0.87	0.99	0.94	0.92	0.93	1.27	1.10	1.05	1.27	1.49	1.32	0.77-1.49
	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	

The first group (I°) of chorotypes shows increasing values southwards, discriminating the LBs of central-southern Italy; the EUR species, included in this group, follow a contra-trend. On the other hand the second group (II°) shows decreasing values southwards, discriminating the LBs of northern Italy. The third group (III°) does not show a definite trend, possibly due to the small number of species in the samples.

Diversity analysis

The values of dominance (Berger-Parker index) and evenness (Pielou index) for "chorological communities" show trends along the peninsula (Fig. 8): dominance slowly increases and the evenness decreases at bioclimatic boundary (LB 8-10) and in the Calabrian subpeninsula (LB 23-27). The correlation test of the "chorotypes matrix" constrained on the diversity values gave significative results (Annex 4): PO and O, directly correlated with the dominance index (r = .84 and r = .95, respectively; p< .01) show the highest values; the chorotype PO was negatively correlated with the evenness index (r = -.85; p< .01).

Discussion

Gradients and clusters

Climatic and orogeographical factors, in addition to historical- and ecological-biogeographical ones, were the main factors associated with chorological patterns in Italy.

A Mediterranean-ness gradient was recognizable along the first axis of the Correspondence Analysis of the "chorotype matrix" (Fig. 5). Similarly, while a geographical gradient emerged in the Correspondence Analysis of the "LB matrix" (Fig. 6).

In the first case two significant groups of chorotypes were discriminated (see also Fig. 4): The first (I°) had a southern distribution (with PO, O, EUCm, EUTm, EUR and MED correlated negatively with latitude) and the second (II°) having a mostly northern distribution (with OA, EU, EUS, EUC and EUR correlated positively with latitude).

Since "mediterraneity" is a complex factor expressed by latitude and climate, multiple regression results confirm their role for OA, EUS, EUCm and MED (predictor variable LAT) and for PO and O (predictor variable MED PED and MED TOM, respectively) (while pattern of EUS was explained by different predictors: LAT, ALT MAX, MED TOM and pattern of EUTm by ALT MAX in Annex 2).

The dendrogram of LBs (Fig. 7) showing the chorotypes distribution along Italy, showed a phylogeographic structure with three clusters corresponding to continental/northern Italy (I°), central-southern Italy (II°) and Calabrian sub-peninsula (III°). This subdivision is consistent with the two main Italian bioclimatic zones: The LBs of the first cluster is included in the Eurosiberian region, while the LBs of the other clusters belong to the Mediterranean region, according to Pedrotti (1991).

The new assemblage "chorotype clusters/LB clusters" (Annex 3) highlightes as the values of the northern and southern chrotypes groups discriminate the LBs of the Eurosiberian and Mediterranean regions, respectively.

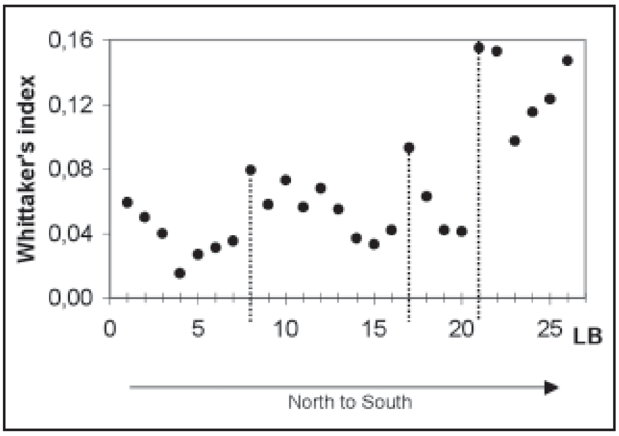

Fig. 3. Trends of species turnover (from Whittaker b index): the broken lines indicate the discontinuities along Italy.

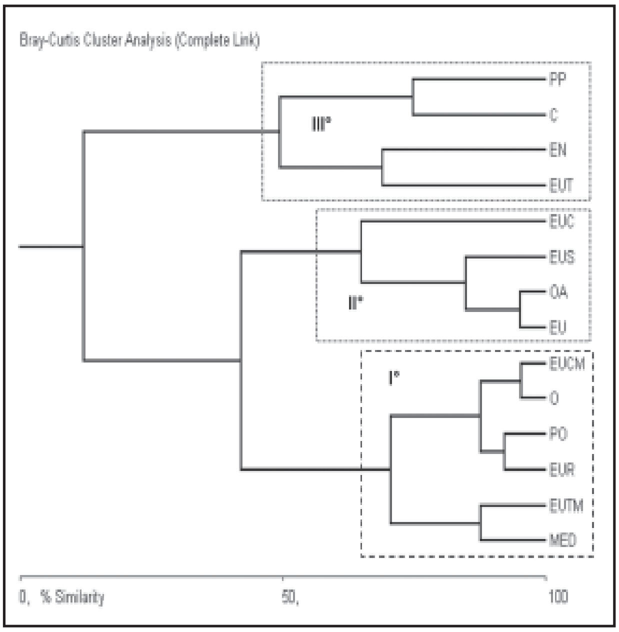

Fig. 4. Dendrogram from Cluster Analysis of chorotypes. Three clusters are highlighted (I°, II°, III°: see text). (For the abbreviations, see Fig.2).

Trends and contra-trends

The EUS species were associated with the "continental" pole of the climatic gradient (Fig. 5). In fact, they are elements with a northern distribution, related to cold climates and to higher altitudes (La Greca, 1963; 1975; 1984; Boano & Brichetti, 1989). The correlation in pairs also bears out their decreasing trend towards the south (Fig. 2, Table 2); the MED species was linked to the opposite pole of the gradient. Multiple regression results emphasized the role of LAT, MED TOM and ALT MAX like predictors for EUS species and of LAT for MED species (Annex 2).

The EUR species, although having a mainly northern distribution and occurring in temperate-cold environments (La Greca, 1963), were unexpectedly included in the group of Mediterranean *sensu latu* species (positive correlation with the latitude and the maximum altitude according to Spearman test in Table 2). However, they showed a contra-trend within the group (Annex 3). This confirms what was observed along the "Mediterranean" gradient: The EUR species represent the intermediate chorotype between the "northern" group and the "southern" one (Fig. 5). Probably, a complex set of variables may determine the pattern of this chorotype, according to multiple regression results (Annex 2).

