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Plant diversity in some alpine islands of the Northern Apennines (Italy)

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Abstract

In the Northern Apennines the alpine vegetation belt is narrow and scattered and can be regarded as an archipelago of alpine islands. Its flora contains 391 taxa which are distributed in 31 plant communities. On such chain many plant species with a geographic distribution centred in Central Europe and the Alps reach their southern geographic limits in Italy and have small population sizes. Four alpine islands covering the size range of the Northern Apennine alpine areas were considered. From North West to South East they were the following: Cavalbianco, Prado-Cusna, Gomito-Tre Potenze and Corno alle Scale. The correlation between species richness and area is very high (r^2= 0.98). Preliminary information about the florogeny of such ecological islands was evaluated by the index of species originality per genera (ORsg). Such index has negative values in every mountain considered. Such result describes the prevalence of an allochtonous trend in the local florogeny and may be explained both by the known natural history of the Northern Apennines and their close proximity to the Western Alps. As shown by phytogeographic evidences, the Northern Apennines may be considered the extreme offshoot of western alpine flora in Italy.

Introduction

Between the ecological islands, the areas which lie along phytogeographical boundaries are of high interest, because their ecological insularities are often coupled with rarity of suitable habitats for many species. It is the case of the areas above the Northern Apennine timberline. This chain stretches along the phytogeographic boundary between the Central European and Mediterranean region of Italy, at about 44° N. Its higher plant diversity is very similar to that of the Western Alps, although significantly impoverished (ARRIGONI 1983). For such reason the Northern Apennine areas above the timberline may be considered the extreme southwards sites for the western alpine flora in Italy

Timberline - which locally corresponds to the altitudinal limit of beech woods - occurs chiefly between 1700 and 1800 m. Only 25 peaks are more than 1750 m high, and few peaks exceed 2000 m. As a consequence, the local alpine vegetation belt is rare, narrow and scattered and its areas can be regarded as an archipelago of ecological islands (Fig. 1). They contain 391 taxa which are distributed in 31 plant communities (PORTANOVA 1999). Their flora is very poor in local endemics but it is rich in small populations of species with peripherical distributions with respect to their main geographic areas, which are centred in Central Europe and the Alps. Such species reach on the Northern Apennines their southern geographic limits in Italy and are locally very rare or rare (Table 1).

At a regional level the alpine islands of the Northern Apennines are considered as a natural wealth and are all protected within Natural Parks. Their rare species are particularly vulnerable to climatic and land use changes. The description of relationships between their local distributions with microclimate and soil features is in progress.

