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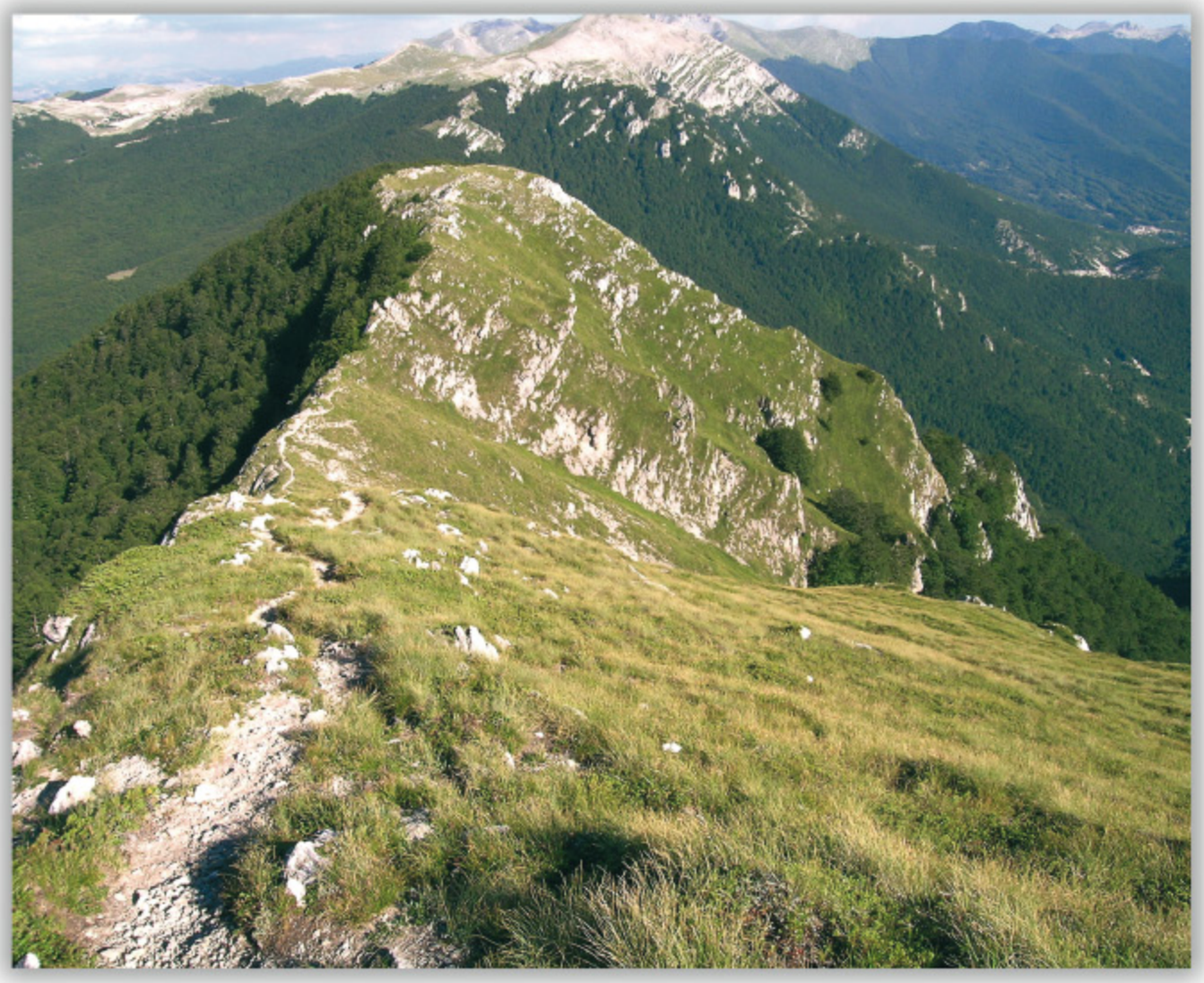

VEGETATION AND LANDSCAPE OF THE SIMBRUINI MOUNTAINS (CENTRAL APENNINES)

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Vegetation and landscape of the Simbruini mountains (Central Apennines)

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Abstract
The analysis of the vegetation and the landscape of the Simbruini mountains is presented. The Simbruini mountains are located on the Tyrrhenian side of the Central Apennines, on the border between the Lazio and Abruzzi regions; the mountain chain has a NW-SE orientation and is characterised by several peaks: Autore (1853 m), Cotento (2014 m), Tarino (1959), Viglio (2176 m) and Crepacuore (1997 m). The paper is composed of three sections. In the first one, the phytosociological and synphytosociological analysis of the vegetation is presented. In the second one, the results of an ecological classification of the landscape, aimed at identifying the main land units of the Simbruini mountains, are discussed and in the last one the landscape changes occurred between 1950 and 2000 are analysed.
From a phytosociological point of view, beech woods are the most important and wider forest type of the area. Their floristic composition is typical of the calcicolous Central-Southern Apennine mountain beech woods (*Cardamino kitaibelii-Fagetum sylvaticae*). At lower altitudes, deciduous woods dominated by *Ostrya carpinifolia* with *Fraxinus ornus* and *Acer opalus* ssp. *obtusatum* (*Melittio melissophyllae-Ostryetum carpinifoliae*), or by *Quercus pubescens (Cytiso sessilifolii-Quercetum pubescentis*) occur, whereas at the same altitudes, on the rocky or steep slopes, *Quercus ilex* woods can be found. Mesophilous woods with *Carpinus betulus* and *Corylus avellana* (*Carpino betuli-Coryletum avellanae*) were found along deeply embanked valleys, sometimes surrounded by *Quercus cerris* woods with *Acer opalus* ssp. *obtusatum* (*Aceri obtusati-Quercetum cerridis*) on deep soils. Along the Simbrivio river banks, small patches of broadleaf ravine woods, classified in the alliance *Tilio-Acerion* (*Aceretum obtusati-pseudoplatani*), can be found. The shrub vegetation is characterised by different communities dynamically linked to the woody types. In fact, shrubs characterised by *Spartium junceum* and *Rubus ulmifolius* (*Spartio juncei–Cytisetum sessilifolii* and *Roso sempervirenti-Rubetum ulmifolii)* were identified in the hilly-sub-mountain belt, whereas at higher latitudes, the pre-forest stage, characterised by *Ribes uva-crispa* and several species of *Rosa* (*Ribeso uvae-crispae-Rosetum dumalis*) can be found. Two kinds of juniper shrubs were identified: the first one in the sub-alpine belt with *Daphne oleoides* and *Arctostaphylos uva-ursi (Daphno oleoidis-Juniperetum alpinae*), and the second one with *Juniperus communis* ssp. *communis* in the lower mountain belt (*Viburno lantanae-Juniperetum communis)*. The following grassland types were identified: three associations of the mountain and sub-mountain belts belonging to the endemic Apennine syntaxonomical alliance *Phleo ambigui-Bromion erecti (Saturejo montanae-Brometum erecti,* A*nthoxantho odorati-Brachypodietum genuensis* and *Koelerio splendentis-Brometum erecti)*, therophytic grasslands (*Trifolio scabri-Hypochoeridetum achyrophori)*, mesophilous meadows of the *Molinio-Arrhenatheretea* class (*Colchico lusitanici-Cynosuretum cristati* community with *Arrhenatherium elatius)*, sub-alpine xerophytic grasslands with *Sesleria juncifolia* ssp. *juncifolia* and *Carex kitaibeliana* (*Pediculari elegantis- Seslerietum tenuifoliae*), sub-acid communities of the same belt belonging to the *Nardetea strictae (Luzulo italicae-Nardetum strictae* and *Trifolio thalii-Festucetum microphyllae)* and scree vegetation characterised by *Galium magellense* and *Festuca dimorpha (Galio magellensis-Festucetum dimorphae)*. Moreover, two associations of the chasmophytic vegetation and calcareous rocky crevices were found (*Saxifrago australis-Trisetetum bertolonii* and *Arenario bertolonii-Cystopteridetum alpinae*). The vegetation of the woody edges was also analysed (community with *Salvia glutinosa* and *Aegopodium podagraria*), although further investigations are needed.
The synphytosociological analysis of the plant communities allowed the identification of the main vegetation series: *Cytiso-Querceto pubescentis* sigmetum, *Ciclamino Hederifolii-Querceto ilicis* sigmetum, *Melittio melissophyllae-Ostryeto carpinifoliae* sigmetum, *Cardamino kitaibelii-Fageto sylvaticae* sigmetum, *Carpino betuli-Coryleto avellanae* sigmetum and *Daphno-Junipereto alpinae* sigmetum.
In the second section of the paper, an ecological classification of the landscape aimed at identifying the main land units of Simbruini mountains was applied, based on a new methodology. In particular, a maximum likelihoods classifier, applied to topographical, climatic and land use variables, allowed the identification of 8 Land Units characterised by environmental, vegetational and land use variables.
Finally, the landscape change of the Simbruini mountains between 1950 and 2000 was analysed. This change was analysed and quantified through the photointepretation of digital, georeferenced aero photographs of the years 1954 and 2000 and application of several landscape indexes. A significant expansion of forests common to all the Apennine chain was highlighted. This process, linked to the abandonment of the traditional selvicoltural practices, in turn, determined by the emigration of the population, in search of economic opportunities, towards the coastal areas,. The current reforestation processes can determine the homogeneity of the landscape and the disappearance of semi-natural and cultural habitats, thus threatening the survival of many species.
The integrated methodological approach we presented, being based on the phytosociological and synphytosociological analysis, the ecological classification of the landscape and the analysis of its historical transformations, provides a comprehensive analysis useful for guiding environmental planning activities and for implementing conservation strategies and actions.

Key words: Central Apennines, vegetation, landscape ecology, phytosociology, sinphytosociology, sintaxonomy, land use change.

Phytosociological analysis of the vegetation

Introduction

The Simbruini mountains extend for about 35000 ha and are located at about 30 km East of Rome. The name Simbruini comes from Latin *sub imbribus* meaning "under the rain". The huge amount of fresh water, which is one of the most noticeable environmental features of the area, was exploited since the old Roman times with the construction of several aqueducts (Anio Novus, Marcio, and Claudio) to supply Rome.