The "Mediterranean" chorological group, increased in proportion towards south, which is opposite to classical peninsular trends: Indeed, some faunistic groups may show geographical trends or contra-trends of species richness in relation to single climatic components (Seib, 1980), as observed also in continental contexts (Emlen *et al.,* 1986).

The relationships found between chorotype's trends and orogeographical factors agree with Brichetti (1997) and with analogous trends observed in the plant chorotypes correlated with the climate along the Italian peninsula: In particular, EUS, EUR, and MED landbird trends are consistent with the Eurosibiric (and Boreal), European, and Mediterranean plant trends (Testi *et al.,* 1996).

A close link among these abiotic factors (latitude, altitude, area), correlated along the Italian peninsula (Battisti & Contoli, 1999), is furthermore evidenced by the sign of the correlations with the chorotypes: Corresponding to a negative correlation of the chorotypes with the

Table 2. Correlations between percentage of the chorotypes versus latitude North (LAT), maximum altitude (ALT MAX), percentage of the Mediterranean area (MED TOM and MED PED). Spearman rank correlation test: ** = P< .01; *** = P< .001; NS = Not significant. (For the abbreviations, see Fig.2).

	LAT		ALT MAX		MED TOM		MED PED	
Chorotypes	r_s	P	r_s	P	r_s	P	r_s	P
PO	-.63	***	-.67	***	.70	***	.69	***
OA (°)	.72	***	.72	***	-.69	***	-.71	***
OA(°°)	.31	NS	.32	NS	-.21	NS	-.25	NS
PAL	.85	***	.63	***	-.84	***	-.82	***
O	-.57	**	-.64	***	.57	**	.63	***
EU	.75	***	.59	**	-.72	***	-.79	***
EUS	.85	***	.79	***	-.80	***	-.77	***
EUC(*)	.65	***	.73	***	-.72	***	-.70	***
EUCm	-.75	***	-.51	**	.66	***	.66	***
EUTm	-.61	***	-.84	***	.65	***	.60	**
EUR	.66	***	.65	***	-.71	***	-.69	***
MED	-.73	***	-.52	**	.75	***	.71	***

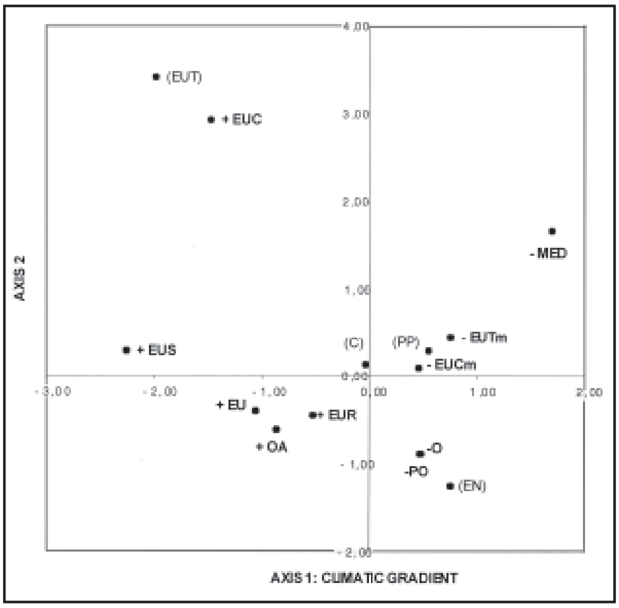

Fig. 5. Distribution of the chorotypes according to Correspondence analysis. + = positive correlation with latitude; - = negative correlation with latitude; the chorotypes not considered in the statistical analysis are reported in brackets. (For the abbreviations, see Fig.2).

latitude and the maximum altitude, there is always a positive correlation with the area of Mediterranean climate, and *vice versa* (Table 2).

The latitudinal trends of species composition observed thus follow either proportional trends decreasing southwards, or contra-trends (Fig. 2). Also in species richness, contra-trends were observed in other peninsulas, with the same north-south latitudinal development as in Italy (*e.g.* Baja California, Florida) where a number of groups, climatically characterised, show patterns opposite to traditional peninsular ones (reptiles, Seib, 1980; scorpions, Due & Polis, 1986; tree species, Schwartz, 1988; lepidoptera, Brown & Opler, 1990).

The following factors are suggested to be responsible for trends and contra-trends observed:

1) Climate appear important in determining chorological patterns along Italy, confirming what has already been pointed out for peninsular diversity patterns (Means & Simberloff, 1987; Taylor & Regal, 1978).

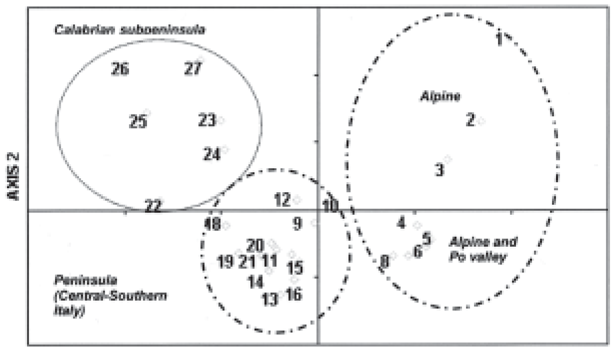

Fig. 6. Correspondence analysis of LBs. The clusters of the LBs belonging to Continental-Northern Italy (LB 1-8), peninsular (Central-Southern) Italy (LB 9-21) and the Calabrian subpeninsula (LB 22-27) are highlighted.

2) Orogeographical and geomorphological factors also influence patterns in peninsulas. The results of this paper emphasise the role of the Apennines as a faunistic bridge, as suggested by the oscillations in the turnover index (Fig. 3). Other authors have already stressed that the Apennine system is a factor of interference (La Greca, 1963; Massa, 1982; Racheli & Zilli, 1985; Battisti & Contoli, 1997; Cagnin *et al.,* 1998); in some cases, the Apennine favours the biogeographic continuity of individual species and groups, while in other cases it represents a filter to species dispersal because of the climatic, orophysiographical and ecological *sensu latu* discontinuities. These discontinuities are one of the main factors causing high rate of endemism in the peninsular Italy (Massa, *in verbis*).

The "Apennine effect" is analogous to what was observed in other peninsulas, where the local orogeographical-geomorphological factors affect the distribution of the faunas, in addition or alternative to the Simpsonian model: For Florida, the "Everglades effect" (Means & Simberloff, 1987); for Baja California, the ecological and orogeographical effect linked to the central desert (Due & Polis, 1986; Wiggins, 1999); for the Iberian peninsula the effect linked with the development of the orogeographical systems in an east-west direction (Cagnin *et al.,* 1998).

