

Floristic and phytosociological analysis of thermophilous oak woodland in Pomarolo (Trentino, NE Italy)

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SUMMARY - *Floristic and phytosociological analysis of thermophilous oak woodland in Pomarolo (Trentino, NE Italy)* - The flora and vegetation of a wooded area near Pomarolo (Trentino, NE Italy) were investigated as part of a wider forest monitoring programme named EFOMI (Ecological Valuation in Alpine Forest Ecosystems by Integrated Monitoring). The flora was accurately recorded, compared with past surveys and related to the regional plant distribution mapping data. Landolt and Ellenberg ecological indexes were applied to the floristic census and gave the general indication that in the past ten years species typical of dryer habitats and warmer climates increased significantly, possibly connected to climate change. The vegetation was studied employing the phytosociological methodology allowing to refer the plant community to the association *Mercuriali ovatae-Ostryetum*. This is a thermophilous young community still evolving in its dynamic series towards its climax. In this association the now disused coppice practice and reforestation with alien trees, now gradually disappearing, can still be noted. Many species from clearings and transition areas can be noted.

RIASSUNTO - *Analisi floristica e vegetazionale del querceto termofilo di Pomarolo (Trentino, Italia)* - La flora e la vegetazione di un querceto termofilo nei pressi di Pomarolo (Trentino, Italia) sono state censite e caratterizzate nell'ambito di un progetto più ampio di monitoraggio della salute dei boschi (EFOMI - Valutazione Ecologica di Cenosi Forestali sottoposte a Monitoraggio Integrato). La flora è stata raffrontata con dati rilevati nella stessa zona anni addietro e il suo valore fitogeografico locale è stato analizzato con riferimenti ai dati del progetto di cartografia floristica provinciale. L'analisi dei fattori ecologici mediante l'uso degli indici di Ellenberg e Landolt ha messo in evidenza come negli ultimi dieci anni vi sia stato un significativo aumento delle specie tipiche di ambienti aridi e climi secchi, forse dovuto a mutamenti globali del clima. Per quanto riguarda la vegetazione, l'analisi fitosociologica ha permesso di identificare il querceto come un bosco termofilo, ancora in fase di evoluzione, e inquadrabile nell'associazione *Mercuriali ovatae-Ostryetum*. È stato altresì evidenziato come siano presenti specie appartenenti ad associazioni di margine e di transizione, e come nelle formazioni boschive presenti sia ancora possibile riconoscere l'influsso dell'attività dell'uomo.

Key words: flora, vegetation, phytosociology, thermophilous oak woodland, Trentino

Parole chiave: flora, vegetazione, fitocenosi, querceto termofilo, Trentino

1. INTRODUCTION

A sound analysis of the effects of climate change on complex ecosystem such as forests requires a multidisciplinary approach. The EFOMI Project (Ecological Valuation in Alpine Forest Ecosystems by Integrated Monitoring) tries to address this issue. One of the chosen sites was a thermophilous oak woodland in Pomarolo (Trentino, NE Italy) that has been monitored since 1992 (Minerbi *et al.* 1996; Ambrosi *et al.* 1998; Ambrosi *et al.* 2002; Marchetti *et al.*

2002) as part of the 2nd level European monitoring network for pollution (ID code IT04). The EFOMI monitoring activities were carried out between 2001 and 2003 aiming to characterise and evaluate the flora and the vegetation of the area.

2. STUDY AREA

The study area is located near Pomarolo (TN) at coordinates 45° 56' 41" N and 11° 03' 28" E (map Datum:

Rome 1940). It lies on a gentle slope facing East and extends for approx. 2 hectares, it is forested by mixed broadleaves, dominated by downy oak (*Quercus pubescens* Willd.), and ranges from an altitude between 650 and 700 m a.s.l.

This area, like most of the local woodlands, was traditionally managed for coppice, altering in this way its natural structure and species composition, also affecting tress age class distribution (Ciancio 2003). These types of woodlands can generally be considered fragments of forests isolated in cultivated areas.

The mesoclimate can be defined as subalpine-continental with a sub-mediterranean component; rain patterns can be defined sub-equinotial, increasing the aridity of the site already critical because of the already thin soil layer (Minerbi *et al.* 1996; Ambrosi *et al.* 2002; Marchetti *et al.* 2002). The mean annual rainfall is approx. 1078 mm, with peak values in spring, autumn and summer, and minimum values in winter (Marchetti *et al.* 2002); the annual mean temperature is approx. 11 °C. According to FAO soil classification, Pomarolo belongs to brown Eutric Cambisol, developed on limestone base rock (Minerbi *et al.* 1996).

3. METHODS

The flora was accurately recorded during a 3 year period. The target area include a diverse range of microhabitat ranging from woodland to small clearings and rocky outcrops that host a significantly different flora with respect to the properly wooded area. The full list of species is presented in Appendix 1 and also includes information on growth form and distribution area groups.

Ecological indicators were applied in relation to soil moisture content, soil pH, soil nutrients humus, soil aeration, soil salinity, light and temperature according to Landolt (1977) and Ellenberg (1992). Other data

were recorded in 1993 (IASMA, unpublished data) in this area.