The wide altitudinal range and the complex morphology determined a very high level of plant

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species and communities diversity, which has been studied by several authors since the beginning of the last century (Cufodontis, 1939; Veri & Bruno, 1978; Avena *et al*., 1980; Fascetti *et al*., 1987; Veri L., 1988; Abbate & Scagliusi, 1993; Travaglini, 1999), up to the recent analyses of the main vegetation series and their related dynamism (Fortini, 1997; Blasi *et al*., 1998; Attorre & Bruno, 2003; Blasi *et al*., 2001b).

The Simbruini mountains are characterised by a massive calcareous chain. They are located in the Lazio region, about 60 km from the Tyrrhenian coast and 100 km from the Adriatic one; their orientation is mainly parallel to the Apennines with a S-W orientation and many peaks: Autore (1853 m), Cotento (2014 m), Tarino (1959 m), Viglio (2156 m) and Crepacuore (1997 m).

The morphology of the area is characterised by karst plateaus, with an impressive system of sinkholes, allowing the infiltration of a huge quantity of rain that feeds the complex watercorses network. In particular, the springs of the Aniene river, the main affluent of the Tiber, emerge here together with several important aquifers, still supplying the city of Rome.

The Simbruini mountains were indicated by the Società Botanica Italiana in 1971 as an important biodiversity site with a high priority of conservation, due to the presence of ancient beech forests, numerous orchid species and many other plant species deserving conservation, and a very rich and abundant fauna, including the Apennine wolf and bear.

In order to conserve this important biodiversity hotspot, in 1983 the Monti Simbruini Regional Park was created and, today, the area is also included in a Special Protection Zone and hosts several Sites of Community Importance (Fig. 1).

Geological, geomorphological and pedological features

The Simbruini mountains consist mainly of Mesozoic litho-stratigraphical units in a carbonatic shelf *facies*, ranging in age from Upper Trias to part of the Upper Cretaceous, at the Southern limit of the Tethys Ocean Basin. The geological formations belong to the Lazio-Abruzzi series.

The peripheric sectors of this unit can be recognised with continuity from the West (Sabine side), to the North (Aquilan side) and to the East (Marsica and Molise side). The Southern edge of the neritic shelf is not exposed, but it can be localised between the Lepini and Ausoni mountains and the line joining Circeo and Pozzo Fogliano, where both pelagic and transitional *facies* have been recognised (Praturlon, 1993). Small outcrops of more recent deposits, still carbonatic but in a different *facies*, occur only at the Northern boundary of the mountain range.

From a tectonic point of view, the Simbruini mountains consist of a series of thrust faults toward NE, defining structural elements with specific litho-bio-chrono-stratigraphical features. The whole mountain group has overthrusted towards the valley of the Liri river (Fig. 2).

The Simbruini mountains are characterised by:

- A carbonatic shelf, fractured and karstified all over the area; it is highly permeable and absorbs yearly large quantities of meteoric water, which infiltrates into the ground down to the large aquifers, saturating the base of the calcareous ridges and feeding the major sources.
- A basal dolomitic complex, near Filettino, less permeable than the limestone, which feeds sources and perennial watercourses up to the high altitudes.
- The complex of the marly-arenaceous flysh, of limited extension and poor in underground water.
- The complex of the alluvial deposits from perennial watercourses, which contains overlapping and generally well delimited aquifers.

The stratigraphy of the area is based on the geological data reported in Sheet no. 376 of the Geological Map of Italy at 1: 50,000 scale (Damiani & Pannuzzi, 1981a). In this description the geological formations have been grouped into the following units (Fig. 3):

A) Lower dolomitic unit (Upper Trias- Lower Lias)
The Triassic terms represent the oldest nucleus exposed of this structure. They extend from Filettino to the sources of the Aniene river, at the base of the Faito plateau and they occur again in the area of Vallepietra (Devoto, 1970).

B) Lower calcareous unit (middle Lias- Malm)
There is a gradual transition to a more and more calcareous *facies*, represented by micritic and intramicritic limestone, locally interbedded with crystalline dolomitic rocks. This unit is lithologically more heterogeneous than the previous one, but the sedimentary basin gradually tends to become uniform.

C) Upper dolomitic unit (Neocomian – Cenomanian)
The deposits mostly consist of well stratified limestones, micritic, intramicritic and intra-bio micritic, brown or dark grey, with intercalations of thick and massive banks of microcrystalline greyish dolomites.

D) Upper calcareous unit (upper Cretaceous – lower Miocene)
This is the most widespread unit throughout the study area. The lower portion, of Cretaceous age, consists of light brown to white micritic limestone, with rare dolomitic and clayey intercalations. The Miocenic

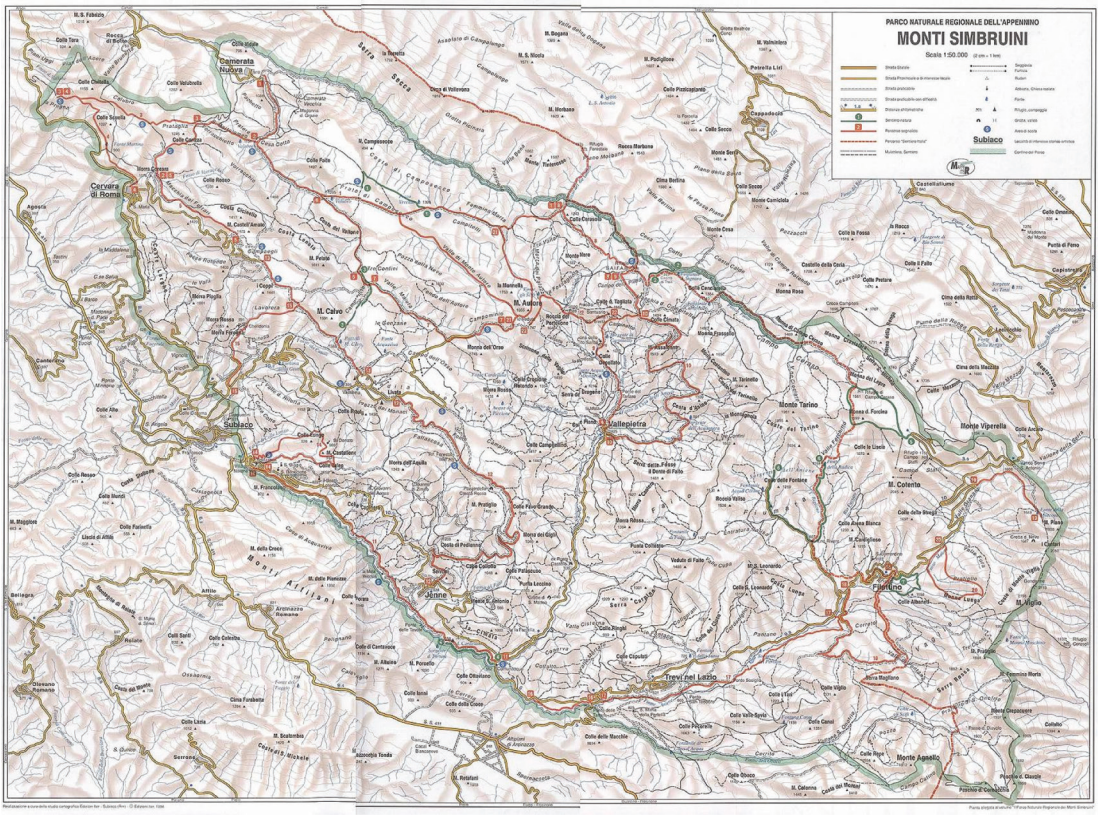


Fig. 1 - The Monti Simbruini Regional Park.

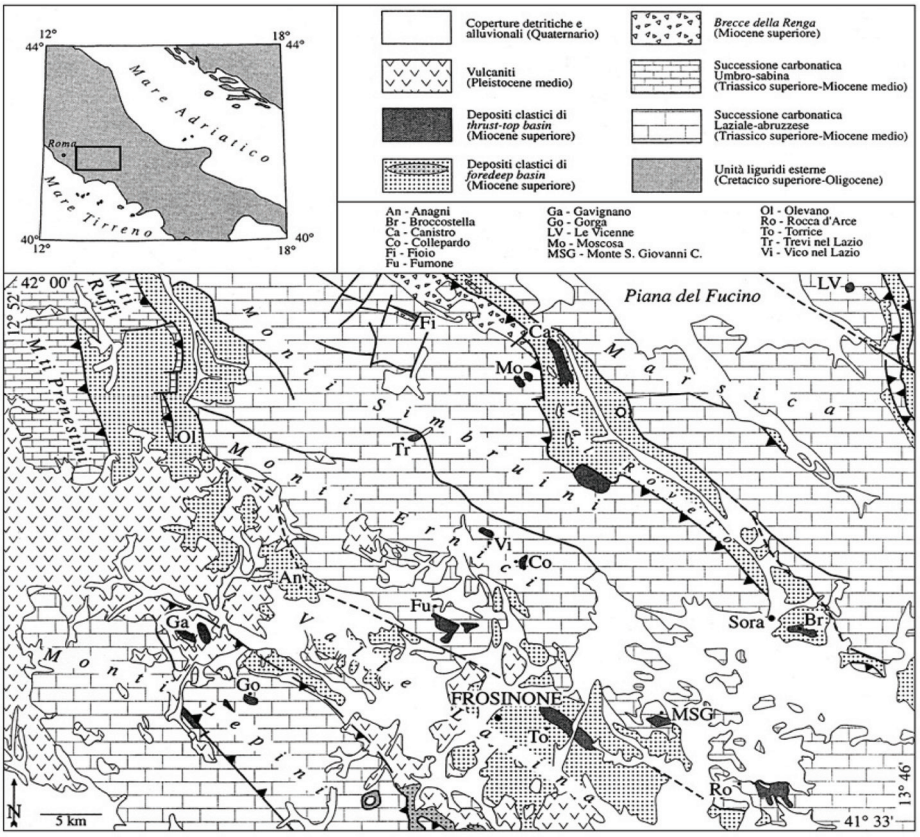


Fig. 2 - Geological scheme of the study area (Cipollari & Cosentino, 1999).