3) The ecology as well as the dispersal capacity of the individual species can constitute an additional factor (Massa, 1987). It is noted that in Italy about 60% (N=61) of the landbird species belonging to the "northern" chorotypes (OA, EU, EUS, EUC, EUR) are associated with forest habitats, while a smaller percentage (about 30%; N=75) of the species belonging to "southern" chorotypes (PO, O, EUCm, EUTm, MED) (Figs. 2 and 5).

This skewed north-south distribution of the forest landbird species depends on the prevalence of the European (*sensu latu*) chorotype which have a more northern distribution in respect to the other ecological types (Covas & Blondel, 1998).

Massa (1993) assigned the faunistic impoverishment along the Italian peninsula to this inhomogeneous distribution of the European *s.l.* and the Mediterranean *s.l.* species. This can also be explained by the macroscale fragmentation of the forest areas, due to orogeographical-climatic factors as well as to recent and historical anthropisation.

Discontinuities and turnover

Within the main trends a number of discontinuities emerge:

1) A first chorological distinction is noted between the LBs of continental/northern Italy (LB 1-8) and those of peninsular Italy (LB 9-27), where the oscillations of the turnover index are marked (Fig. 3). This faunistic discontinuity corresponds to the bioclimatic boundary (LB 7-9) between the Eurosiberian and Mediterranean regions, according to Pedrotti (1991) (Fig. 6), as already observed for the landbird fauna in Italy (Battisti & Testi, 2001) and in the Iberian peninsula (Telleria & Santos, 1994).

2) A second discontinuity is observed at the Southern tip of the Abruzzo Apennines (LB 16-18) evidenced by the turnover index values (Fig. 3).

3) The Calabrian subpeninsula (LB 23-27) differs from the rest of the Italian peninsula (Fig. 6). This emerged also from the turnover analysis where between LB 20 and

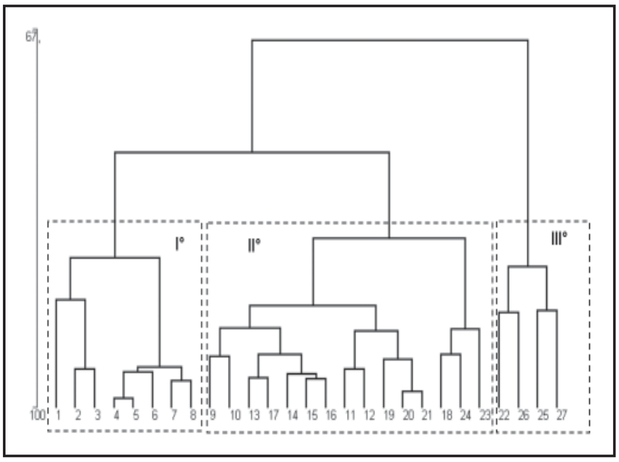

Fig. 7. Dendrogram from Cluster Analysis of LBs. Three clusters are highlighted: I° = Continental-Northern Italy; II° = peninsular (Central-Southern) Italy; III° = Calabrian subpeninsula.

22 the values are higher and more oscillating (Fig. 3), although that may be ascribed also to the limited numerical sample decreasing southwards. Indeed, the latitudinal trends of the values reflect, to a large extent, the number of species in common, in its turn depending on the number of species in the LBs: The turnover patterns reflect the richness patterns (Gregory *et al.,* 1998).

These two last discontinuities (Southern tip of the Abruzzo Apennines and Calabrian subpeninsula) may be influenced by various factors: The increasing aridity of the climate (Pignatti, 1998), the reduction of the maximum altitudes and of the area, the fragmentation of the forest habitats at macro- and mesoscale with the consequent simplification of the vegetation structure and of its dynamism, as well as the anthropic impact mainly linked to frequent fires and long-time deforestation. Indeed, a strong effect of historical human disturbance is known where peninsular discontinuities were observed (Bulgarini, 1999).

Chorological diversity

The discontinuities observed were further confirmed by the oscillations in the dominance index (Berger & Parker, 1970) and by the evenness index (Pielou, 1969) applied to "chorological communities": The dominance values increase and the evenness ones decrease where these discontinuities occur (Fig. 8).

Evenness may describe the trends and the discontinuities better than dominance: Indeed, this is considered an ecological parameter that explains environmental variations *sensu latu*, including those indirectly induced by man (Pignatti *in verbis*, Contoli, 1986a). The reduction in evenness along the peninsula and at the bioclimatic, orogeographical and ecological *s.l.* support this argument (Fig. 8). The chorotypes may be regarded as a community whose evenness is reduced towards the tip of the peninsula in relation to the factors listed above.

Conclusion

The chorological patterns show different trends according to orogeographical, climatic and ecological *sensu latu* factors which together with the historical-biogeographical ones, can explain the distribution and composition of breeding landbird fauna along the Italian peninsula.

Hence, the primary role of these factors, in influencing the affinities between faunas is emphasized through chorological patterns, although the marked oscillations observed along the trends towards south, evident in some chorotypes, may be influenced also by their limited sample of species.

The abiotic and biotic factors above mentioned and the consequent inhomogeneous distribution and composition of chorotypes may influence the "Peninsula effect" observed in landbird species richness trends along Italy (Massa, 1982).

Among the chorotypes, the Eastern-Palaearctic (PO) and the Olopalaearctic (O), because of their high and significant correlation compared with the values of the diversity indices (Annex 4), may be regarded as indicators able to provide synthetic information on general chorological trends along the Italian peninsula. That allows focusing on chorotypes other than those traditionally used in correlations with orogeography and climate (*e.g.* MED, EUC m, EUS, OA).

At macroscale level the chorological patterns may describe the two main bioclimates of the peninsula corresponding to Eurosiberian and Mediterranean regions *sensu* Pedrotti (1996), evidencing the two corresponding clusters of chorotypes ("northern": OA, EU, EUS, EUC, EUR and "southern": PO, O, EUCm, EUTm, MED) (Figs. 4 and 5).

At mesoscale level, they show orogeographical, climatic and ecological *s.l.* contra-trends and discontinuities (Figs. 2 and 3). These evidences confirm the literature assumptions regarding the role of the discontinuities in turnover dynamics and spatial patterns (Dale & Powell, 2001).