As far as possible, these data were compared with the actual data. As far as forest vegetation analysis is concerned, some quadrates were taken according to the SIGMA methodology (Braun-Blanquet 1964); cover-abundance values were recorded according to Pignatti & Mengarda (1962). The taxonomic treatment is after Pignatti (1982), the syntaxonomic treatment is after Poldini (1982, 1987); Oberdorfer (1983, 1992); Del Favero & Lasen (1993); Poldini & Vidali (1996); Del Favero (2000); Odasso (2002); Poldini *et al.* (2002).

4. RESULTS AND DISCUSSION

4.1. Flora

The floristic census yielded 214 species belonging to 52 families. The threatened species included in the local Red Data Book (Prosser 2001) are: *Orchis morio* L., *Pulsatilla montana* (Hoppe) Rchb. and *Quercus robur* L. in threat category LR; *Verbascum phoeniceum* L. (new record for the grid base area) in threat category EN. Notable species are also the alpine endemics *Galium rubrum* L., *Pulmonaria australis* (Murr) Sauer and *Phyteuma betonicifolium* Vill. occurring in the whole Alpine chain and the East Alpine endemic *Bromus condensatus* Hackel, occurring in the foothills of the Eastern Alps.

4.1.1. Growth forms

The growth form analysis is carried out according to the scheme proposed by Raunkiaer (1934).

In Pomarolo, the biological spectrum is as follows Hemicryptophytes (H) 117 (54.9%), Geophytes (G) 33 (15.3%), Phanerophytes (P) 30 (14.0%), Chamaephytes (Ch) 21 (9.8%), Nano Phanerophytes (NP) 7 (3.3%) and Therophytes (T) 6 (2.8%).

Tab. 1 - Percentage of growth form types in Pomarolo, in Italy and in Trentino - South Tyrol.

Tab. 1 - Valori % rilevati a Pomarolo per le forme biologiche e valori % per l'Italia e per la regione Trentino - Alto Adige.

	Species Nr.	T	I	He	G	H	Ch	NP	P
Italy	5,811	25.1	2.3	0.3	12.1	41.7	10.3	3.6	4.9
Trentino - South Tyrol	2,551	20.1	2.6	0.3	12.6	49.1	7.1	2.7	5.6
Pomarolo	214	2.8	0	0	15.3	54.9	9.8	3.3	14.0

Table 1 shows the comparison among the figures recorded in Pomarolo, in the whole of Italy and in the administrative district Trentino - South Tyrol according to Pignatti (1994). With respect to the general Italian situation, Pomarolo shows a low level of Terophytes and a high number of Hemicryptophytes, confirming the temperate climate of the area; a significantly higher level of Geophytes is an indication of possible periodical draught stress and is also typical of broadleaves deciduous woodlands. A high percentage of Phanerophytes, Chamaephytes and Nano Phanerophytes is typical of a forest community, in particular the abundance of shrubs and bushes (C and NP) indicates a young evolving wood.

4.1.2. Plant distribution groups

An analysis of the repartition of the different species surveyed in standard distribution groups as defined by Pignatti (1982, 1994) produces these figures: Eurasian species 112 (52.1%), Nordic species 34 (15.8%), South European Orophytes 32 (15.3%), Euri Mediterranean 20 (9.3%), Cosmopolite 7 (3.3%), Atlantic 6 (2.8%) and Mediterranean Montane 3 (1.4%).

Table 2 shows the comparison between the figures recorded in Pomarolo and in the whole of Italy and in the administrative district Trentino - South Tyrol according to Pignatti (1994). Euro-Mediterranean and Mediterranean Mountain groups show values higher

Tab. 2 - Percentage of geographical distribution area groups in Pomarolo, in Italy and in Trentino - South Tyrol.

Tab. 2 - Valori % rilevati a Pomarolo per le forme corologiche e valori % per l'Italia e per la regione Trentino - Alto Adige.

	Species Nr.	Endemic	Steno-med.	Euri-med.	Med.-Mount.	Euras.	Atlant.	Orof. Sudeur.	Nordic	Cosm.
Italy	5,590	13.50	16.65	7.72	7.16	20.93	3.83	9.80	8.42	11.96
Trentino - South Tyrol	2,551	4.1	1.5	9.8	2.5	32.0	2.6	17.2	16.7	11.1
Pomarolo	214	0	0	9.3	1.4	52.1	2.8	15.3	15.8	3.3

Tab. 3 - Percentage of Landolt indices for the species listed in 1993 and in 2002-2003. (F= moisture, L= light, T= temperature, K= continentality, R= pH, N= nutrients, H= humus, D= granulometry).

Tab. 3 - Valori percentuali degli Indici di Landolt per le specie rilevate nel 1993 e nel 2002-2003. (F= umidità, L= luminosità, T= temperatura, K= continentalità, R= acidità, N= disponibilità di nutrienti, H= contenuto in humus del suolo, D= granulometria).