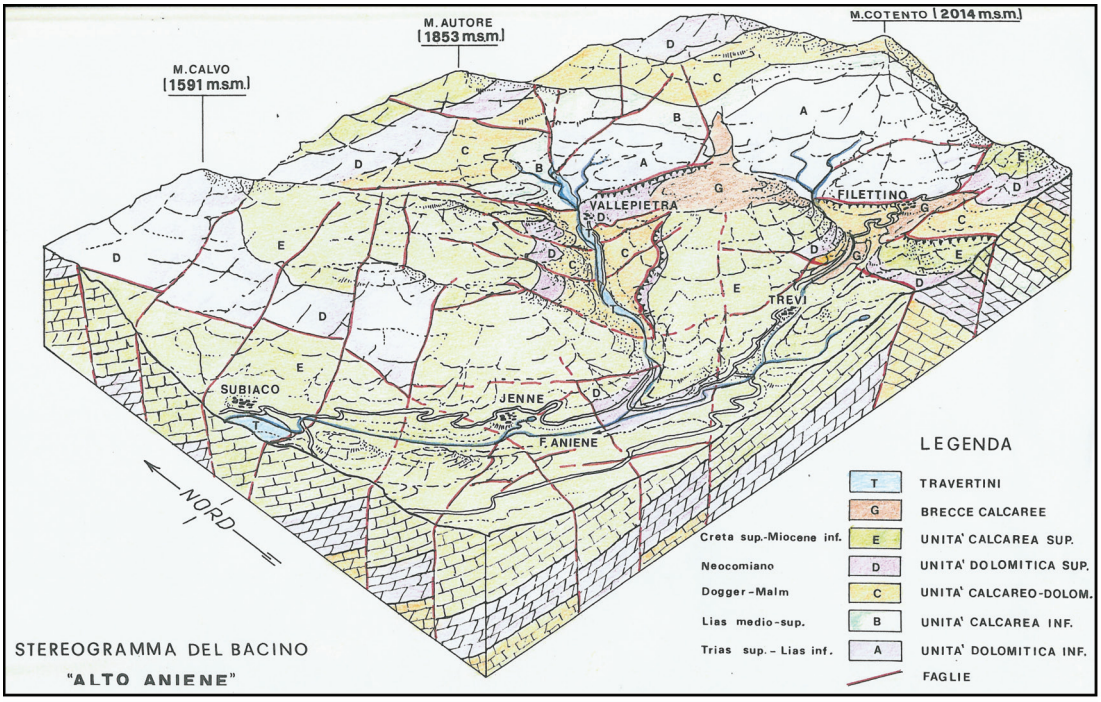


Fig. 3 - Stereogram of the Upper Aniene basin (233 km^2). In the present study the B and C units are considered as a single lithological unit, called "Lower Calcareous Unit" (B).

portion consists of "Limestone with Bryozoa and Lithotamnia".

E) Pelitic – arenaceous unit (Middle – Upper Miocene)

This is the least widespread unit in the study area. It consists of turbiditic clayey-arenaceous sequences.

F) Ruditic unit (Pliocene)

It is composed mostly of calcirudites with eterometric elements from the carbonatic shelf and of polygenic puddingas, with pelites occurring at the base. This unit is rather permeable, being highly porous and fractured: therefore small suspended aquifers are stored in it (Fonte Moscosa).

G) Continental succession (Pleistocene – Olocene)

The Quaternary deposits are essentially represented by continental terms. The most widespread are the calcareous breccias which generally fill the valley bottom or accumulate as slope deposits. Travertine is also rather frequent.

In the study region, the beginning of the Pliocene corresponds to the complete and definitive emersion of the area and from this time on the area has been modelled by exogenous agents.

The carbonatic rocks (limestone and dolomites) are highly susceptible to erosion and denudation; the valleys deeply incised by water are more or less broadly V-shaped, depending upon their evolution stage, and sometimes the hydrographic network is characterised by deep gorges.

The erosion is particularly strong in areas where the dolomites are largely exposed, as in the Simbrivio river basin. In fact the dolomitic rocks, having been subjected to a secondary re-crystallization processes and to intense tectonic phenomena, are often incoherent or have weakly aggregated crystals. This favours the erosion by the run–off water, with formation of small valleys deeply incised, separated by steep ridges, leading to a gullies morphology, as in the area of Vallepietra.

Depositional processes are dominant mostly along the banks of the Aniene river, in correspondence of terraced flat areas which are periodically flooded. Along the lower course of the river there are alluvial paleo-deposits forming a series of high terraces along the talweg.

Karsts landforms are particularly represented, due to the presence of calcareous lithotypes exposed all over the Simbruini-Ernici mountain range. In the area the surface karsts features are particularly widespread, such as lapiez and karren in the highest steep areas; sinkholes, dolinas, uvala, polje in the endorheic basins ("Campo dell'Osso", "Campo Secco", "Campo Staffi"). There is also a rather complex hierarchised underground drainage system, with caves of highly variable sizes and forms, which has developed due to the fact that the calcareous rocks of the Simbruini mountains are highly fissured and fractured (Lodi 1996). Examples of hypogeic forms are the "Inferniglio" and "Pertuso"

caves, whereas karstic accumulations of *terra rossa* with pyroclastic inclusions (from the quaternary intrappenninic volcanism) fill the depressions of the endorheic basins.

At the highest elevations glacial and/or periglacial landforms are present, formed during the Pleistocene, in particular in the late Wurm. The glacial erosion forms are particularly widespread in the area with several glacial cirques, some of them rather well preserved. Erosion by mountain glaciers created a number of valleys which today are U-shaped, more or less narrow, with morainic deposits at the end.

The rapid evolution of the geomorphological conditions caused the migration of the base level of the karsts aquifer, leading to the submersion of the paleo-network and starting an erosion process on new levels. This favoured the rejuvenation of this area, as in all the other calcareous structures of the Central Apennine.

The hydrographic network of the Upper Aniene river is located is in a stage of uplifting (Damiani & Pannuzzi, 1981b) and the whole carbonatic hydrostructure of the Simbruini-Ernici mountains mainly consists of three hydro-geological basins: the basin of the Upper-Middle Aniene, the basin of the Cosa river and the basin of the Amaseno river. These belong to different main drainage basins of Central Italy. The waters of the Upper- Middle Aniene basin are collected into the Tiber (hydrological basin of the Tiber river); the Cosa is a left tributary of the Sacco river, which flows into the Liri, while the Amaseno is a left tributary of the Liri. Both courses belong to the hydrological basin of Liri-Garigliano (Fig. 4).

The soils of the Simbruini-Ernici mountains originated from different types of calcareous rocks, often karstified. Lithosols are dominant soils in the steepest and strongly eroded areas, highly stony and rocky, whereas Rendzinas and Brown calcareous soils occur on the less steep slopes. They are characterised by a rather fine texture and variable contents of calcium carbonates. The brown calcareous soils are rather deep and are mostly located at the foot of slopes, being mostly of colluvial origin. The most evolved soil types are acid brown soils, lacking carbonates and partially desaturated, which occur into sinkholes and depressions.

Climatic and Bioclimatic aspects

For a definition of climatic and bioclimatic characteristics of the study area, we followed the methodology proposed by Attorre *et al*. (2007).

Based on this approach, the study area falls completely within the temperate region (Rivas-Martínez, 1990) (Fig. 5), being characterised by the lack of summer aridity and cold winter, and by an average minimum temperature of the coldest month between 1.2 and 2.9 ° C.

The amount of annual rainfall ranges between 1200-2000 mm, with the highest values at the summit of the Mount Viglio and the lower values along the Aniene river at the bottom of the massif (Fig. 6). The peaks of rainfall are recorded in winter (November and December), with averages ranging from 100-200 mm of rainfall distributed in 8-10 days per month.

The average annual temperature is strongly correlated with the altitudinal gradient and ranges between 4.5 °C at the top of the highest peaks and 14 °C at the bottom of the valleys. (Fig. 7).

The map of the thermotypes was produced according to methodology proposed by Rivas-Martínez (1996). The most widespread thermotype is the Lower Montane, followed by the Upper Montane. At altitudes above 1800 m the Lower Subalpine thermotype can be

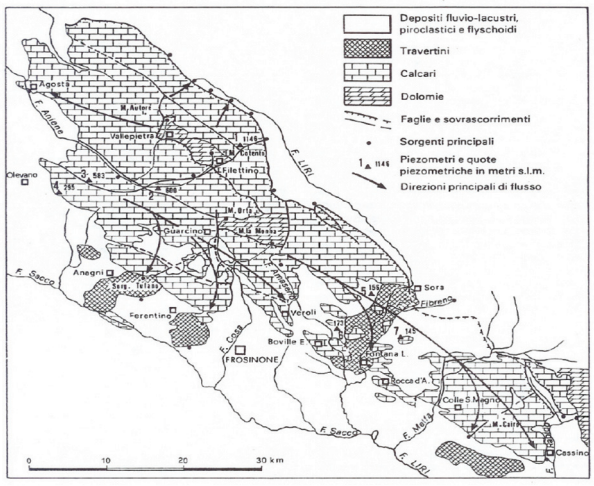


Fig. 4 - Hydrogeological scheme of the Simbruni-Ernici-Cairo mountain range (from Celico 1990).

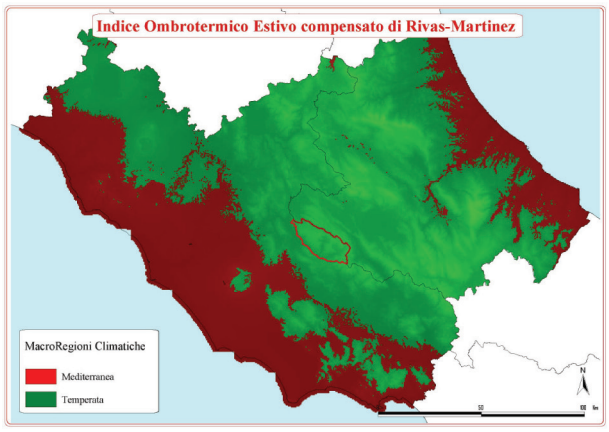


Fig. 5 - Location of the study area within the temperate region.