In particular, these patterns are well described by the chorological diversity indices; the dominance and evenness oscillate markedly at level of the bioclimatic boundary and in the Calabrian subpeninsula (Fig. 8). The reduction in evenness along the peninsula may be an evidence of an environmental non-equilibrium in response to the overlapping of various factors, as the increasing of climatic aridity and forest fragmentation.

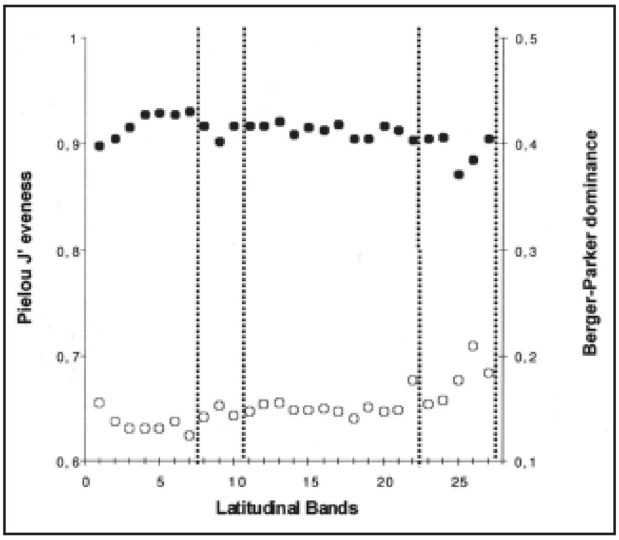

Fig. 8. Chorological diversity *versus* LBs: Dominance index (according to Berger & Parker, 1970) and evenness index (according to Pielou, 1969). The sectors among the brocken lines indicate the discontinuities. Black points: evenness; white points: dominance.

These results allow to regard the chorotypes as component of "chorological communities distributed along Italy according to a phylogeographic structure" and as "keystone" elements for the biogeographical gradients analyses.

This method could be extended to other faunistic, ecologic and phenologic groups to correlate their distribution with a pool of environmental variables and could be useful in applied biogeographical research (Spellerberg & Sawyer, 1999).

Acknowledgments

We wish to thank Prof. Longino Contoli and Prof. Bruno Massa for their critical reading of the text, their useful suggestions and the bibliographical indications; Mr. Peter Glendening, Dr. Alessandro Zocchi and Dr. Roberto Crosti for the translation and revision of English language.

References

Abbott, I. 1980. Theories dealing with the ecology of landbirds on islands. Advances in Ecological Research 11: 329-371.

Battisti, C. & Contoli, L. 1997. Sulla componente di ricchezza della diversità avifaunistica in Italia: peninsularità ed insularità. Rivista Italiana di Ornitologia 67: 113-126, in Italian with English summary.

Battisti, C. & Contoli, L. 1999. Mean range of the species, bird richness and ecogeographical factors: data from italian peninsula and islands. Avocetta 23: 48-57.

Battisti, C. & Testi, A. 2001. Peninsular patterns of breeding landbird richness in Italy: On the role of climatic, orographic and vegetational factors. Avocetta 25: 289-297.

Begon, M., Harper, J.L. & Townsend, C.R. 1986. Ecology-Individuals, Populations and Communities. Blackwell Scientific Publications.

Berger, W.H. & Parker, F.L. 1970. Diversity of planktonic Foraminifera in deep sea sediments. Science 168: 1345-1347.

Blackburn, T.M. & Gaston, K.J. 1996. Spatial patterns in the species richness of birds in the New World. Ecography 19: 369-376.

Boano, G. 1988. L'uso di una classificazione ecologica e corologica nello studio delle comunità ornitiche. L'esempio dei boschi planiziari del Piemonte. Naturalista siciliano 12: 33-40, in Italian with English summary.

Boano, G. & Brichetti, P. 1989. Proposta di una classificazione corologica degli uccelli italiani. I. Non Passeriformi. Rivista Italiana di Ornitologia 59: 141-158, in Italian with English summary.

Boano, G., Brichetti, P. & Micheli, A. 1990. Proposta di una classificazione corologica degli uccelli italiani. II. Passeriformi e specie accidentali. Rivista Italiana di Ornitologia 60: 105-118, in Italian with English summary.

Brichetti, P. 1997. Le categorie corologiche dell'avifauna italiana. In: Brichetti P., Gariboldi A., Manuale pratico di ornitologia. Edagricole, pp. 223-237, in Italian.

Brichetti, P. & Massa, B. 1998. Check-list degli Uccelli italiani aggiornata a tutto il 1997. Rivista Italiana di Ornitologia 68: 129-152, in Italian with English summary.

Brown, J.W. & Opler, P.A. 1990. Patterns of butterfly species density in peninsular Florida. Journal of Biogeography 17: 615-622.

Bulgarini, F. 1999. La carta delle aree selvagge come base per l'individuazione di possibili connessioni. Dossier "Reti ecologiche". Attenzione WWF 16: 31-33, in Italian.

Bulgarini, F., Calvario, E., Fraticelli, F., Petretti, F. & Sarrocco, S. (eds.) 1998. Libro rosso degli Animali d'Italia. Vertebrati. WWF Italia, in Italian.

Busack, S.D. & Hedges, S.B., 1984. Is the peninsula effect a red herring? American Naturalist 123: 266-275.

Cagnin, M., Moreno, S., Aloise, G., Garofalo, G., Villafuerte, R., Gaona, P. & Cristaldi, M. 1998. Comparative study of Spanish and Italian terrestrial small mammal coenoses from different biotopes in Mediterranean peninsular tip regions. Journal of Biogeography 25: 1105-1113.

Cody, M. L. 1993. Bird diversity components within and between habitats in Australia. In: Ricklefs R.E. and Schluter D. (eds.) Species diversity in ecological communities, pp. 147-158. The University of Chicago Press, Chicago.

Contoli, L. 1986a. Sulla diversità dei sistemi trofici "Strigiformi-mammiferi" nel parco del Circeo e le relative valutazioni ambientali. In: Atti Convegno "Aspetti Faunistici e problematiche zoologiche Parco Nazionale del Circeo": 169-181, in Italian with English summary.

Contoli, L. 1986b. Sistemi trofici e corologia: dati su Soricidae, Talpidae, Arvicolidae d'Italia predati da *Tyto alba* (Scopoli 1769). Hystrix 1: 95-118, in Italian with English summary.