	Landolt indices								
	F	L	T	K	R	N	H	D	
1993									
0	2.11	1.05	1.05	1.05	4.21	1.05	2.11	6.32	
1	11.58	1.05	0.00	0.00	3.16	1.05	0.00	1.05	
2	48.42	9.47	6.32	13.68	10.53	61.05	6.32	6.32	
3	36.84	45.26	46.32	54.74	34.74	30.53	60.00	24.21	
4	1.05	41.05	31.58	30.53	44.21	6.32	29.47	51.58	
5	0.00	2.11	14.74	0.00	3.16	0.00	2.11	10.53	
2003									
0	0.95	0.47	0.47	0.95	2.37	0.47	0.95	3.32	
1	15.17	1.42	0.00	0.00	1.42	1.42	0.00	1.90	
2	46.45	8.53	5.69	14.69	6.16	55.45	8.53	5.69	
3	34.60	44.55	38.39	52.61	37.44	31.75	63.98	31.28	
4	2.84	41.23	39.34	31.75	51.18	10.43	26.07	44.55	
5	0.00	3.79	16.11	0.00	1.42	0.47	0.47	13.27	

than the average, indicating in this way a warm climate with mild winters. The high percentage of South European Orophytes is typical of mountain habitats and includes the notable Alpine Endemics already mentioned at 4.1 (*Bromus condensatus*, *Galium rubrum*, *Phyteuma betonicifolium* and *Pulmonaria australis*). Eurasian species are the predominant group (> 50%), being typical of deciduous forests and arid steppe grasslands that are the main habitats present in the study area. **The scarcity of Cosmopolite and Atlantic species** as opposed to the abundance of the Nordic elements can be accounted for the geographical location of the study area.

Tab. 4 - Percentage of Ellenberg indices for the species listed in 1993 e and in 2002-2003. (L= light, T= temperature, K= continentality, F= moisture, R= pH, N= nutrients).

Tab. 4 - Valori percentuali degli Indici di Ellenberg per le specie rilevate nel 1993 e nel 2002-2003. (L= luminosità, T= temperatura, K= continentalità, F= umidità, R= acidità, N= disponibilità di nutrienti).

	Ellenberg indices					
	L	T	K	F	R	N
1993						
0	1.23	10.53	2.50	0.00	6.15	2.90
1	0.00	0.00	0.00	0.00	1.54	10.14
2	0.00	0.00	8.75	4.41	6.15	20.29
3	0.00	5.26	30.00	27.94	6.15	33.33
4	14.81	0.00	37.50	35.29	1.54	11.59
5	7.41	45.61	12.50	22.06	6.15	10.14
6	13.58	22.81	5.00	5.88	1.54	10.14
7	43.21	8.77	3.75	2.94	27.69	1.45
8	19.75	7.02	0.00	1.47	35.38	0.00
9	0.00	0.00	0.00	0.00	7.69	0.00
10	0.00	0.00	0.00	0.00	0.00	0.00
2003						
0	0.56	8.89	1.73	0.00	4.79	4.67
1	0.00	0.00	0.00	1.28	0.68	8.00
2	1.69	0.00	13.29	9.62	4.11	20.67
3	1.69	5.93	26.59	26.28	2.05	29.33
4	8.43	1.48	32.37	28.85	3.42	9.33
5	10.11	35.56	19.65	20.51	4.11	10.67
6	12.36	28.15	4.05	8.33	3.42	8.00
7	41.57	12.59	2.31	3.85	30.82	6.67
8	18.54	7.41	0.00	1.28	37.67	2.00
9	5.06	0.00	0.00	0.00	8.90	0.67
10	0.00	0.00	0.00	0.00	0.00	0.00

4.1.3. Ellenberg and Landolt ecological indicators

Ellenberg (1992) assigned to approx 2,000 European species specific values (min 1 max 9) related to their tolerance to different ecological parameters (air parameters: L= luminosity, T= temperature, K= continentality; soil parameters: F= moisture, R= pH, N= nutrients). Landolt (1977) produced a similar system for the Swiss flora, with 10 parameters (min 1 max 5) that can be applied with success to our alpine sites as well (air parameters: L= luminosity, T= temperature, K= continentality; soil parameters: F= moisture, R= pH, N= nutrients, H= humus, D= granulometry, S= salinity, W= growth forms).

This analysis was applied to data collected in 2002 and 2003 and back in 1993 as shown in table 3 and table 4 (IASMA, unpublished data). However, this comparison must be evaluated carefully as there is no herbarium material dating back to 1993 that might be double checked for reference and dubious species. In both periods we can notice a predominance of plants that prefer luminous sites (> 85%), basic limestone soils (> 88%) with a medium to high humus contents (94%), with sandy to gravel texture (86%), with an intermediate climate between sub-oceanic and sub-continental (83%). As far as moisture, nutrients and temperature are concerned in 2002-2003, we can notice an increase in the percentage of species that characterise poorer soils (+5%), arid soils (+4.2% according to Landolt, + 8.2% according to Ellenberg) and warmer climates (+8% according to Landolt, + 10.1% according to Ellenberg) as shown in figure 1 and 2 respectively.

From a more general point of view, the predominant species belong to nutrient poor soils (87.2%), arid soils (97%) and moderately warm climates (76 to 78%).

4.2. Vegetation

As reported in table 5, nine quadrates were taken in the wooded area in order to describe the vegetation that can be referred to the following syntaxonomic scheme:

QUERCO-FAGETEA Br.-Bl. et Vlieger in Vlieger 1937

Quercetalia pubescentis Klika 1933

Carpinion orientalis Horvat 1958

Helleboro nigri-Ostryenion carpinifoliae Ubaldi 2002

Mercuriali ovatae-Ostryetum carpinifoliae Poldini 1982

The order *Quercetalia pubescentis* identifies the mixed thermophilous forest, both sub-Mediterranean and Mediterranean-Mountain, that occurs in the northern part of the Mediterranean basin (Poldini 1989; Oberdorfer 1992). The associations present in