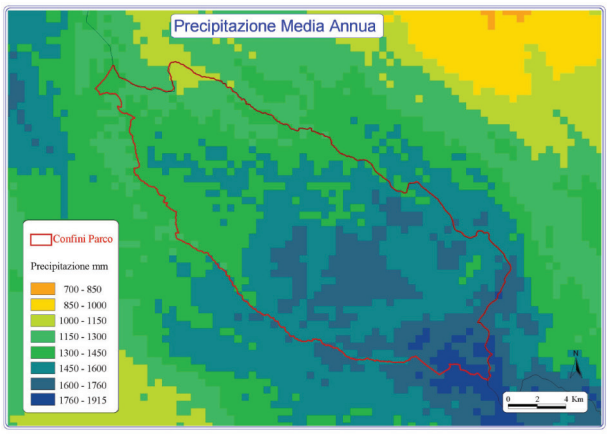


Fig. 6 - Map of annual precipitation.

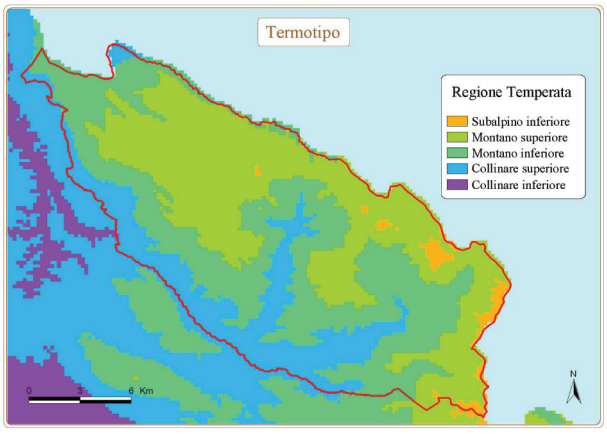


Fig. 8 - Map of the thermotypes.

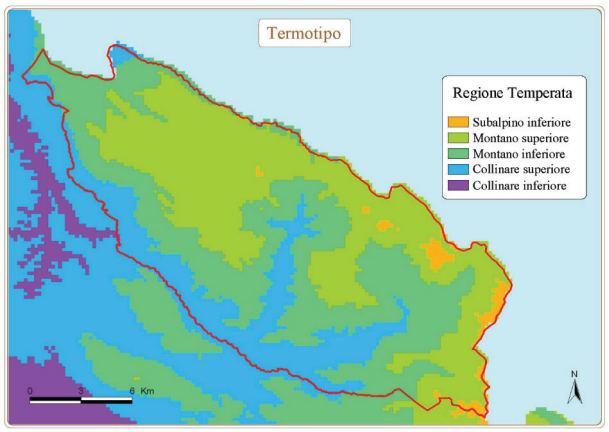


Fig. 7 - Map of Mean Annual Temperature.

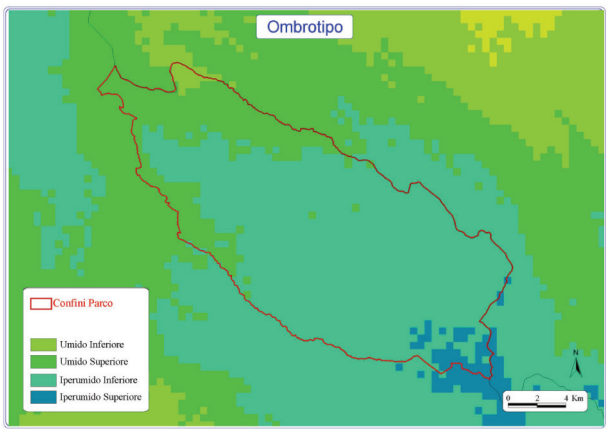


Fig. 9 - Map of the ombrotypes.

found (Fig. 8).

The map of the Ombrotypes based on Rivas-Martínez (1996) shows that the area is characterised by four types: Lower Humid, Upper Humid, Lower Hyperhumid and Upper Hyperhumid. The predominant type is Lower Hyperhumid with values of rainfall between 1400 and 1750 mm of annual precipitation (Fig. 9).

The Cold Stress Index (Mitrakos, 1982) shows how the values are more frequent in the range 70-90 (Fig. 10) indicating a cold stress for vegetation particularly significant at higher altitudes.

Fig. 10 - Map of the Cold Stress Index.

Flora

The flora of the Simbruini mountains was investigated by Attorre *et al.* (2006) and 1812 entities including species and subspecies were recorded. Field surveys were carried out during the period 2000-2005 and the floristic list of 1500 entities was integrated with 312 entities from scientific literature (Cufodontis 1939, Veri & Bruno 1978, Veri 1988 and Culicelli *et al.*, 1999).

The 1460 native entities include: 1431 species, 568 genera and 112 families, 11 of which belong to *Pteridophytes*, 3 to *Gymnosperms* and 98 to *Angiosperms*; the most represented families were the *Compositae* (181), *Leguminosae* (123), *Poaceae* (113), *Caryophyllaceae* (71) and *Labiatae* (69). The

presence of 49 entities belonging to the *Orchidaceae* is worthy of note and if we include the bibliographic references this number rises up to 51 - more than two thirds of all orchids of the Lazio region.

The biological spectrum (Fig.11) shows the predominance of hemicryptophytes (40,8%) followed by therophytes (27%). The percentage of these two biological forms is correlated with the climatic features of the mountain chain, since hemicryptophytes are especially adapted to temperate-cold climates and generally abundant in mountain areas. Conversely, the percentage of therophytes is a measure of the influence of the Mediterranean climate being mainly widespread on low hilly areas, on cultivated and ruderal soils, in xeric grasslands on steep slopes with a southern exposure. The presence of a group of hydrophytes (0,7%) is correlated with the abundance of spring water along the Aniene river. Geophytes (14,6%) are generally linked to mixed mesophilous and beech woods, while the percentage of chamaephytes is high mainly on cliffs and rocks, while it decreases in other environments. The phanerophytes and nano-phanerophytes percentages are high (respectively 7,5% and 2,7%), indicating the diversity of forest species.

The dominance of the Euro-Asiatic species (25,5%) and the lower percentage of Mediterranean species (11,9%) is in accordance with the temperate climate characterising the area. Species with a wide distribution are few (13,5% cosmopolitan plus naturalised species) and this, in turn, highlights the good level of conservation of the mountain chain. The high percentage of Orophytes (11,6%) is linked to the rocky environments, while Boreal species (8,7%) are mainly localised in the shrubs and grasslands above the tree line. Atlantic species (2,5%) are scarce, as are the species with eastern European distribution (4,7%). The percentage of endemic species (4,6%) is very remarkable: these species mainly characterise high-altitude cliffs.

Comparing our data with the Prodromus of the Roman Flora (Anzalone, 1996, 1998) and the checklist of the Italian Flora (Conti *et al*., 2005), the Simbruini mountains appeared to be characterised by a high number of rare and interesting species. In particular 276 entities (18,3%) turned out to be rare (172) or very rare (100).

From a conservation point of view, the taxa included in the Red Regional List are 63 (Conti *et al*., 1997), 37 of which considered at low risk (LR), 24 vulnerable (VU), 1 critically endangered (CR) (*Potentilla supina* L. – Fig. 13) and 1 is considered extinct in the wild (EW) (*Taraxacum alpinum* (Hoppe) Hegetschw).

Rare, interesting species with a very limited distribution are *Cerastium latifolium* L., *Ranunculus magellensis* Ten., endemic, *Geranium subcaulescens* DC., *Cerastium cerastoides* (L.) Britton, *Draba aizoides* L. and *Taraxacum alpinum* (Hoppe) Hegetschw.

Myosotis sylvatica Hoffm. considered dubious by Pignatti (1982) and Conti *et al*. (2005), was found in the Pratiglio valley; *Tulipa australis* Link. (Fig. 14)

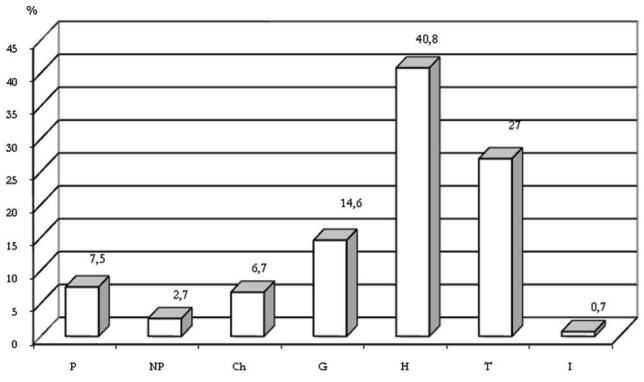


Fig. 11 - Biological spectrum (from Attorre *et al*., 2006).

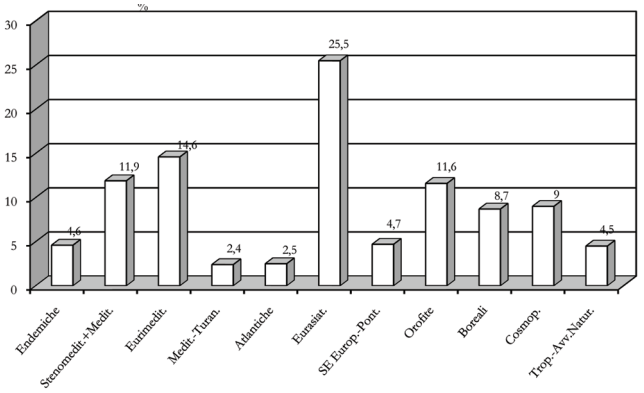


Fig. 12 - Chorological spectrum (from Attorre *et al*., 2006).

Fig. 13 - *Potentilla supina* L.

and *Thesium alpinum* L. ssp. *alpinum* (Veri, 1988) have the only known populations for the Lazio region in the Simbruini mountains.