Contoli, L. 2000. Rodents of Italy: species richness maps and Forma Italiae. Hystrix 11: 39-46.

Cook, R.E. 1969. Variations in species density in North American birds. Systematic Zoology 18: 63-84.

Cotgreave, P. & Harvey, P.H. 1994. Association among biogeography, phylogeny and bird species diversity. Biodiversity letters 2: 46-55.

Covas, R. & Blondel, J. 1998. Biogeography and history of the Mediterranean bird fauna. Ibis 140: 395-407.

Dale, M.R.T. & Powell, R.D. 2001. A new method for characterizing point patterns in plant ecology. Journal of Vegetation Science 12: 597-608.

Diamond, J.M. & May, R.M. 1977. Species turnover rates on islands: dependence on census interval. Science 197: 266-270.

Dice, L.R. 1945. Measures of the amount of ecological association between species. Ecology 26: 297-302.

Due, A.D. & Polis, G.A. 1986. Trends in scorpion diversity along the Baja California peninsula. American Naturalist 128: 460-468.

Emlen, J.T., DeJong, M.J., Jaeger, M.J., Moermond, T.C., Rusterholz, K.A. & White, R.P. 1986. Density trends and range boundary constraints of forest birds along a latitudinal gradient. Auk 103: 791-803.

Fisher, A.G. 1959. Latitudinal variations in organic diversity. Evolution 14: 64-81.

Fowler, J. & Cohen, L. 1993. Statistica per ornitologi e naturalisti. Franco Muzzio Editore, Padova, in Italian.

Gregory, R.D., Greenwood, J.J.D. & Hagemeijer, E.J.M. 1998. The EBCC Atlas of European Breeding Birds: a contribution to science and conservation. Biologia e Conservazione della Fauna 102: 38-49.

Kathleen Lyons, S. & Willig, M.R. 1999. A hemispheric assessment of scale dependence in latitudinal gradients of species richness. Ecology 80: 2483-2491.

Kiester, A.R. 1971. Species density of North American amphibians and reptiles. Systematic Zoology 20: 127-137.

La Greca, M. 1963. Le categorie corologiche degli elementi faunistici italiani. Atti Accademia Nazionale Italiana di Entomologia. Rendiconti 11: 231-253, in Italian.

La Greca, M. 1975. La caratterizzazione degli elementi faunistici e le categorie corologiche nella ricerca zoogeografica. Animalia 2: 101-129, in Italian.

La Greca M. 1984. Le origini della fauna italiana. Le Scienze 187: 66-79, in Italian.

Lawlor, T.E. 1983. The peninsula effect on mammalian species diversity in Baja California. American Naturalist 121: 432-439.

Lebreton, P. & Ledant, J.-P. 1981. Remarques d'ordre biogéographique et écologique sur l'avifauna méditerranéenne. Vie Milieu 30: 195-208, in French with English summary.

Lo Valvo, M. & Massa, B. 1988. Analisi multivariata di alcune variabili che influenzano la ricchezza specifica in isole mediterranee e macaronesiche. Naturalista siciliano 12 (Suppl.): 217-222, in Italian with English summary.

McAleece, N. 1997. BioDiversity Professional software. Version 2. The natural History Museum and the Scottish Association for Marine Science.

Massa, B. 1982. Il gradiente faunistico nella penisola italiana e nelle isole. Atti Società italiana di Scienze Naturali, Museo civico storia naturale di Milano 123: 353-374, in Italian with English summary.

Massa, B. 1987. Considerazioni sui popolamenti di uccelli terrestri delle isole mediterranee. Biogeographia, Lavori Società italiana di Biogeografia 10: 163-186, in Italian with English summary.

Massa, B. 1993. Gli uccelli della fauna italiana. Atti Convegni Lincei 86: 79-96, in Italian with English summary.

MacArthur, R.H. & Wilson, E.O. 1967. The theory of island biogeography. Princeton Univ. Press, Princeton, N.J.

Means, D.B. & Simberloff, D. 1987. The peninsula effect: habitat-correlated species decline in Florida's herpetofauna. Journal of Biogeography 14: 551-568.

Meschini, E. & Frugis, S. 1993. Atlante degli uccelli nidificanti in Italia. Supplementi di Ricerche di Biologia di Selvaggina 20, 1-344 pp, in Italian with English summary.

Minelli, A. 1990. Faunal turnover and equilibrium models in island biogeography: some problems in the study of species diversity in island biota. Atti Convegni Lincei 85: 85-95.

Parenzan, P. 1991. La macrolepidotterofauna italiana con particolare riferimento all'Italia meridionale e alla Puglia. Atti XVI Convegno Nazionale Italiano di Entomologia: 3-32, in Italian.

Parenzan, P. 1994. Proposta di codificazione per una gestione informatica dei corotipi W-paleartici, con particolare riferimento alla fauna italiana. Entomologica 28: 93-98, in Italian.

Pedrotti, F. 1991. Carta della vegetazione reale d'Italia. Scala 1: 1.000.000. Ministero dell'Ambiente. Università di Camerino. SELCA, Firenze, in Italian.

Pedrotti, F. 1996. Suddivisioni botaniche dell'Italia. Giornale Botanico Italiano 130: 214-225, in Italian with English summary.

Pielou, E.C. 1969. An introduction to mathematical ecology. John and Wiley and Sons, New York .

Pignatti, S. 1998. I boschi d'Italia. Sinecologia e biodiversità. UTET, Torino, 673 pp., in Italian.

Power, D.M. 1972. Numbers of bird species on the California islands. Evolution 26: 451-463.

Racheli, T. & Zilli, A. 1985. Modelli di distribuzione dei Lepidotteri nell' Italia meridionale. Biogeographia, Lavori della Società Italiana di Biogeografia 11: 165-194, in Italian with English summary.

Raivio, S. 1988. The peninsular effect and habitat structure: bird communities in coniferous forests of the Hanko Peninsula, southern Finland. Ornis Fennica 65: 129-145.

Rosenzweig, M.L. 1992. Species density gradient: we know more and less than we thought. Journal of Mammalogy 73: 715-730.

Ruffo, S. 1959. Le origini della fauna italiana. In: Touring Club Italiano. La fauna. Conosci l'Italia, vol. 3, pp. 254-261, in Italian.

Schall, J.J. & Pianka, E.R. 1978. Geographical trends in numbers of species. Science 201: 679-686.