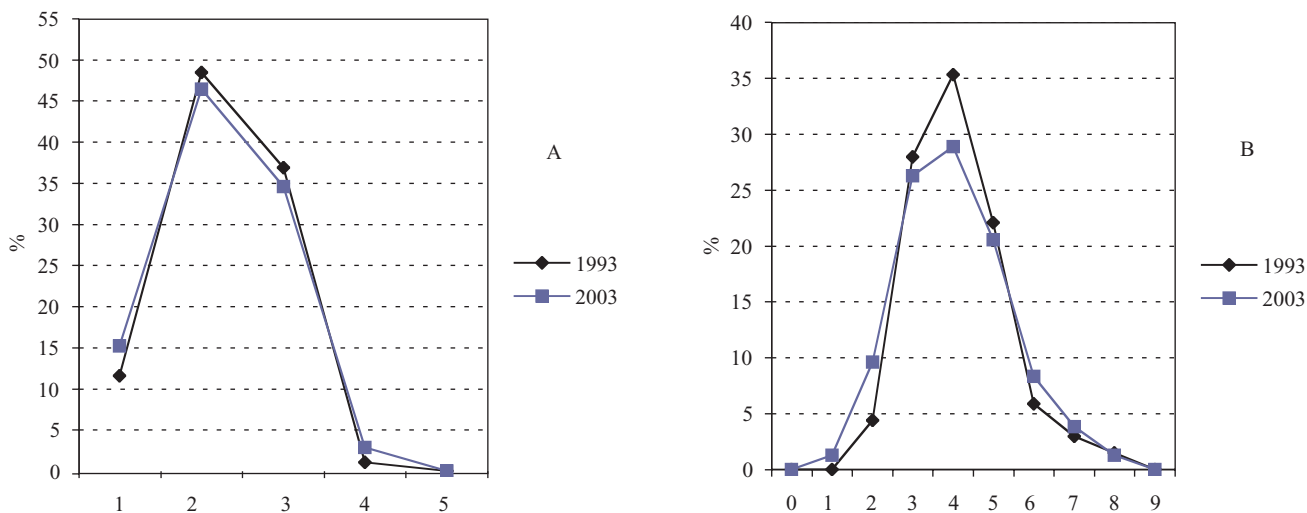


Fig. 1 - Comparison between percent values according to Landolt (A) and Ellenberg (B) moisture index for the species recorded in 1993 and in 2002-2003.

Fig. 1 - Confronto tra i valori percentuali secondo Landolt (A) e Ellenberg (B) dell'indice di umidità per le specie rilevate nel 1993 e nel 2002-2003.

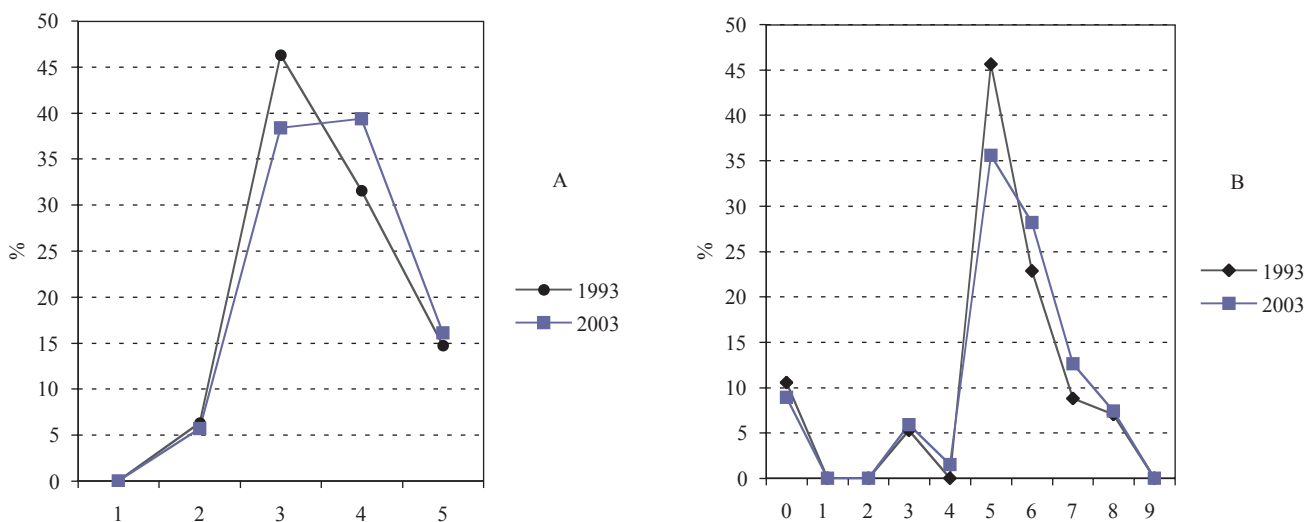


Fig. 2 - Comparison between percent values according to Landolt (A) and Ellenberg (B) temperature index for the species recorded in 1993 and in 2002-2003.