Materials and methods

Phytosociological and synphytosociological investigation was performed according to Braun-Blanquet (1964), Westhoff & van der Maarel (1978) Géhu & Rivas-Martínez (1981, Géhu, 2006; Biondi, 2011; Blasi *et al*., 2011; Pott, 2011). In total, 318 relevés (including 417 vascular plant taxa) were carried out between 2007 and 2009. At each site the relevés were selected in relation to the homogeneity of physical features, vegetation structure and species dominance. Plot sizes ranged from 200 m^2 to 4 m^2 (Table 4), depending on the plant community. Cover/abundance data for all vascular plants were recorded in the field using the Braun-Blanquet (1964) scale. A database was created in TURBOVEG (Hennekens & Schamineé 2001) and data were then exported as percentages for further analyses. In particular, a classification, based on chord distance and average link, and an ordination, based on principal coordinates analysis, were performed for each physiognomic vegetation type: woods, shurblands and grasslands.

Taxonomy refers to "Flora d'Italia" (Pignatti, 1982), "Prodromo della Flora Romana" (Anzalone 1996; 1998), the "Checklist of the Italian Vascular Flora" (Conti *et al*., 2005). For plant species identification we also referred to local studies of Veri & Bruno (1978), Veri (1988) and Attorre *et al*. (2006).

Fig. 14 - *Tulipa australis* Link.

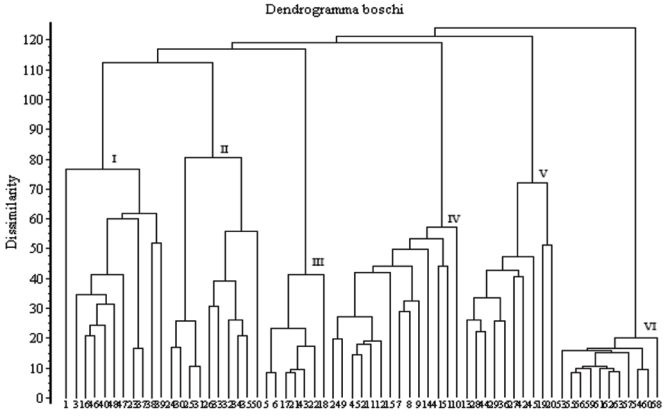


Fig. 15 - Dendrogram of the relevès of woody vegetation belonging to the *Querco-Fagetea and Quercetea ilicis*.

Results

Woody vegetation

Woody vegetation covers a great part of the massif and the variability of climatic and geomorphological features determines the presence of different vegetation types.

Classification analysis identified 6 different groups as showed in the dendrogram of figure 15.

Groups I, II and IV identify the relevès belonging to *Quercetalia pubescenti-petraeae* and, respectively, represent *Quercus pubescens* (*Cytiso sessilifolii-Quercetum pubescentis*), *Ostrya carpinifolia* (*Melittio melissophillae-Ostryetum carpinifoliae*) and *Quercus cerris* (*Aceri obtusati-Quercetum cerridis*) woods.

Cluster III represents the evergreen sclerophyllous woods with *Quercus ilex* (*Ciclamino hederifolii-Quercetum ilicis* belonging to *Quercetalia ilici*), while clusters V e VI identify the mesophilous woods belonging to *Fagetalia sylvaticae*, respectively, woods dominated by *Carpinus betulus* and *Corylus avellana* (*Carpino betuli-Coryletum avellanae*) and the beech woods of the *Cardamino kitaibelii- Fagetum sylvaticae*.

Along several streams, in very steep escarpments, mesophilous wood dominated by *Acer opalus* ssp. *obtusatum* and *Acer pseudoplatanus* were found. Due to their rarity and limited extension, the relevès were not included in the multivariate analysis, but only discussed.

I– *Cytiso sessilifolii - Quercetum pubescentis*
II–*Melittio melissophyllae-Ostryetum carpinifoliae*
III – *Cyclamino hederifolii-Quercetum ilicis*
IV – *Aceri obtusati-Quercetum cerridis*
V – *Carpino betuli-Coryletum avellanae*
VI – *Cardamino kitaibelii- Fagetum sylvaticae*

This classification was confirmed by the scattergram obtained by plotting the relevés along the first two ordination axes obtained by the PCoA (Fig. 16).

I– *Cytiso sessilifolii-Quercetum pubescentis*
II–*Melittio melissophyllae-Ostryetum carpinifoliae*
III – *Cyclamino hederifolii-Quercetum ilicis*

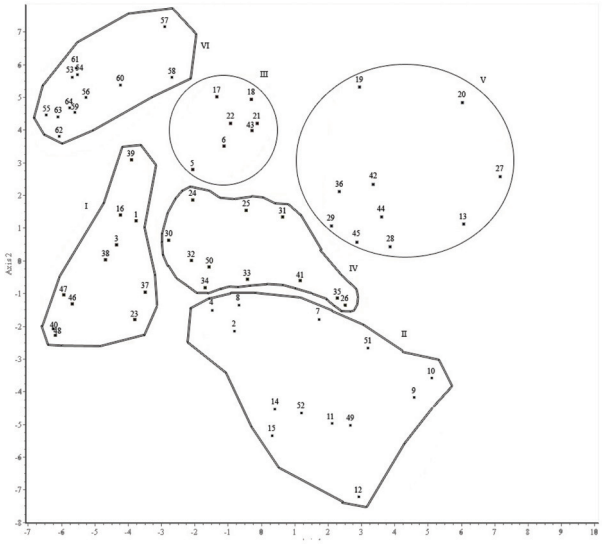


Fig. 16 - Relevès scattergram along the first two ordination axes of the PCA.

V – *Aceri obtusati-Quercetum cerridis*
V – *Carpino betuli-Coryletum avellanae*
VI – *Cardamino kitaibelii- Fagetum sylvaticae*

Cardamino kitaibelii- Fagetum sylvaticae Ubaldi *et al.* ex Ubaldi 1995 (Tab.1)

Beech woods are the most widespread forest community of the mountain belt (Fig. 17).

Above 1000 - 1200 m, in fact, monospecific woods of *Fagus sylvatica* can be found. They cover an area around 13000 ha - almost half of the territory - and they represent one of the most peculiar elements of the landscape (Attorre *et al*., 2002).

The substratum is mainly formed by limestone and the soils are deep, sub acidic, rich in humus (Sanesi, 1982). The phytosociological analysis allowed these woods to be classified in the *Cardamino kitaibelii-Fagetum sylvaticae*, which describes the microtherm beech formations of the Apennines. They are generally monospecific, with a reduced understory cover but with many geophytes such as *Cardamine enneaphyllos*, *Polystichum aculeatum*, *Cardamine kitaibelii*, *Paris quadrifolia*, *Galium odoratum* and *Polygonatum multiflorum*. The first three species, together with *Epilobium montanum*, represent the characteristic and differential species of the association.

Beech woods are considered the natural potential vegetation of the mountain areas of the Central-South Apennines (Feoli & Lagonegro, 1982; Lucchese & Monterosso, 1994; Paglia, 1995; Blasi *et al*., 1998; Biondi *et al*., 1999, 2002a, b). Due to the abandonment of traditional agro-silvo-pastoral activities in the second half of the last century, beech woods expanded (Falcucci *et al*. 2007) and shurblands of *Rosa* sp. pl. and *Juniperus communis* represented germination chambers for beech seedlings and sapling, protecting them from livestock grazing.

Fig. 17 - Beech wood.

Melittio melissophyllae-Ostryetum carpinifoliae Avena, Blasi, Scoppola & Veri 1980 (Tab. 2)

Mixed deciduous woods dominated by *Ostrya carpinifolia* are the most widespread forest type in the sub-mountain areas of the massif; they are present in all the exposures, from 400 m up to the beech woods. Together with *Ostrya carpinifolia,* other tree species such as *Acer opalus* ssp. *obtusatum, Quercus pubescens* and *Fraxinus ornus* can be found. The understory is characterised by *Laburnum anagyroides, Rosa canina, Cytisophillum sessilifolius* and *Crataegus monogyna*. The herbaceous layer is dominated by *Sesleria autumnalis*, common species are *Melittis melissophyllum, Fragaria vesca* and *Hepatica nobilis*. At higher altitudes, mesophilous species belonging to the *Fagetalia sylvaticae,* such as *Euphorbia dulcis, Mercurialis perennis* and *Lathyrus vernus,* can be found.

The phytosociological analysis allowed this wood to be classified in the *Melittio melissophillae-Ostryetum carpinifoliae*. This association has been identified in the Central Apennines (Avena *et al*., 1980) and recognised in the study area as well (Blasi *et al*., 1998); it belongs to the *Laburno anagyroidis-Ostryenion carpinifoliae* sub-alliance including the mesophilous woods widespread on calcareous, marly-arenaceous and flysch substrata of the Apennines. Characteristic species of the association are *Acer opalus* ssp. *obtusatum*, *Melittis melissophyllum* ssp. *melissophyllum*, *Laburnum anagyroides* and *Tamus communis*.