Schwartz, M.W. 1988. Species diversity patterns in woody flora on three North American peninsulas. Journal of Biogeography 15: 759-774.

Scott J.M. & Csuti B. 1997. Gap analysis for biodiversity survey and maintenance. In: M.L. Reaka-Kudla, D.E. Wilson and E.O. Wilson (eds). Biodiversity II. Understanding and protecting our biological resources. Joseph Henry Press, Washington, pp. 331-340.

Seib, R.L. 1980. Baja California: a peninsula effect for rodents but not for reptiles. American Naturalist 115: 613-620.

Simpson, G.G. 1964. Species density of North American recent mammals. Systematic Zoology 13: 57-73.

Snow, D.W. & Perrins, C.M. 1998. The Birds of Western Palearctic. Vol. I. Non Passerines. Concise edition. Oxford Univ. Press, Oxford.

Spellerberg, I.F. & Sawyer, J.W. 1999. An introduction to applied biogeography. Cambridge University Press, Cambridge.

Sutherland, W.J. 2000. The conservation handbook. Research, management and policy. Blackwell Science Ltd, Oxford.

Taylor, R.J. & Regal, P.J. 1978. The peninsular effects on species diversity and the biogeography of Baja California. American Naturalist 112: 583-593.

Telleria, J.L. & Santos T. 1994. Factors involved in the distribution of forest birds in the Iberian Peninsula. Bird Study 41: 161-169.

Testi, A., Napoleone I. & Cigni, A. 1996. Floristic and phytogeographical diversity in some protected areas in Italy. Ecologia mediterranea 22: 81-100.

Tomaselli, R., Balduzzi, A. & Filippello, S. 1973. Carta bioclimatica d'Italia. Collana verde, 33, Ministero Agricoltura e Foreste, Roma, in Italian.

Tramer, E.J. 1974. On latitudinal gradients in avian diversity. Condor 76: 123-130.

Vaurie, C. 1959, 1965. The Birds of the Palearctic Fauna. Vol. 1 (Passeriformes), Vol. 2 (non Passeriformes). Whitherby ed., London.

Vigna Taglianti, A., Audisio, P. A., Belfiore, C., Biondi, M., Bologna, M.A., Carpaneto, G.M., De Biase, A., De Felici, S., Piattella, E., Racheli, T., Zapparoli, M. & Zoia, S. 1992. Riflessioni di gruppo sui corotipi fondamentali della fauna W-paleartica ed in particolare italiana. Biogeographia, Lavori della Società Italiana di Biogeografia 16: 159-179, in Italian with English summary.

Whittaker, R.H. 1960. Vegetation of the Siskiyou Mountains, Oregon and California. Ecological Monography 30: 279-338.

Whittaker, R.H. 1977. Evolution of species diversity in land communities. In: Evolutionary Biology (eds M.K. Hecht, W.C. Steere, B. Wallace). Plenum press, New York and London. Vol. 10, pp. 1-67.

Wiens, J.A. 1989. The ecology of bird communities. Volume 2. Processes and variations. Cambridge University Press, Cambridge.

Wiggins, D.A. 1999. The peninsula effect on species diversity: a reassessment of the avifauna of Baja California. Ecography 22: 542-547.

Wilson, J. W. III 1974. Analytical zoogeography of North American mammals. Evolution 28: 124-140.

Wilson, M.V. & Shmida, A. 1984. Measuring Beta Diversity with presence-absence data. Journal of Ecology 72: 1055-1064.

Zilli, A. & Racheli, T. 1985. I Lepidotteri come strumento per la descrizione della b–diversità fra regioni italiane. Biogeographia, Lavori della Società Italiana di Biogeografia 11: 279-293, in Italian with English summary.

Annex 1. Breeding landbird species, reported by sistematic order, versus Latitudinal Band (LB) matrix.

species	chorotype	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Columba livia	C				x	x						x	x	x	x	x	x	x	x	x	x	x	x	x				
Columba oenas	EUC					x	x	x	x		x	x		x	x	x	x	x	x	x	x	x						
Columba palumbus	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Streptopelia decaocto	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x			
Streptopelia turtur	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Clamator glandarius	MED									x		x	x	x	x	x												
Cuculus canorus	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tyto alba	C	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Otus scops	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x
Bubo bubo	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Glaucidium passerinum	EUS	x	x	x	x	x	x	x																				
Athene noctua	EUCm		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Strix aluco	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Asio otus	OA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x			
Aegolius funereus	OAb	x	x	x	x	x	x	x	x																			
Caprimulgus europaeus	EUCm		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x			
Apus apus	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Apus pallidus	MED			x	x	x	x	x	x	x		x		x	x		x		x	x	x	x	x	x	x			
Apus melba	EUTm	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	
Alcedo atthis	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		
Merops apiaster	EUTm			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x				
Coracias garrulus	EUTm					x					x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	
Upupa epops	PP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x			x
Jynx torquilla	EUS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Picus canus	PO	x	x	x	x																							
Picus viridis	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dryocopus martius	EUS	x	x	x	x	x	x		x									x			x	x	x	x	x			x
Picoides major	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Dendrocopos medius	EUR												x		x	x	x			x	x	x		x				
Dendrocopos leucotus	EUS																x											
Dendrocopos minor	EUS	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x			
Picoides tridactylus	OAb	x	x	x																								
Melaconorypha calandra	MED											x			x	x	x	x	x	x	x	x	x	x				
Calandrella brachydactyla	EUCm			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Galerida cristata	PP			x	x	x	x	x	x			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Lullula arborea	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Alauda arvensis	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Riparia riparia	OA		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x							
Ptyonoprogne rupestris	EUCm	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x		x	x	x	x	x	x	x		
Hirundo rustica	OA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Hirundo daurica	PP							x	x	x		x			x		x		x		x							
Delichon urbica	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Anthus campestris	EUCm			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x
Anthus trivialis	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Anthus spinoletta	EUC	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x					
Motacilla flava	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x				x		x
Motacilla cinerea	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Motacilla alba	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cinclus cinclus	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x		x	x	x	
Troglodytes troglodytes	OA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Prunella modularis	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					x			
Prunella collaris	EUC	x	x	x	x	x	x	x	x	x		x		x	x	x	x	x		x	x	x			x			
Erithacus rubecula	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Luscinia megarhynchos	EUTm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Luscinia svecica	EU		x				x																					
Phoenicurus ochruros	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Phoenicurus phoenicurus	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x		x
Saxicola rubetra	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						x	x		x	
Saxicola torquata	PP	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Oenanthe oenanthe	OA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Oenanthe hispanica	MED				x	x			x					x	x	x	x	x	x	x	x	x	x	x	x			
Monticola saxatilis	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Monticola solitarius	EUCm		x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Turdus torquatus	EUR	x	x	x	x	x	x	x	x	x	x					x												
Turdus merula	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Turdus pilaris	EUS	x	x	x	x	x	x	x	x																			
Turdus philomelos	EUS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x						
Turdus viscivorus	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cettia cetti	EUTm		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Cisticola juncidis	MED		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Locustella luscinioides	EUT		x	x	x	x	x	x	x		x	x	x	x														
Acrocephalus melanopogon	EUTm				x		x	x	x		x	x	x	x	x			x										