Fig. 2 - Confronto tra i valori percentuali secondo Landolt (A) e Ellenberg (B) dell'indice di temperatura per le specie rilevate nel 1993 e nel 2002-2003.

this order can be both climax association and early stages associations in the vegetation dynamics (Pignatti 1998). Poldini (1987) includes European *Ostrya*- and *Quercus* forests into the alliance *Carpinion orientalis*, that occurs in south eastern Europe reaching westwards the Liguria district (Poldini 1989). The characteristic species of this alliance present in our quadrants are *Ostrya carpinifolia* and *Fraxinus ornus*, both present with high frequency and cover. In the steepest parts the predominant association is *Mercuriali ovatae-Ostryetum carpinifoliae*, comprising species such as *Sesleria varia*, *Coronilla emerus*, *Hedera helix* and *Polygala chamaebuxus*, with the presence of transgressive species originat-

ing from border areas such as *Vincetoxicum hirundinaria*, *Geranium sanguineum* and *Anthericum ramosum*, and from grasslands areas such as *Teucrium chamaedrys*. A group of species belonging to *Prunetalia spinosae*, such as *Juniperus communis*, *Rubus ulmifolius*, *Crataegus monogyna*, *Cornus sanguinea* and *Viburnum lantana*, is also constantly present in all releveés and can be an indication of a pre-existing climatic forest or one of its degradation forms (Oberdorfer 1982; Poldini 1989).

The high cover of *Corylus avellana* and *Quercus cerris*, that might reach notable sizes, and the presence of other mesophilous species indicate patches of deeper, less arid and more evolved soils.

Another component is represented by trees planted in the past for timber production such as *Picea excelsa*, *Larix decidua*, *Pinus nigra* and *Pinus sylvestris*; these species do not belong to the natural vegetation of the area and are slowly dying out, being represented only by old individuals with no recruitment. They prevent the natural succession along the potential sige-tum and make more difficult to correctly refer this vegetation to a well defined phytosociological category.

5. CONCLUSIONS

The analysis of growth forms and geographical distribution groups defined the wooded stand as a broad-leaved thermophilous woodland, enjoying a temperate climate with occasional draughts, located on the southern parts of the alpine chain. Ellenberg and Landolt indices support this definition, specifying that the soil is slowly evolving toward a more nutrient rich type. If compared with 1993, the 2002-2003 surveys point out an increase in species typical of warmer and arid climates, possibly an effect of climate change. As a more general remark, the woods are rather young owing to the presence of frequent clearings, many shrubs and a high number of species (214), whereas in mature oak forests the number of species do not usually exceeds 40 to 60 species despite being one of the more diverse forest type within Italy (Pignatti 1998). The present situation actually originated from traditional land use that with the common practices of coppicing and grazing altered physiognomy and species composition of the original forests enhancing the presence of transition and border species and suppressing the understory original component. As a consequence the syntaxonomy cannot be easily defined, as a matter of fact, albeit the woodland can be referred to a generic thermophilous oak woodland, that is typical of the southern parts of the Alps (Marchesoni 1958), there is also a alien component of mature conifers, and some clearings where grassland and border species penetrated. All things considered the vegetation is evolving towards its climax: species belonging to *Prunetalia* are re-colonising the small clearings, while conifers are slowly dying out to be replaced by species belonging to the order *Quercetalia pubescentis*.

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Appendix 1 - List of all recorded species arranged in systematic order. The systematic treatment is after the standard *Flora d'Italia* (Pignatti 1982). The list includes the Latin name and information on growth form and distribution area groups in brackets.

Appendice 1 - Lista di tutte le specie registrate organizzata in ordine sistematico. Il trattamento sistematico segue lo standard della Flora d'Italia (Pignatti 1982). La lista include il nome latino e, tra parentesi, l'informazione sulla forma di crescita e sull'area di distribuzione.

PTERIDOPHYTA

Aspleniaceae

Asplenium ruta-muraria L. (H ros - Circumbor.)

Hypolepidaceae

Pteridium aquilinum (L.) Kuhn (G rhiz - Cosmop.)

Polypodiaceae

Polypodium vulgare L. (H ros - Circumbor.)

GYMNOSPERMAE

Cupressaceae

Juniperus communis L. [P caesp (P scap) - Circumbor.]

Pinaceae

Larix decidua Miller (P scap - Orof. Centroeuro.)

Picea excelsa (Lam.) Link (P scap - Eurosib.)

Pinus nigra Arnold (P scap - Illirico)

Pinus sylvestris L. (P scap - Orof. Eurasiat.)

ANGIOSPERMAE

DICOTYLEDONES

Aceraceae

Acer campestre L. [P scap (P caesp) - Europeo-Caucas.]

Acer pseudoplatanus L. (P scap - Europeo-Caucas.)

Anacardiaceae

Cotinus coggygria Scop. [NP (P caesp/ P scap) - S-Europ.-Turan.]

Apocynaceae

Vinca minor L. (Ch rept - Medio-Europ.-Caucas.)

Araliaceae

Hedera helix L. (P lian - Submedit.-Subatl.)

Asclepiadaceae

Vincetoxicum hirundinaria Medicus (H scap - Eurasiat.)

Berberidaceae

Berberis vulgaris L. (NP - Eurasiat.)

Boraginaceae

Anchusa officinalis L. [H scap (H bienn) - Pontico]

Buglossoides purpureocaerulea (L.) Johnston (H scap - S-Europ.-Pontico)

Echium vulgare L. (H bienn - Europ.)

Pulmonaria australis (Murr) Sauer (H scap - Endem. Alpica)

Buddlejaceae

Buddleja davidii Franchet (P caesp - Cina)

Campanulaceae

Campanula glomerata L. (H scap - Eurasiat.)

Campanula rapunculoides L. (H scap - Europeo-Caucas.)