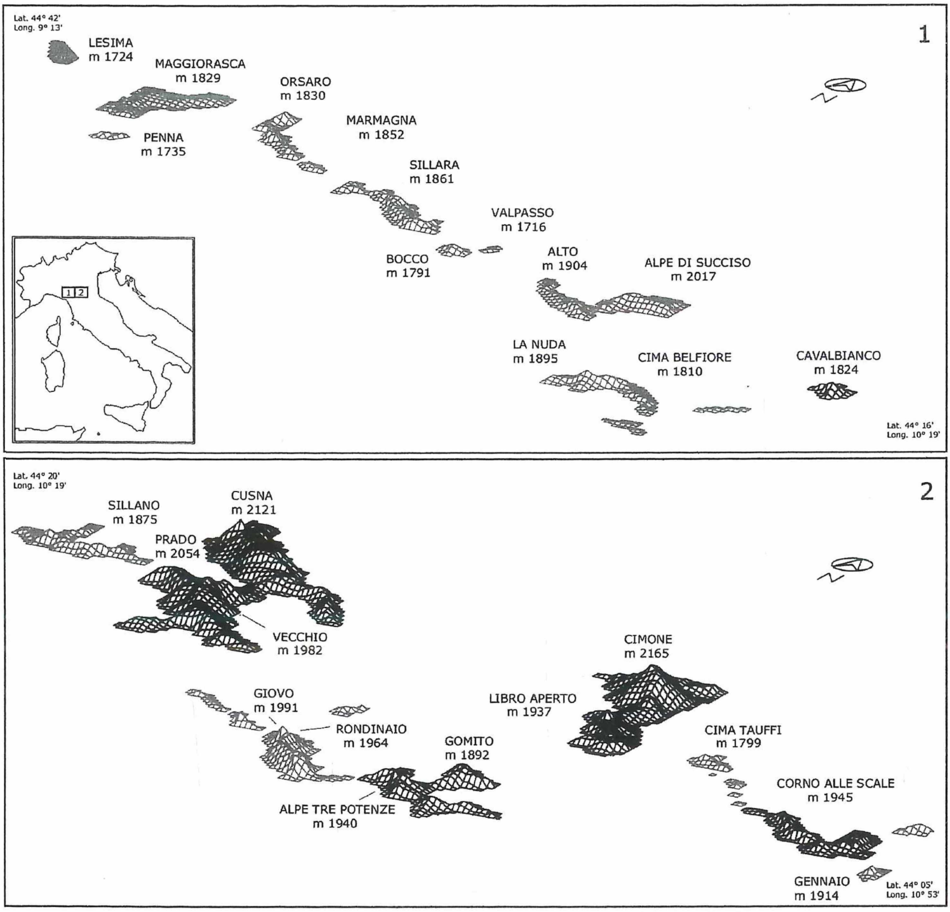

Fig. 1: The Northern Apennine areas above the timberline. The four alpine islands considered are drawn in black (from FERRARI & PICCOLI 1997; modified).

In order to improve conservation strategies, a preliminary survey was made on the taxonomic and phytogeographic diversity of the northern Apennine alpine islands. To estimate conservation value of the different mountain areas, preliminary information were obtained on the following plant diversity features:

1. Main florogenic trends
2. Relationship between species richness and area
3. Spatial diversity of species and chorotypes

The alpine islands considered

Four alpine islands were considered. From North West to South East they are the following: Cavalbianco (600 ha), Prado-Cusna (2357 ha), Gomito-Tre Potenze (551 ha) and Corno alle Scale (440 ha). Their different areas and elevations cover the local extension range of the alpine vegetation belt (Table 2). Landforms generated by Würmian glacial cirques are very frequent. In the highest peaks periglacial morphogenesis is still active. The lithological substrate is a turbiditic compact sandstone (upper Oligocene-lower Miocene), locally named "macigno". Annual precipitation of summit ridges ranges from 1000 to 3500, with a mean of

Table 1: Rare species of the Northern Apennine alpine vegetation. Degrees of rarity, chorotypes and types of rarity are indicated. The rarity degree (RI) was estimated according GÉHU & GÉHU (1980) and is taken from FERRARI et al (2000). Abbreviations of chorotypes are as follows: AA- arctic-alpine; CB- circumboreal; CS- cosmopolitan; EN- endemic; EA- Eurasian; OR- orophyte; SC- subcosmopolitan; SN- subendemic. Abbreviations of rarity types are the following: Gr- narrow geographic range; Hs- habitat specificity; Pd- Peripheral distribution, Sp- small population size. Other explanations in the text.