Cyclamino hederifolii-Quercetum ilicis Biondi, Casavecchia & Gigante 2003 (Tab. 3)

This association includes the mixed evergreen sclerophyllous woods dominated by *Quercus ilex*

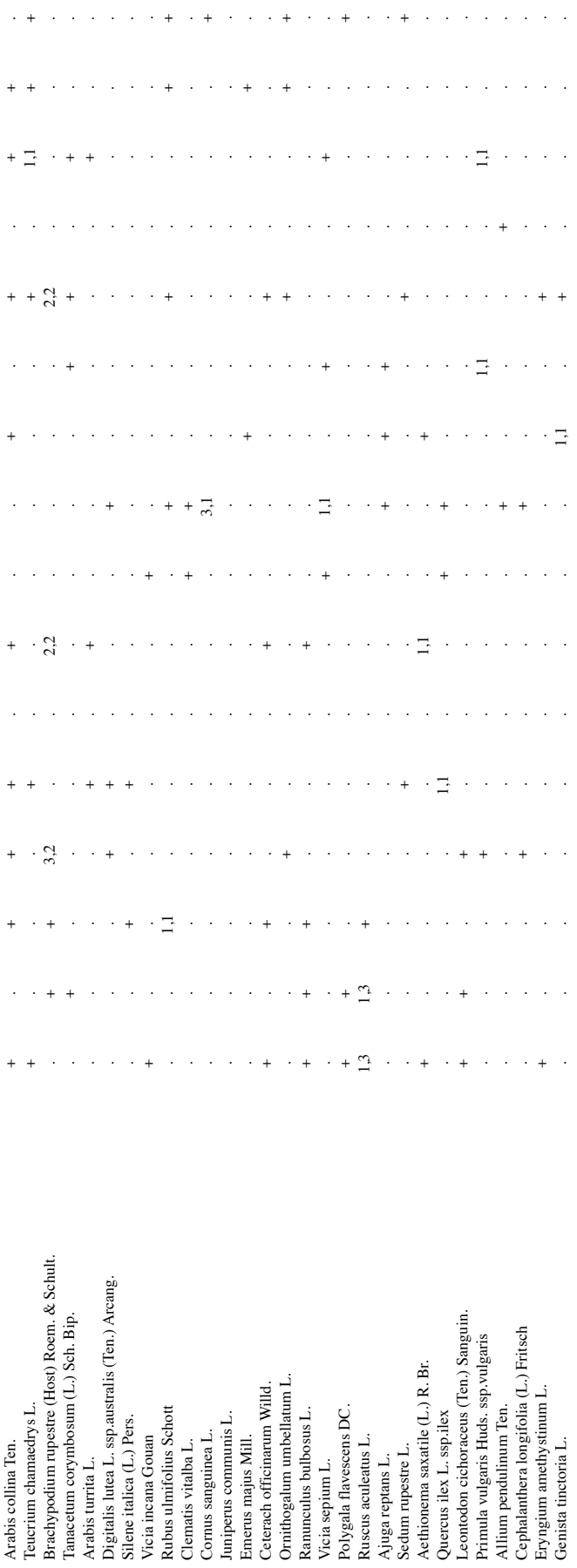
Tab.1 - *Cardamino kitaibelii-Fagetum sylvaticae* Ubaldi *et al.* ex Ubaldi 1995

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12
Altitude (m)	1450	1420	1350	1400	1580	1330	1350	1410	1400	1550	1400	1420
Aspect	SE	SE	NW	SE	S	SW	W	S	E	SW	NW	E
Slope (°)	20	20	10	20	15	15	10	15	10	20	15	5
Area (m²)	200	200	200	200	200	200	200	200	200	200	200	200
Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100
Cardamino kitaibelii-Fagetum sylvaticae Ubaldi *et al.* ex Ubaldi 1995												
Epilobium montanum L.	+	.	.	+	.	1	+	+	.	.	.	.
Cardamine enneaphyllos (L.) Crantz	.	.	.	+	.	+	.	+	.	1	.	.
Polystichum aculeatum (L.) Roth	.	.	+	+	.	.	.	.	.	.	.	.
Cardamine kitaibelii Becherer	.	.	.	.	.	+	.	.	.	.	.	.
Geranio nodosi-Fagenion sylvaticae (Gentile 1974) Ubaldi & Speranza 1985, *Fagion sylvaticae* Luquet 1926												
Cardamine bulbifera (L.) Crantz	1	+	+	+	+	.	+	.	.	.	.	+
Aremonia agrimoniodes (L.) DC. ssp agrimonioides	+	.	+	.	+	.	.	.	.	+	+	.
Adenostyles glabra (Mill.) DC. ssp. glabra	.	.	.	+	.	+	+	.	+	.	.	.
Paris quadrifolia L.	.	.	.	.	.	+	.	+	+	.	+	.
Actea spicata L.	+	.	.	.	+	.	.	.	.	+	.	.
Fagetalia sylvaticae Pawlowski 1928												
Fagus sylvatica L.	5	5	5	5	5	5	5	5	5	5	5	5
Lactuca muralis (L.) Gaertn.	+	+	.	.	+	+	.	.	+	+	+	+
Galium odoratum (L.) Scop.	+	.	+	.	+	.	2	1	.	.	1	+
Luzula sylvatica (Hudson) Gaudin ssp. sylvatica	1	+	.	+	+	.	.	+	1	.	.	.
Milium effusum L.	.	1	1	.	.	.	.	.	1	+	1	+
Lathyrus vernus (L.) Bernh. ssp. vernus	.	.	.	.	.	.	1	.	+	+	+	1
Brachypodium sylvaticum (Hudson) Beauv. ssp. sylvaticum	.	.	.	.	+	2	2	+	.	.	.	1
Dryopteris filix-mas (L.) Schott	.	+	+	.	.	.	.	+	.	+	+	.
Acer pseudoplatanus L.	.	+	.	.	.	.	.	.	.	1	+	1
Prenanthes purpurea (L.)	+	+	.	.	.	+	.	.	.	.	.	.
Stellaria nemorum L. montana (Pierrat) Berher	.	.	.	.	.	.	+	.	+	+	.	.
Euphorbia dulcis L.	.	.	.	.	+	.	.	.	.	.	.	.
Querco-Fagetea Br. Bl. et Vlieg 1937												
Ranunculus lanuginosus L.	.	+	.	+	+	1	+	1	.	.	.	+
Viola reichenbachiana Jordan	.	1	+	1	+	1	.	.	+	+	.	.
Polygonatum multiflorum (L.) All.	.	1	2	.	.	.	+	+	2	+	.	.
Daphne laureola L. ssp. laureola	+	+	+	.	.	.	.	.	1	.	+	+
Euphorbia amygdaloides L. ssp. amygdaloides	1	+	.	+	.	+	+	+	.	.	.	.
Ajuga reptans L.	+	.	+	+	+	.	.	.	.	.	+	.
Sanicula europaea L.	.	.	.	.	+	+	+	.	+	.	.	+
Campanula trachelium L. ssp. trachelium	+	.	.	.	.	+	.	+	+	.	+	.
Poa nemoralis L.	+	.	+	+	.	.	.	.	.	.	.	1
Neottia nidus-avis (L.) L.C.M. Richard	.	.	.	.	.	.	+	+	.	.	.	+
Epipactis helleborine (L.) Crantz ssp. helleborine	.	.	.	.	.	.	.	.	.	+	+	+
Melica uniflora Retz.	.	.	.	.	+	.	.	.	+	.	.	.
Hieracium murorum L.	.	+	.	.	.	.	.	.	.	.	.	.
Hepatica nobilis Miller	.	.	.	.	.	.	+	.	.	.	.	.
Melittis melissophyllim L. ssp. melissophyllum	.	.	.	.	.	+	.	.	.	.	.	.
Primula vulgaris Huds. ssp.vulgaris	.	.	.	.	.	.	.	+	.	.	.	.
Companions												
Fragaria vesca L.	.	2	1	+	1	1	+	.	+	+	.	.
Geranium robertianum L. ssp. robertianum	.	.	1	.	.	.	+	+	1	+	+	+
Geum urbanum L.	+	+	.	.	.	+	.	.	+	.	+	.
Rubus caesius L.	.	.	1	+	+	.	.	.	1	.	+	.
Aquilegia vulgaris L. ssp. vulgaris	+	.	+	.	.	.	.	+	.	+	.	.
Sorbus aucuparia L. ssp. aucuparia	+	+	.	.	.	.	.	.	.	.	+	+
Digitalis lutea L. australis (Ten.) Arcang.	.	.	.	+	.	+	.	.	.	1	.	.
Orthilia secunda (L.) House	+	.	+	+	.	.	.	.	.	.	.	.
Anemone apennina L.	.	+	.	.	.	.	.	.	.	.	.	+
Galium aparine L.	.	.	.	+	.	.	+	.	.	.	.	.
Euphorbia myrsinites L.	.	.	.	.	.	.	.	.	.	.	+	+
Acer opalus Mill. obtusatum (Waldst. & Kit. ex Willd.) Gams	.	.	+	.	.	1	.	.	.	.	.	.
Listera ovata (L.) R. Br.	.	.	.	.	.	.	.	+	.	.	.	+
Sambucus ebulus L.	.	.	.	.	.	.	1	.	.	.	+	.
Ceterach officinarum Willd. ssp. officinarum	.	.	.	+	.	.	.	.	.	.	.	.
Rubus idaeus L.	.	.	.	.	.	+	.	.	.	.	.	.
Asplenium trichomanes L. ssp. trichomanes	.	.	.	.	.	.	.	.	+	.	.	.
Moehringia muscosa L.	+	.	.	.	.	.	.	.	.	.	.	.

Tab. 2 - *Melittio melissophyllae-Ostryetum carpinifoliae* Avena, Blasi, Scoppola & Veri 1980