Phyteuma betonicifolium Vill. (H scap - Endem. Alpica)

Phyteuma ovatum Honck. (H scap - Orof. S-Europ.)

Caprifoliaceae

Viburnum lantana L. (P caesp - S-Europ.)

Caryophyllaceae

Dianthus carthusianorum L. (H scap - Centro e S-Europa)

Dianthus monspessulanus L. (H scap - Orof. S-Europ.)

Dianthus seguieri Vill. [H scap - Centroeuro. (Subatl.)]

Moehringia muscosa L. (H caesp - Orof. S e Centro Europa)

Saponaria ocymoides L. (H scap - Orof. SW-Europ.)

Silene nutans L. (H ros - Paleotemp.)

Silene vulgaris (Moench) Garcke (H scap - Subcosmop.)

Cistaceae

Helianthemum canum (L.) Baumg. (Ch suffr - Europeo-Caucas.)

Helianthemum nummularium (L.) Miller ssp. *grandiflorum* (Scop.) Sch. et Th. (Ch suffr - Europeo-Caucas.)

Compositae (Asteraceae)

Achillea millefolium L. (H scap - Eurosib.)

Aposeris foetida (L.) Less. (H ros - Orof. SE-Europ.)

Artemisia vulgaris L. (H scap - Circumbor.)

Bupthalmum salicifolium L. (H scap - Orof. SE-Europ.)

Centaurea bracteata Scop. (H scap - SE-Europ.)

Centaurea scabiosa L. (H caesp - Eurasiat.)

Erigeron annuus (L.) Pers. (T scap - Nordamer.)

Eupatorium cannabinum L. (H scap - Paleotemp.)

Hieracium sylvaticum (L.) L. (H scap - Eurosib.)

Inula hirta L. (H scap - S-Europ.-S-Siber.)

Lactuca perennis L. (H scap - Euri-Medit.-Occid.)

Leontodon hispidus L. (H ros - Europeo-Caucas.)

Leucanthemum vulgare Lam. (H scap - Eurosib.)

Petasites albus (L.) Gaertn. (G rhiz - Orof. Centroeuro.-W-Asia)

Serratula tinctoria L. (H scap - Eurosib.)

Solidago virgaurea L. (H scap - Circumbor.)

(Appendix 1 - continued)

(Appendice 1 - continua)

- Tanacetum corymbosum* (L.) Sch.-Bip. (H scap - Euri-Medit.)
- Taraxacum officinale* Weber (H ros - Circumbor.)
- Tragopogon pratensis* L. ssp. *orientalis* (L.) Celak. (H scap - Eurosib.)
- Tussilago farfara* L. (G rhiz - Paleotemp.)
- Cuscutaceae
- Cuscuta epithimum* (L.) L. (T par - Eurasiat. Temper.)
- Cornaceae
- Cornus mas* L. (P caesp/ P scap - SE-Europ.-Pontica)
- Cornus sanguinea* L. (P caesp - Eurasiat. Temper.)
- Corylaceae
- Corylus avellana* L. (P caesp - Europeo-Caucas.)
- Ostrya carpinifolia* Scop. (P caesp/ P scap - Circumbor.)
- Crassulaceae
- Sedum album* L. (Ch succ - Euri-Medit.)
- Sedum rupestre* L. (Ch succ - W e Centroeurop.)
- Sedum sexangulare* L. (Ch succ - Centroeurop.)
- Sempervivum arachnoideum* L. (Ch succ - Orof. SW-Europ.)
- Sempervivum tectorum* L. (Ch succ - Orof. S-Europ.)
- Cruciferae (Brassicaceae)
- Arabis hirsuta* (L.) Scop. (H bienn/ H scap - Europ.)
- Dipsacaceae
- Knautia arvensis* (L.) Coulter (H scap/ H bienn - Eurasiat.)
- Scabiosa dubia* Vel. (H scap - Orof. SE-Europ.)
- Scabiosa graminifolia* L. (Ch suffr - Orof. S-Europ.)
- Scabiosa gramuntia* L. (H scap - S-Europ.)
- Ericaceae
- Calluna vulgaris* (L.) Hull [Ch frut (NP) - Circumbor. Euro-Americana]
- Erica carnea* L. [Ch frut (Ch suffr) - Orof. S-Europ.]
- Euphorbiaceae
- Euphorbia amygdaloides* L. (Ch suffr - Centroeurop.-Caucas.)
- Mercurialis perennis* L. (G rhiz - Europeo-Caucas.)
- Fagaceae
- Fagus sylvatica* L. (P scap - Centroeurop.)
- Quercus cerris* L. (P scap - N-Euri-Medit.)
- Quercus pubescens* Willd. (P scap/ P caesp - Europ.)
- Quercus robur* L. (P scap - Europeo-Caucas.)
- Gentianaceae
- Centaurium erythraea* Rafn (H bienn/ T scap - Paleotemp.)
- Geraniaceae
- Geranium sanguineum* L. (H scap - Europeo-Caucas.)
- Globulariaceae
- Globularia punctata* Lapeyr. (H scap - S-Europ.)
- Guttiferae (Clusiaceae)
- Hypericum montanum* L. (H caesp - Europeo-Caucas.)
- Hypericum perforatum* L. (H scap. - Paleotemp.)
- Juglandaceae
- Juglans regia* L. (P scap - SW-Asiat.)
- Labiatae (Lamiaceae)
- Ajuga reptans* L. (H rept - Europeo-Caucas.)
- Calamintha nepeta* (L.) Savi subsp. *nepeta* [H scap (Ch suffr) - Medit.- Mont.]
- Melittis melissophyllum* L. (H scap - Centroeurop.)
- Origanum vulgare* L. (H scap - Eurasiat.)
- Prunella grandiflora* (L.) Scholler (H scap - Orof. S-Europ.)
- Prunella laciniata* (L.) L. (H scap - Euri-Medit.)
- Prunella vulgaris* L. (H scap - Circumbor.)
- Salvia glutinosa* L. (H scap - Orof. Eurasiat.)
- Salvia pratensis* L. (H scap - Euri-Medit.)
- Stachys officinalis* (L.) Trevisan (H scap - Europeo-Caucas.)
- Stachys recta* L. (H scap - Orof. N-Medit.)
- Teucrium chamaedrys* L. (Ch suffr - Euri-Medit.)
- Teucrium montanum* L. (Ch suffr - Orof. S-Europ.)
- Thymus serpyllum* L. aggr. (Ch rept/ Ch suffr - Centroeurop.)
- Leguminosae (Fabaceae)
- Anthyllis vulneraria* L. (H scap - Euri-Medit.)
- Astragalus glycyphyllos* L. (H rept - Eurosib.)
- Chamaecytisus hirsutus* (L.) Link (Ch suffr - Eurosib.)
- Chamaecytisus purpureus* (Scop.) Link (Ch suffr - E-Alp.-Illirico)
- Coronilla emerus* L. (NP - Centroeurop.)
- Coronilla varia* L. (H scap - Circumbor.)
- Dorycnium pentaphyllum* Scop. subsp. *herbaceum* (Vill.) Rouy (H scap/ Ch suffr - S-Europ.-Pontico)
- Genista germanica* L. (Ch suffr (NP) - Centroeurop.)
- Genista tinctoria* L. (Ch suffr - Eurasiat.)
- Hippocrepis comosa* L. (H caesp - Centro e S-Europa)
- Lathyrus niger* (L.) Bernh. (G rhiz - Europeo-Caucas.)
- Lembotropis nigricans* (L.) Griseb. (NP - Centroeurop.-Pontico)
- Lotus corniculatus* L. (H scap - Paleotemp.)
- Medicago lupulina* L. [T scap (H scap) - Paleotemp.]
- Onobrychis arenaria* (Kit.) DC. (H scap - S-Europ.-S-Siber.)
- Ononis natrix* L. (H caesp/ Ch suffr - Euri-Medit.)