RI	Taxon	Chorotype	Type of rarity
0.97	*Hieracium glanduliferum*	OR	Pd/Sp
0.97	*Soldanella pusilla*	OR	Pd/Hs
0.97	*Senecio incanus*	SN	Pd
0.97	*Salix herbacea*	AA	Pd/Hs/Sp
0.97	*Salix breviserrata*	AA	Pd/Sp
0.97	*Pedicularis rostrato-spicata*	OR	Pd/Sp
0.97	*Leucanthemopsis alpina*	OR	Pd
0.90	*Lychnis alpina*	AA	Pd/Sp
0.90	*Luzula lutea*	OR	Pd
0.90	*Gnaphalium supinum*	AA	Pd
0.90	*Carex foetida*	OR	Hs/Sp
0.87	*Polygonum viviparum*	AA	Hs/Sp
0.87	*Luzula alpino-pilosa*	AA	Pd
0.87	*Luzula multiflora*	CB	Sp
0.83	*Gentiana nivalis*	AA	Pd/Sp
0.83	*Viola palustris*	CB	Hs/Sp
0.83	*Soldanella alpina*	OR	Sp
0.83	*Carex ornithopoda*	EA	Pd
0.80	*Silene acaulis ssp bryoides*	AA	Pd
0.80	*Primula apennina*	EN	Gr
0.80	*Carex canescens*	CS	Hs
0.77	*Rhododendron ferrugineum*	OR	Pd/Sp
0.73	*Euphrasia minima*	OR	Pd
0.73	*Euphrasia alpina*	OR	Pd
0.73	*Erigeron uniflorus*	AA	Pd/Sp
0.70	*Lycopodium annotinum*	CB	Pd/Sp
0.63	*Armeria marginata*	SN	Gr
0.60	*Saxifraga latina*	EN	Gr/Sp
0.57	*Sempervivum montanum*	OR	Pd
0.57	*Huperzia selago*	SC	Sp
0.50	*Gentiana purpurea*	OR	Pd
0.43	*Pinguicula vulgaris*	EA	Hs/Pd
0.43	*Leuchorchis albida*	AA	Sp
0.40	*Pulsatilla alpina*	OR	Sp
0.40	*Viola calcarata ssp cavillierii*	EN	Gr
0.40	*Sempervivum arachnoideum*	OR	Sp
0.40	*Festuca violacea ssp. puccinellii*	SN	Pd
0.40	*Botrychium lunaria*	SC	Sp
0.37	*Saxifraga moschata*	OR	Sp
0.27	*Festuca riccerii*	EN	Gr
0.27	*Astrantia minor*	OR	Pd
0.27	*Aster bellidiastrum*	OR	Sp
0.23	*Aster alpinus*	CB	Sp

2000 mm (ROSSETTI 1988). Precipitation mostly occurs as snow from November to April and snow melts from May to the beginning of July, according to differences in topography and exposure. The climax is a *Vaccinium gaultherioides - V. myrtillus* heathland, but acidophytic and mesophytic alpine grasslands as well screes communities are often selected by landforms. Phytosociological vegetation types belong to orders such as *Loiseleurio-Vaccinietalia*, *Salicetalia herbaceae*, *Nardetalia*, *Caricetalia curvulae*, *Androsacetalia alpinae*. Some plant communities are impoverished forms and others are probably vicariant communities of those described for the Alps (TOMASELLI 1991; TOMASELLI 1994; FERRARI & PICCOLO 1997).

Table. 2: Geographic and taxonomic data. The sixth column shows the values of the index of species originality per genera.

alpine island	area (ha)	elevation (m)	genera	species	ORsg
Prado-Cusna (PC)	2357	2121	178	336	- 0.01
Cavalbianco (CV)	600	1854	123	179	- 0.02
Gomito- Tre Potenze (GP)	551	1940	159	274	- 0.01
Corno alle Scale (CS)	440	1945	145	235	- 0.01

Florogenic trends

Information about the florogeny of such ecological islands was evaluated by the regression of the number of species on the square numbers of genera. The result is shown by the scatterplot diagram of Fig. 2. The four islands considered lie on the regression line. A clearer insight on such result can be obtained by the index of species originality per genera (MALYSHEV 1991):

$$ORsg: (S - S') / S \qquad (1)$$

where S and S' are, respectively, observed and expected numbers of species. S' may be calculated by the regression equation. The index has slight negative values in every mountain considered (Table 2). Such fact indicates a low species diversity within the genera, i.e. a prevalence of an allochtonous trend in the florogeny of the alpine islands considered. The prevalence of allochtonous trends may be explained by their peripheral location with respect to the geographic distribution of Boreal and alpic vegetation in Italy.