(cont.)

species	**chorotype**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Acrocephalus schoenobaenus	EU			x	x	x	x	x	x																			
Acrocephalus palustris	EUR	x	x	x	x	x	x	x	x	x			x		x	x												
Acrocephalus scirpaceus	EUTm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x
Acrocephalus arundinaceus	EUTm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		
Hippolais polyglotta	MED	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Sylvia sarda	MED														x													
Sylvia undata	MED							x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x	x	x
Sylvia conspicillata	MED									x				x	x	x	x	x	x	x	x	x	x		x	x	x	x
Sylvia cantillans	MED				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sylvia melanocephala	MED		x		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sylvia hortensis	MED				x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x						
Sylvia nisoria	EUC	x	x	x	x	x	x	x	x	x	x																	
Sylvia curruca	EU	x	x	x	x	x	x	x	x																			
Sylvia communis	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sylvia borin	EUS	x	x	x	x	x	x	x	x	x	x				x													
Sylvia atricapilla	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Phylloscopus bonelli	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x							
Phylloscopus sibilatrix	EUR	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x		x
Phylloscopus collybita	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Regulus regulus	EU	x	x	x	x	x	x	x	x	x	x				x	x	x	x			x			x	x			x
Regulus ignicapillus	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x
Muscicapa striata	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x
Ficedula albicollis	EUR		x	x	x	x		x	x		x			x	x	x	x	x	x	x	x	x		x				x
Panurus biarmicus	EUC				x	x	x	x	x	x			x	x		x	x	x										
Aegithalos caudatus	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Parus palustris	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x		x	
Parus montanus	EUS	x	x	x	x	x	x	x								x	x	x										
Parus cristatus	EUR	x	x	x	x	x	x	x	x																			
Parus ater	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Parus caeruleus	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Parus major	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Sitta europaea	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Tichodroma muraria	EUCm	x	x	x	x	x	x	x	x	x	x			x	x	x	x											
Certhia familiaris	OA	x	x	x	x	x	x	x	x	x	x				x	x	x	x				x						
Certhya brachydactyla	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Remiz pendulinus	EUC			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
Oriolus oriolus	PO		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	

Lanius collurio	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Lanius minor	EUT		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
Lanius senator	MED			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Garrulus glandarius	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Pica pica	OA	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Nucifraga caryocatactes	EUS	x	x	x	x	x	x	x	x																			
Phyrrhocorax graculus	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x										
Phyrrhocorax phyrrocorax	EUCm				x	x	x	x	x	x		x		x	x	x	x	x			x	x						
Corvus monedula	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Corvus corone corone	O	x	x	x	x	x	x	x	x	x																		
Corvus corone cornix	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Corvus corax	OA	x	x	x	x	x	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	x	x	x	x	x
Sturnus vulgaris	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x				x			
Passer italiae	EN	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Passer domesticus	C	x	x	x	x	x	x	x																				
Passer hispaniolensis	MED																x											
Passer montanus	PO	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Petronia petronia	EUCm						x		x					x	x	x	x	x	x	x	x	x		x	x	x	x	x
Montifringilla nivalis	EUCm	x	x	x	x	x	x	x	x					x	x	x	x											
Fringilla coelebs	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Serinus serinus	EUR	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Serinus citrinella	EUR	x	x	x	x	x	x	x	x																			
Carduelis chloris	EUTm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Carduelis carduelis	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Carduelis spinus	EU	x	x	x	x	x	x	x																x	x	x		x
Carduelis cannabina	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Carduelis flammea	OAb	x	x	x	x	x	x	x	x																			
Loxia curvirostra	OA	x	x	x	x	x	x	x	x	x	x				x	x	x				x	x		x	x			x
Pyrrhula pyrrhula	EUS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x					
Coccothraustes coccothraustes	O	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		x								
Emberiza citrinella	EUS	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x						
Emberiza cirlus	MED		x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emberiza cia	EUCm	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Emberiza hortulana	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x		x				
Emberiza schoeniclus	EU	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			x			x		x				
Emberiza melanocephala	MED							x							x	x	x	x	x	x	x	x			x			
Miliara calandra	EUTm			x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

Annex 2. Correlations between chorotypes values and independent variables (latitude, altitude and climate) from multiple regression analysis.

Regression summary for Dependent Variable: model summary.

chorotypes	R	R square	Adj. R sq.	Std. Err.	F (4, 22)	p-level
PO	0.771	0.594	0.520	1.0802	8.053	0.000
OA	0.824	0.678	0.620	0.8033	11.604	0.000
PAL	0.851	0.725	0.675	1.2891	14.498	0.000
O	0.763	0.582	0.506	1.4694	7.663	0.001
EU	0.764	0.584	0.508	1.2566	7.721	0.000
EUS	0.953	0.909	0.892	0.7955	54.666	0.000
EUC	0.778	0.606	0.534	1.0931	8.449	0.000
EUCm	0.835	0.698	0.643	0.8663	12.705	0.000
EUTm	0.819	0.671	0.611	0.7755	11.199	0.000
EUR	0.719	0.517	0.429	1.0153	5.892	0.002
MED	0.794	0.63	0.562	1.9967	9.356	0.000