(Appendix 1 - continued)

(Appendice 1 - continua)

- Ononis spinosa* L. ssp. *austriaca* (Ch suffr - Euri-Medit.)
Trifolium montanum L. (H scap - S-Europ.-Pontico)
Trifolium pratense L. (H scap - Eurosib.)
Trifolium repens L. (H rept - Paleotemp.)
Trifolium rubens L. (H scap - Centroeurop.)
- Oleaceae
Fraxinus ornus L. [P scap (P caesp) - Euri-N-Medit.-Pontica]
Ligustrum vulgare L. (NP - Europ.-W-Asiat.)
- Plantaginaceae
Plantago lanceolata L. (H ros - Eurasiat.)
Plantago major L. (H ros - Eurasiat.)
- Polygalaceae
Polygala chamaebuxus L. (Ch suffr/ NP - Orof. S-Europ.)
Polygala comosa Schkuhr (H scap - Centroeurop.-Sudsiber.)
- Primulaceae
Cyclamen purpurascens Miller (G bulb - Orof. NE-Medit.)
Primula veris L. (H ros - Euri-Medit.)
Primula vulgaris Hudson (H ros - Europeo-Caucas.)
- Pyrolaceae
Monotropa hypophegea Wallroth (G par - Circumbor.)
- Ranunculaceae
Clematis recta L. [H scap - Eurosib. (Steppica)]
Clematis vitalba L. (P lian - Europeo-Caucas.)
Hepatica nobilis Miller (G rhiz - Circumbor.)
Pulsatilla montana (Hoppe) Rchb. (H scap - SE-Europ.-Steppica)
Ranunculus acris L. (H scap - Subcosmop.)
Ranunculus bulbosus L. (H scap - Eurasiat.)
Ranunculus nemorosus DC. (H scap - S-Europ.-S-Siber.)
- Rhamnaceae
Frangula alnus Miller [P caesp (P scap) - Centroeurop.-Caucas.]
- Rosaceae
Crataegus monogyna Jacq. [P caesp (P scap) - Paleotemp.]
Filipendula vulgaris Moench (H scap - Centroeurop.-S-Siber.)
Fragaria vesca L. (H rept - Eurosib.)
Potentilla alba L. (H ros - Centroeurop.-Pontico)
Potentilla recta L. (H scap - NE-Medit.-Pontico)
Prunus avium L. (P scap - Pontico)
Prunus mahaleb L. [P caesp (P scap) - S-Europ.-Pontica]
Prunus spinosa L. (P caesp - Europeo-Caucas.)
Pyrus pyraeaster Burgsd (P scap - Eurasiat.)
Rubus caesius L. (NP - Eurasiat.)
- Rubus ulmifolius* Schott (NP - Euri-Medit.)
Sanguisorba minor Scop. (H scap - Subcosmop.)
Sanguisorba officinalis L. (H scap - Circumbor.)
Sorbus torminalis (L.) Crantz (P scap/ P caesp - Paleotemp.)
- Rubiaceae
Cruciata glabra (L.) Ehrend. (H scap - Eurasiat.)
Galium mollugo L. (H scap - Euri-Medit.)
Galium rubrum L. (H scap - Endem. S-Alpico-N-Appenninico)
Galium verum L. (H scap - Eurasiat.)
- Salicaceae
Populus nigra L. (P scap - Paleotemp.)
Populus tremula L. (P scap - Eurosib.)
- Santalaceae
Thesium bavarum Schrank (G rad - SE-Europ.-Pontica)
Thesium linophyllum L. (G rad/ H scap - SE-Europ.)
- Scrophulariaceae
Melampyrum pratense L. (T scap - Eurosib.)
Melampyrum velebeticum Borbàs (T scap - Illirico)
Pseudolysimachion spicatum (L.) Opiz (H rept - Eurasiat.-Subcont.)
Rhinanthus alectorolophus (Scop.) Pollich (T scap - Centroeurop.)
Verbascum phoeniceum L. (H scap - S-Europ.-S-Siber.)
Veronica chamaedrys L. (H scap - Eurosib.)
Veronica officinalis L. (H rept - Eurasiat. Montana)
- Umbelliferae (Apiaceae)
Daucus carota L. [H bienn (T scap) - Paleotemp.]
Eryngium amethystinum L. (H scap - NE-Medit.)
Laserpitium siler L. (H scap - Orof. S-Europ.)
Peucedanum oreoselinum (L.) Moench (H scap - Europeo-Caucas.)
Peucedanum verticillare (L.) Koch (H scap - Orof. Alpico-Appenn.)
Pimpinella major (L.) Hudson (H scap - Europeo-Caucas.)
Pimpinella saxifraga L. (H scap - Europeo-Caucas.)
Trinia glauca (L.) Dumort. (H scap - SE-Europ.)
- Urticaceae
Urtica dioica L. (H scap - Subcosmop.)
- Valerianaceae
Valeriana collina Wallroth (H scap - Centroeurop.)
- Violaceae
Viola alba Besser (H ros - Euri-Medit.)
Viola hirta L. (H ros - Europ.)
- MONOCOTYLEDONES
- Cyperaceae
Carex flacca Schreber (G rhiz - Europ.)