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Date	10/05/06	10/05/06	10/05/06	10/05/06	10/05/06	10/05/06	15/05/06	15/05/06	15/05/06	18/05/06	18/05/06	18/05/06	18/05/06	22/05/06	22/05/06	22/05/06
Latitude	338295	338322	339015	344351	339958	344178	344039	344212	344507	343778	344539	344647	353423	359654	353638	353609
Longitude	4652421	4652514	4652281	4695292	5659925	4644984	4644830	4643151	4643191	4645636	4645392	4645444	4635354	4637055	4636684	4636805
Altitude (m)	830	905	915	935	924	951	957	815	850	849	1052	1069	760	1020	1008	1013
Aspect	WSW	SW	SW	S	NW	ENE	ENE	N	NW	NNW	NNW	NNW	N	N	NNW	NE
Slope (°)	25	25	25	25	25	30	30	45	20	40	30	30	25	25	20	4
Rock (%)	10	10	5	10	15	30	-	30	10	10	10	10	-	10	10	10
Stone (%)	15	10	5	-	-	10	10	10		5	-	-	3	10	3	3
Area (m^2)	200	100	150	150	150	120	150	200	150	100	150	150	150	150	150	180
Dominant tree layer (A)																
Height (m)	10 – 12	8	8 - 10	12	13	10	8 - 10	10 - 11	8 - 10	7 - 8	15	10 - 12	10 - 12	12	8- 10	8 – 12
Cover (%)	80	80	90	85	85	80	70	95	90	85	80	70	90	95	100	95
Dominated tree layer (B)																
Height (m)	4–6	-	-	-	1-6	-		-	4 - 6		4 - 6	5 - 7	-	-	5 - 7	4–6
Cover (%)	20	-	-	-	20	-		-	40	-	10	50	-	-	30	10
Shrub layer (C)																
Height (m)	0.5 - 1.5	0.5 - 1.6	0.5 - 3	0.4 - 3	-	0.7 - 2	-	0.7 - 2	0.5 - 1.5	0.5 - 2.5	0.5 - 1.20	0.5 - 2	1 - 3	0.5 - 2	0.5 - 1	-
Cover (%)	10	10	20	15	-	5	-	10	15	15	10	10	30	5	5	-
Herbaceous layer (E)																
Cover (%)	70	70	60	90	50	30	70	40	60	85	95	85	85		30	70
Melittio-Ostryetum carpinifoliae Avena, Blasi, Scoppola & Veri 1980																
Melittis melissophyllum L. ssp. melissophyllum	1,1	+	1,1	+	+		1,1	+	+	+		1,1	+		1,1	+
Acer opalus Mill. ssp.obtusatum (Waldst. & Kit. ex Willd.) Gams		+	+		2,3	+		+	2,2		+	+		+	+	1,1
Laburnum anagyroides Medik.					+	+	+	2,1		1,1	+				+	
Tamus communis L.		+		+	+			+					+	+		+
Laburno anagyroidis-Ostryenion carpinifoliae (Ubaldi 1995) Blasi, Di Pietro & Filesi 2004																
Anemone apennina L.	.	+	1,1	.	1,1	+	1,1	1,1	+	+	1,1	+	1,1	+	1,1	.
Festuca heterophylla Lam.	.	.	+	+	.	+	.	2,2	2,2	.	1,1	2,1	1,3	1,1	+	.
Lathyrus venetus (Mill.) Wohlf.	.	.	.	+	+	.	+	+	+	+	+	+	.	.	+	+
Veratrum nigrum L.	.	.	.	.	.	+	.	+	+	+	2,1	+	+	.	+	+
Daphne laureola L.	.	.	.	+	+	.	.	1,2	+	+	1,2	+	.	+	.	.
Lilium bulbiferum L. ssp.croceum (Chaix) Jan	.	.	.	+	.	+	.	.	.	+	+	+	+	+	.	.
Primula veris L. ssp.suaveolens (Bertol.) Gutermann & Ehrend.	.	.	+	+	+	+	.	.	.	1,1	.	.	.	+	.	+
Malus sylvestris (L.) Mill.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+
Sanicula europaea L.	.	.	.	.	.	.	.	.	.	.	1,1	.	.	.	.	.
Carpinion orientalis Horvat 1958																
Ostrya carpinifolia Scop.	3,3	4,4	5,5	5,2	3,4	5,5	4,4	4,4	5,5	5,5	5,4	4,4	5,1	4,5	5,5	5,5
Fraxinus ornus L. ssp.ornus	2,1	1,2	+	+	1,1	.	+	1,1	+	+	+	+	+	+	+	+
Sesleria autumnalis (Scop.) F.W. Schultz	+	3,3	3,3	3,2	3,1	.	+	2,3	1,1	3,2	3,2	3,2	1,2	3,1	1,1	3,2
Asparagus acutifolius L.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Quercetalia pubescenti-petraeae Klika 1933 corr. Moravec in Béguin et Theurillat 1984																
Cyclamen hederifolium Aiton	+	+	.	+	+	+	2,1	+	.	+	.	+	+	+	.	.
Helleborus foetidus L. ssp.foetidus	.	.	+	+	.	+	+	.	.	+	+	+	+	+	+	.
Campanula trachelium L. ssp. trachelium L.	.	.	.	+	.	.	.	+	+	+	+	+	+	+	+	+
Quercus pubescens Willd. ssp.pubescens	1	+	+	1,1	+	.	+	.	.	+	.	.	.	.	.	.
Cornus mas L.	.	.	.	.	+	.	.	.	+	+	+	.	+	.	.	.
Ptilostemon strictus (Ten.) Greuter	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Aristolochia lutea Desf.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.

Quercus cerris L.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+
Hypericum perfoliatum L.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Potentilla micrantha Ramond ex DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1,1
Acer monspessulanum L. ssp.monspessulanum	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Querco-Fagetea Br.Bl. & Vlieger in Vlieger 1937																
Hepatica nobilis Schreb.	.	.	.	1,1	1,1	1,1	1,1	+	+	1,2	+	.	1,3	+	1,3	+
Fragaria vesca L. ssp. vesca	.	.	+	1,1	.	+	1,1	+	+	+	+	+	+	+	.	.
Corylus avellana L.	.	.	.	1,1	1,3	+	.	.	+	+	1,1	3,3	2,3	.	3,4	1,1
Sorbus aria (L.) Crantz (I)	.	.	.	.	+	+	+	.	.	+	+	+	.	.	.	+
Hieracium murorum L.	.	.	.	+	.	.	.	+	.	+	+	+	.	1,1	.	1,1
Melica uniflora Retz.	.	.	.	.	+	.	.	+	.	.	.	+	+	.	+	+
Neottia nidus-avis (L.) Rich.	.	.	.	.	+	.	.	.	+	+	+	.	.	+	+	.
Viola reichenbachiana Jord. ex Boreau	.	.	.	+	+	+	.	.	.	1,1	.	.	+	.	+	.
Carex flacca Schreb.ssp. flacca	1,1	+	.	+	.	+	+	.	.	+	.	.	.	.	.	.
Rosa arvensis Huds.	.	.	1,1	.	.	.	.	.	+	.	.	+	.	.	.	.
Cyanus triumfetti (All.) Dostál ex Á. & D. Löve	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.
Polygonatum odoratum (Mill.) Druce	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.
Lactuca muralis (L.) Gaertn.	.	.	.	.	+	.	.	+	.	+	.	.	+	.	+	.
Saxifraga rotundifolia L. ssp. rotundifolia	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Lilium martagon L.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
Fagus sylvatica L. ssp.sylvatica	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+
Euphorbia dulcis L.	.	.	.	.	.	.	.	.	.	+	.	.	.	1,1	.	.
Mercurialis perennis L.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Thalictrum aquilegiifolium L. ssp. aquilegiifolium	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
Acer pseudoplatanus L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Lathyrus vernus (L.) Bernh.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Listera ovata (L.) R. Br.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Cardamine bulbifera (L.) Crantz	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Luzula forsteri (Sm.) DC.	.	.	.	.	.	1,1	.	.	.	.	+	.	.	.	.	.
Acer campestre L.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+
Cephalanthera damasonium (Mill.) Druce	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Hieracium racemosum Waldst. & Kit. ex Willd.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Euphorbia amygdaloides L.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Astragalus glycyphyllos L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Companions	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cruciata glabra (L.) Ehrend.	+	+	+	1,1	1,1	+	1,1	+	.	+	+	+	.	+	+	+
Viola suavis M. Bieb. ssp.suavis	+	1,2	+	.	+	1,1	+	.	+	+	.	+	+	+	+	+
Hedera helix L.	.	.	.	+	.	+	+	+	1,2	1,2	.	+	3,4	.	1,1	+
Lonicera caprifolium L.	+	+	+	+	+	+	.	.	.	+	.	.	+	.	+	+
Luzula sylvatica (Huds.) Gaudin	.	.	.	.	.	+	.	1,1	.	+	+	.	+	+	+	+
Galium corrudifolium Vill.	+	1,3	.	+	+	.	+	.	.	.	+	+	.	.	.	.
Cyclamen repandum Sm. ssp.repandum	1,3	.	1,3	.	2,1	.	+	.	+	+	.	+	.	.	.	.
Carex halleriana Asso	+	+	+	+	.	.	.	.	.	2,3	+	.	.	.	.	+
Cerastium arvense L.	+	.	+	+	.	.	+	.	.	.	+	+	.	.	.	+
Asplenium trichomanes L.	.	.	.	.	+	+	.	+	+	.	.	.	.	+	.	+
Clinopodium vulgare L.	+	.	+	.	.	.	.	+	.	+	.	+	.	.	.	.
Oenanthe pimpinelloides L	.	+	.	.	.	.	.	.	.	+	+	.	.	.	+	+
Seseli montanum L. ssp. montanum	.	+	.	+	+	.	.	.	.	.	+	+	.	.	.	.
Trifolium alpestre L.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	+
Cytisophyllum sessilifolium (L.) O. Lang	+	+	+	+	+	+	.	2,1	.	.	.	.	.	+	.	.
Rosa s.p.	+	+	.	+	.	.	+	.	.	.	1,2	.	.	.	.	.
Crataegus monogyna Jacq.	+	+	1,1	1,1	.	.	.	.	.	.	.	1,1	.	.	.	.
Aremonia agrimonoides (L.) DC.	.	.	+	+	.	+	.	+	+	.	+	+	.	+	+	+



together with deciduous tree species such as *Quercus pubescens*, *Ostrya carpinifolia* and *Fraxinus ornus*. Due to the abundance of deciduous species and the presence of characteristic species, such as *Cyclamen hederifolium* and *Asplenium onopteris,* the reference association is the *Ciclamino hederifolii-Quercetum ilicis,* described by Biondi *et al*. (2003), vicariant, in the Italian peninsula, of the thermophilous woods included in the *Fraxino orni-Quercetum ilicis,* more widespread in the Balkans.

This woody association is particularly abundant between 500 and 800 m, while in cliffs and very steep escarpments it can reach 1100 m.

It has been hypothesised that this type of wood has been favoured by an excessive timber harvesting on southern exposures, where soil erosion processes determined the presence of rendzine or protorendzina soil and where *Quercus ilex* is more competitive than deciduous tree species.

The herbaceous layer is poor of species, due to the very high tree cover. The Mediterranean floristic component (*Quercetea* and *Quercetalia ilicis*) is well represented even if not very abundant: *Rubia peregrina*, *Asparagus acutifolius, Ruscus aculeatus* and *Smilax aspera*.

Carpino betuli-Coryetum avellanae Ballelli, Biondi & Pedrotti 1980 (Tab. 4)

The mesophilous woods dominated by *Corylus avellana* and *Carpinus betulus*, can be found in small areas at the bottom of narrow canyons characterised by cool and humid microclimatic conditions.