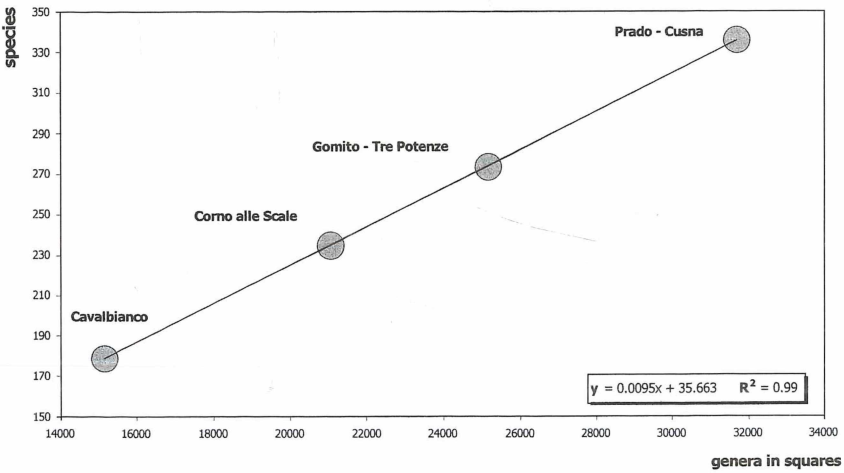

Fig. 2: Regression of species on genera in squares.

Species/area relationship

As shown by Table 2, the increase of area corresponds to an increase in species number. The log-normal distribution leads to a linear relationship between the logarithm of the species number and the logarithm of the area (Fig. 3). The correlation ist very high ($r^2 = 0.97$) and the increase of species number with area is significant ($P = \leq 0.02$). The tangent of the slope the regression line - usually indicated as z - can be used as a measure of Δ-diversity, i.e. of the degree to which the local floras are differentiaed (WHITTAKER 1972). It is expressed as (PRESTON 1962):

$$Z = (\log_2 S_{1a} - \log_2 S_{sm}) / (\log_2 A_{1a} - \log_2 A_{sm}) \quad (2)$$

Where S_{1a} is the species richness of the largest area A_{1a} and S_{sm} the richness of the smallest one (A_{sm}). The Δ-diversity was z = 0.17, i.e. a value lower than the theoretical one indicated by PRESTON (z = 0.27) for proper islands of different size. Such result may be explained by observing that our ecological islands correspond to a single belt, which contains a relatively low number of habitats.

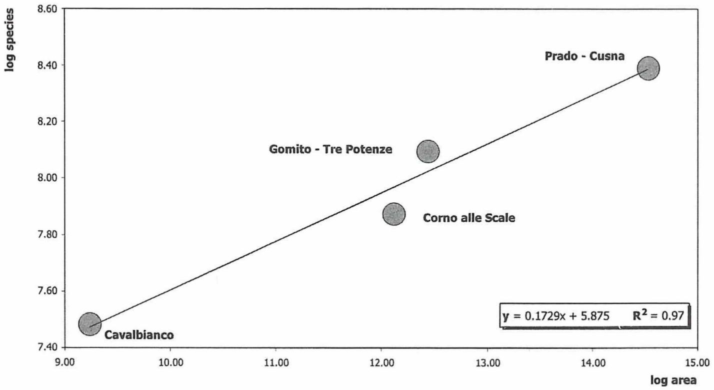

Fig. 3: Relationship between the species number and area.

Phytogeographic features

Table 3 shows the chorological spectra of the alpine islands considered. They are ordered according to the geographic distribution of the mountains from North-West (left) to South-East (right). South-european orophytes, and Boreal taxa are the dominant chorotypes. It is noteworthy a relevant amount of Arctic-alpine taxa. The largest area considered (Prado-Cusna), has the highest content of such chorotypes, while the smallest area (Cavalbianco) has the lowest one.

For a better description of such fact we have estimated the spatial species turnover of the chorotypes. Turnover was calculated as:

$$T = 1 - S \quad (3)$$

where S is the SØRENSEN (1948) similarity index.