(Appendix 1 - continued)

(Appendice 1 - continua)

Gramineae (Poaceae)

- Agrostis tenuis* Sibth. (H caesp - Circumbor.)
Avenula pubescens (Hudson) Dumort. (H caesp - Eurosib.)
Bothriochloa ischaemon (L.) Keng (H caesp - Termocosmop.)
Brachypodium rupestre (Host.) R. et S. subsp. *caespitosum* (Host.) Scholtz (H caesp - Subatl.)
Briza media L. (H caesp - Eurosib.)
Bromus condensatus Hackel (H caesp - Endem. E-Alpico)
Bromus erectus Hudson (H caesp - Paleotemp.)
Dactylis glomerata L. (H caesp - Paleotemp.)
Koeleria pyramidata (Lam.) Domin (H caesp - Centro-N-Europa)
Melica nutans L. (H caesp - Europeo-Caucas.)
Poa alpina L. (H caesp - Circumbor.)
Poa compressa L. (H caesp - Circumbor.)
Sesleria varia (Jacq.) Wettst. (H caesp - Orof. Medioeurop.)

Juncaceae

- Luzula multiflora* (Ehrh.) Lej. [H caesp - (Circum.) Euro-Americana]

Liliaceae

- Allium carinatum* L. (G bulb - Submedit.-Subatl.)
Allium lusitanicum Lam. (G bulb - S-Europa-S-Siberia)
Anthericum liliago L. (G bulb - Submedit.-Subatl.)
Anthericum ramosum L. (G rhiz - Submedit.-Subatl.)

- Colchicum autumnale* L. (G bulb - Centroeurop.)
Lilium bulbiferum L. ssp. *croceum* (Chaix) Baker (G bulb - Orof. Centroeurop.)
Muscari comosum Miller (G bulb - Euri-Medit.)
Ornithogalum umbellatum L. (G bulb - Euri-Medit.)
Polygonatum odoratum (Miller) Druce (G rhiz - Circumbor.)
Tamus communis L. (G rad - Euri-Medit.)
Veratrum nigrum L. (G rhiz - Eurasiat. Temper.)

Orchidaceae

- Cephalanthera longifolia* (Hudson) Fritsch (G rhiz - Eurasiat.)
Cephalanthera rubra (L.) L. C. Rich. (G rhiz - Eurasiat.)
Epipactis helleborine (L.) Crantz (G rhiz - Paleotemp.)
Gymnadenia conopsea (L.) R. Br. (G bulb - Eurasiat. Temper.)
Limodorum abortivum (L.) Swartz (G rhiz - Euri-Medit.)
Listera ovata (L.) R. Brown ex Aiton fil. (G rhiz - Eurasiat.)
Neottia nidus-avis (L.) L. C. Rich. (G rhiz - Eurasiat.)
Orchis morio L. (G bulb - Europeo-Caucas.)
Orchis tridentata Scop. (G bulb - Euri-Medit.)
Platanthera bifolia (L.) Rchb. (G bulb - Paleotemp.)
Traunsteinera globosa (L.) Rchb. (G bulb - Orof. S-Europ.)