Coefficients

	B	Std. Err.	Beta	t	p-level
PO					
Constant	7.488	11.738		0,638	0.530
LAT	0.114	0.275	0.19	0,414	0.683
ALT MAX	0.000	0.000	-0.319	-1.332	0.196
MED TOM	-0.009	0.013	-0.259	-0.662	0.515
MED PED	**0.054**	**0.023**	**0.926**	**2.384**	**0.026**
OA					
Constant	-19.706	8.728		-2.258	0.034
LAT	**0.589**	**0.204**	**1.177**	**2.882**	**0.009**
ALT MAX	0.001	0.000	0.382	1.791	0.087
MED TOM	0.010	0.010	0.356	1.025	0.317
MED PED	0.023	0.017	0.471	1.361	0.187
PAL					
Constant	28.539	14.008		2.037	0.054
LAT	0.646	0.328	0.745	1.971	0.061
ALT MAX	0.000	0.000	-0.174	0.881	0.388
MED TOM	-0.014	0.016	-0.283	-0.879	0.389
MED PED	0.002	0.027	0.026	0.082	0.936
O					
Constant	25.203	15.967		1.579	0.129
LAT	-0.235	0.374	-0.294	-0.630	0.535
ALT MAX	0.000	0.000	-0.194	-0.798	0.433
MED TOM	**-0.041**	**0.018**	**-0,915**	**-2.307**	**0.031**
MED PED	0.08668	0.031	1.115	2.828	0.100
EU					
Constant	-10.316	13.654		-0.756	0.458
LAT	0.02	0.319	0.585	1.260	0.221
ALT MAX	0.000	0.000	0.197	0.813	0.425
MED TOM	0.014	0.015	0.364	0,919	0.368
MED PED	-0.024	0.026	-0.360	-0.916	0.370
EUS					
Constant	-52.943	8.644		-6.125	0.000
LAT	**1.294**	**0.202**	**1.393**	**6.397**	0.000
ALT MAX	**0.001**	**0.000**	**0.269**	**2.363**	**0.027**
MED TOM	**0.031**	**0.010**	**0.602**	**3.243**	**0.004**
MED PED	0.016	0.017	0.182	0.984	0.336
EUC					
Constant	-0.265	11.877		-0.022	0.982
LAT	0.088	0.278	0.143	0.316	0.755
ALT MAX	0.000	0.000	0.189	0.799	0.433
MED TOM	0.011	0.013	0.319	0.828	0.417
MED PED	-0.468	0.023	-0.786	-2.051	0.052
EUCm					
Constant	55.734	9.413		5.921	0.000
LAT	**-0.945**	**0.22**	**-1.699**	**-4.29**	0.000
ALT MAX	0.000	0.000	0.039	0.187	0.853
MED TOM	-0.021	0.011	-0.661	-1.959	0.063
MED PED	-0.017	0.018	-0.323	-0.964	0.345
EUTm					
Constant	19.610	8.427		2.327	0.030
LAT	-0.208	0.197	-0.436	-1.055	0.303
ALT MAX	**-0.001**	**0.000**	**-0.769**	**-3.562**	**0.002**
MED TOM	-0.004	0.009	-0.145	-0.411	0.685
MED PED	-0.014	0,016	-0,299	-0,854	0,402
EUR					
Constant	4.068	11.032		0.369	0.716
LAT	0.147	0.258	0.284	0.568	0.576
ALT MAX	0.000	0.000	0.366	1.403	0.175
MED TOM	-0.005	0.012	-0.181	-0.424	0.676
MED PED	0.004	0.021	0.072	0.169	0.867
MED					
Constant	69.897	21.695		3.222	0.004
LAT	-1.387	0.508	-1.197	-2.732	0.012
ALT MAX	0.000	0.001	-0.047	-2.732	0.838
MED TOM	0.013	0.024	0.203	0.545	0.591
MED PED	-0.082	0.042	-0.739	-1.992	0.059

Annex 3. Table structured from the Cluster Analysis: Three clusters of chorotypes and three clusters of LBs are shown.

	I°	**II°**	**III°**
	LB 1-8	**LB 9-21, 23,24**	**LB 22, 25-27**
I°	**mean values**	**mean values**	**mean values**
MED	5.52	10.65	10.93
EUTm	6.43	8.37	8.63
EUR	12.83	10.90	10.32
PO	10.91	11.89	14.67
O	13.05	14.04	18.69
EUCm	12.80	14.75	15.92
tot	**61.53**	**70.61**	**79.16**
II°			
EU	9.66	7.42	4.98
OA	9.18	7.00	6.63
EUS	8.57	4.75	2.30
EUC	4.72	3.63	0.95
tot	**32.13**	**22.80**	**14.86**
III°			
EUT	1.39	1.02	0
EN	0.82	0.92	1.33
C	1.73	1.65	1.65
PP	2.41	3.00	3.00
tot	**6.34**	**6.59**	**5.99**

Annex 4. Correlations among chorotypes and diversity indices values.

	MED	**EUTm**	**EUR**	**PO**	**O**	**EUCm**	**EU**	**OA(°)**	**EUS**	**EUC**	**EUT**	**EN**	**C**	**PP**	**J'**	**d**
MED	1															
EUTm	0.75	1														
EUR	-0.85	-0.80	1													
PO	0.24	0.44	-0.36	1												
O	0.20	0.31	-0.29	0.88	1											
EUCm	0.61	0.63	-0.58	0.38	0.39	1										
EU	-0.77	-0.67	0.78	-0.53	-0.63	-0.58	1									
OA	-0.88	-0.88	0.78	-0.39	-0.37	-0.64	0.77	1								
EUS	-0.74	-0.79	0.66	-0.67	-0.62	-0.83	0.71	0.83	1							
EUC	-0.25	-0.37	0.28	-0.90	-0.80	-0.46	0.40	0.35	0.71	1						
EUT	-0.30	-0.16	0.22	-0.68	-0.63	-0.40	0.40	0.25	0.52	0.66	1					
EN	0.30	0.39	-0.38	0.94	-0.95	0.47	-0.60	-0.42	-0.72	-0.91	-0.74	1				
C	0.09	0	-0.10	0	-0.07	-0.38	-0.03	-0.12	0.15	0.01	-0.03	-0.01	1			
PP	0.58	0.34	-0.46	0.14	-0.10	0.43	-0.32	-0.49	-0.54	-0.36	-0.24	0.25	-0.03	1		
Pielou J'	-0.17	-0.29	0.19	-0.85	-0.75	-0.40	0.46	0.26	0.57	0.73	0.70	-0.77	0.19	-0.05	1	
Berger-Parker (d)	0.35	0.37	-0.39	0.84	0.95	0.53	-0.69	-0.49	-0.71	-0.76	-0.71	0.93	-0.12	0.21	-0.75	1