The turnover values are shown by Table 3. It can be observed that:
- the larger the area, the higher the turnover of such taxa.
- Boreal taxa show low mean values, while high mean values characterise the Arctic-alpine

Table 3: Phytogeographic features of the Northern Apennine alpine islands. Chorological spectra and chorotype turnovers. Abbreviations of alpine islands as in Table 2.

chorotype	CV	PC	GP	CS	CV-PC	PC-GP	GP-CS
endemic	5%	7%	3%	6%	0.44	0.60	0.43
eurimediterranean	2%	1%	1%	1%	0.71	0.33	0.60
med-montane	2%	3%	1%	2%	0.50	0.64	0.71
eurasian	20%	14%	15%	18%	0.36	0.32	0.39
atlantic	1%	1%	1%	1%	0.67	0.43	0.60
S-european orophyte	35%	36%	38%	35%	0.37	0.39	0.37
circumboreal	23%	22%	28%	23%	0.37	0.29	0.24
arctic-alpine	6%	11%	7%	8%	0.57	0.46	0.43
cosmopolitan	6%	5%	6%	6%	0.36	0.38	0.17

taxa and Apennine endemics, to whom belong the locally rarest species. The alpine areas considered have a high originality as to Arctic-alpine taxa and Apennine endemics. In other words, the most of the Arctic-alpine taxa and endemics are linked to one or very few islands.

Concluding remarks

Plant diversity of the Northern Apennine alpine vegetation we have examined, is characterized by some main features:

1. Its origin is mainly due to immigration of species from genetic centres which are in common with the Western Alps.
2. Its species richness is linked to the extent of the alpine belt.
3. The spatial distributions of the Arctic-alpine and Apennine endemic taxa, (i.e of the most vulnerable taxa), show high links to one or few alpine islands.
4. Arctic-alpine, and Boreal taxa as a whole, have a high spatial turnover of species. As a consequence, their species have a scattered spatial distribution. On the alpine islands the chorotypes contain a species number which is related to the extent of the vegetation belt. No evidence was found on a richness loss along the geographic gradient - from North-West to South-East - that was outlined by OZENDA (1964) and FERRARINI (1979).

References

ARRIGONI, P.V., 1983 (1980): Aspetti corologici della flora sarda. - Lavori Soc. Ital. Biogeogr., n.s. **8**: 81-109.

FERRARI, C. & PICCOLI, F. (1997): The ericaceous dwarf shrublands above the Northern Apennine timberline. - Phytocoenologia **27** (1): 53-76.

FERRARI, C., PEZZI, G; & PORTANOVA, A. (2000): The distribution of rare plant species on Mount Prado, a Northern Apennine diversity hot spot. - Acta Phytogeographica Suecica **85** (in press).

FERRARINI, E. (1979): Note floristiche sull' Appennino settentrionale (dal passo della Cisa al Passo delle Radici). - Webbia **33** (2): 235-267.

GÉHU, J.M. & GÉHU, J. (1980) Essai d' objectivation de l' evaluation biologique des milieux naturels. Exemples littoraux. – In: GEHU, J.M. (ed) Seminaire de Phytosociologie Appliqée: 75-94. Amicale Francophone de Phytosociologie, Metz

MALYSHEV, L. I. (1991): Some quantitative approaches to problems of comparative floristics. - In: NIMIS, P.L. & CROVELLO, T.J. (eds), Quantitative approaches to phytogeography: 15-33 Kluwer Publishers, Dordrecht.

Ozenda, P. (1964): Biogeographie végétale. Editions Doin, Paris.

PORTANOVA, A. (1999) : Distribuzione della diversità tassonomica e corologica nella vegetazione alpina dell' Appennino settentrionale. Primo contributo. - Tesi Dottorato in Geobotanica (XII ciclo), Univ. Pavia.

PRESTON, F.W. (1962): The canonical distribution of commonness and rarity. - Ecology **43**: 185-215; 410432.

SØRENSEN, T. (1948): A method of establishing groups of equal amplitude in plant sociology based on similarity of species content. - Det Kong. Danske Vidensk. Selsk. Biol. Skr. (Copenhagen) **5** (4): 1-34.

TOMASELLI, M. (1991): The snow-bed vegetation in the Northern Apennines. - Vegetatio **94**: 177-189.

TOMASELLI, M. (1994): The vegetation of summit rock faces, talus slopes and grasslands in the northern Apennines. - Fitosociologia 26: 35-50.

WHITTAKE, R.H. (1972): Evolution and measurement of species diversity. - Taxon **21**: 213-251.

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