The structure of this plant community is characterised by a shrub layer 4-5 m tall with *Corylus avellana*, and a dominant tree layer 10-15 m tall with *Carpinus betulus* and other broadleaf tree species such as *Acer opalus* ssp. *obtusatum* (Fig. 19).

From a phytosociological point of view, this plant community was included in the *Carpino betuli-Coryletum avellanae,* which is typical of small narrow valleys of the Central Apennines (Ballelli *et al*., 1980). It belongs to the Apennine sub-alliance *Pulmonario apenninae–Carpinenion betuli* (*Erythronio dentis-canis-Carpinion betuli*) (Biondi *et al*., 2002a).

Characteristic and differential species of the association are geophytes of the *Fagetalia sylvaticae,* such as *Galanthus nivalis* and *Corydalis cava* ssp. *cava*. Other frequent species of the herbaceous layer are *Melica uniflora*, *Campanula trachelium* and *Lactuca muralis*.

Cytiso sessilifolii – Quercetum pubescentis Blasi, Feoli & Avena 1982 (Tab. 5)

The woods with *Quercus pubescens* are classified in the *Cytiso sessilifolii-Quercetum pubescentis* association, which describes the downy oak woods of

Tab. 3 - *Cyclamino hederifolii-Quercetum ilicis* Biondi, Casavecchia & Gigante, 2003

No. relevé	1	2	3	4	5	6	7	8
Date	11/05/06	11/05/06	12/05/06	15/05/06	11/05/06	11/05/06	15/05/06	11/05/06
Latitude	340572	340668	341380	343807	343644	343657	344646	345259
Longitude	4647205	4647187	4646497	4642636	4642285	4642375	4641789	4641468
Altitude (m)	865	820	750	541	580	610	500	531
Aspect	WNW	W	SW	SW	W	NW	S	SW
Slope (°)	25	20	25	20	35	25	50	50
Rock (%)	10	20	20	-	20	40	10	20
Stone (%)	10	30	70	50	10	3	15	30
Area (m^2)	100	80	250	100	200	250	100	100
Dominant tree layer (A)								
Height (m)	8 - 10	8 - 10	10 - 12	6 - 8	8 - 10	10	13	10
Cover (%)	90	100	100	20	100	95	97	95
Dominated tree layer (B)								
Height (m)	-	.	-	4	-	-	7	4 - 5
Cover (%)	-	.	-	100	-	-	10	15
Shrub layer (C)								
Height (m)	0.5 - 1.20	0.5 - 1.70	0.5 - 1.20	-	0.5 - 2	0.5 - 1.80	0.5 - 3	-
Cover (%)	15	10	20	-	10	25	20	-
Herbaceous layer (E)								
Cover (%)	30	10	20	70	20	20	40	20
Cyclamino hederifolii-Quercetum ilicis Biondi *et al*. 2003, *Fraxino orni-Quercion ilicis* Biondi *et al*. 2003								
Cyclamen hederifolium Aiton	+	+	+	+	+	.	+	+
Fraxinus ornus L. ssp.ornus	1,2	1,1	1,1	+	+	2,1	1,1	1,1
Asplenium onopteris L.	.	+	+	.	+	.	+	+
Emerus majus Mill.	.	+	1,1	.	.	.	+	+
Ostrya carpinifolia Scop.	1,1	1,3	.	.	.	.	2,1	.
Cyclamen repandum Sm. ssp.repandum	1,3	.	+	1,1	.	.	.	.
Tamus communis L.	.	.	1,1	+	+	.	1,1	1,1
Carpinus orientalis Mill. ssp.orientalis	.	.	.	1,1	.	.	.	.
Quercetalia ilicis Br.-Bl.ex Molinier 1934, *Quercetea ilicis* Br.-Bl. ex A. & O.Bolòs 1950								
Quercus ilex L. ssp.ilex	4,4	4,4	5,5	5,4	5,5	5,4	2,2	5,5
Ruscus aculeatus L.	.	+	+	.	+	.	+	.
Asparagus acutifolius L.	+	+	1,1	+	+	+	+	+
Rubia peregrina L.	1,1	.	1,1	+	1,1	2,1	1,1	+
Smilax aspera L.	.	.	.	.	.	.	.	1,1
Rosa sempervirens L.	+	.	.	.	.	.	.	.
Carex halleriana Asso	.	+	+	.	.	.	.	.
Companions								
Polypodium vulgare L.	+	+	+	.	+	+	+	.
Viola suavis M. Bieb. ssp.suavis	+	+	+	1,1	.	.	+	+
Ceterach officinarum Willd.	+	.	+	.	1,1	+	+	.
Crataegus monogyna Jacq.	+	+	+	.	.	.	.	+
Lonicera caprifolium L.	+	+	+	+	.	.	.	.
Quercus pubescens Willd. ssp.pubescens	+	+	+	.	.	+	.	.
Teucrium chamaedrys L.	+	.	+	.	.	.	+	.
Asplenium trichomanes L.	.	.	+	.	.	.	+	+
Hedera helix L.	.	.	.	3,3	.	+	2,3	.
Arabis turrita L.	.	.	.	.	.	+	.	+
Brachypodium rupestre (Host) Roem. & Schult.	+	.	.	.	.	+	.	.
Brachypodium sylvaticum (Huds.) P. Beauv.	.	.	.	.	.	.	+	+
Buglossoides purpurocaerulea (L.) I.M. Johnst.	.	.	+	+	.	.	.	.
Cornus mas L.	.	.	.	+	.	.	.	+
Cornus sanguinea L.	.	.	.	1,1	.	.	1,1	.
Euonymus europaeus L.	.	.	.	+	.	.	+	.
Galium aparine L.	.	.	.	+	.	.	+	.
Neottia nidus-avis (L.) Rich.	.	.	+	.	+	.	.	.
Rubus ulmifolius Schott	.	.	.	1,1	.	.	+	.
Seseli montanum L. ssp. montanum	+	+	.	.	.	.	.	.
Sesleria autumnalis (Scop.) F.W. Schultz	+	.	.	.	.	.	.	1,3
Acer campestre L.	.	.	.	.	.	.	+	.
Acer monspessulanum L. ssp.monspessulanum	.	.	.	.	+	.	.	.
Arabis collina Ten.	+	.	.	.	.	.	.	.
Calamintha ascendens Jord.	.	.	.	.	.	.	.	+
Campanula trachelium L. ssp. trachelium L.	.	.	.	.	.	.	+	.
Carex flacca Schreb.ssp. flacca	.	.	.	.	.	+	.	.
Carpinus betulus L.	.	.	.	.	.	.	2,2	.
Cephalanthera longifolia (L.) Fritsch	.	.	+	.	.	.	.	.
Clematis vitalba L.	.	.	.	+	.	.	.	.
Cytisophyllum sessilifolium (L.) O. Lang	+	.	.	.	.	.	.	.
Galium corrudifolium Vill.	+	.	.	.	.	.	.	.
Galium lucidum All.	.	.	.	.	.	+	.	.
Geranium purpureum Vill.	.	.	.	.	.	.	+	.
Hieracium murorum L.	.	.	.	.	.	.	.	+
Lactuca muralis (L.) Gaertn.	.	.	.	.	.	.	+	.
Leontodon cichoraceus (Ten.) Sanguin.	+	.	.	.	.	.	.	.
Lilium bulbiferum L. ssp.croceum (Chaix) Jan	.	.	.	.	.	.	+	.
Muscari neglectum Guss. ex Ten.	.	.	+	.	.	.	.	.
Pistacia lentiscus L.	.	.	+	.	.	.	.	.
Platanthera chlorantha (Custer) Rchb.	.	.	.	.	+	.	.	.
Primula veris L. ssp.suaveolens (Bertol.) Guter. & Ehrend.	.	.	.	.	.	.	+	.
Scutellaria columnae All.	.	.	.	.	.	.	.	+

Fig. 18 - *Quercus ilex* wood.

Fig. 19 - *Carpino betuli-Coryletum avellanae*.

the sub-mountain areas of the central Apennines (Blasi *et al*., 1982), localised between 600 and 1000 m, with a southern exposure and a slope between 10° and 40°. Characteristic species are *Cytisophyllum sessilifolium*, *Teucrium chamaedrys*, *Rosa canina*, *Juniperus oxycedrus* and *Cytisus spinescens*.

The tree layer is mainly dominated by *Quercus pubescens*, *Fraxinus ornus* and *Ostrya carpinifolia*. The herbaceous layer is rich in species from the surrounding therophytic and chameephytic communities (*Dactylis glomerata*, *Teucrium chamaedrys* and *Cytisus spinescens*), which are favoured by the reduced tree cover, thin soil and abundant rocks.

According to Blasi *et al*., (2004), this association belongs to the *Cytiso sessilifolii-Quercenion pubescentis* sub-alliance (*Carpinion orientalis*) which is limited to Central Italy.

Aceri obtusati-Quercetum cerridis Ubaldi & Speranza 1982 (Tab. 6)

The turkey oak woods of the Simbruini mountains are mature formations with a well developed tree layer (average cover 85 %, average height 15 m), generally growing on deep soils.

Carpinus orientalis is quite abundant especially in the southern exposures, while *Carpinus betulus* prevails in the more humid and cool areas along the streams.

Turkey oak woods are generally found between 500 and 800 m, other broadleaf deciduous species such as *Fraxinus ornus*, *Ostrya carpinifolia* and *Acer campestre*, are favoured by cutting practices.

The presence of *Cyclamen hederifolium, Cornus mas, Cornus sanguinea* and *Lonicera caprifolium*, allowed the classification of these woody plant communities in the *Aceri obtusati-Quercetum cerridis* association. In fact, despite the high frequency of *Carpinus orientalis*, it was not possible to classify it in the *Carpino orientalis-Quercetum cerridis* association due to the lack of characteristic species.

Turkey oak woods show a noticeable quantity of plant species of *Quercetalia pubescenti-petraeae* and *Querco-Fagetea*, while more rare are the species of the alliance and sub-alliance (*Laburno-Ostrenyion carpinifoliae* and *Carpinion orientalis*).

Aceretum obtusati-pseudoplatani Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002 (Tab. 7)

Two relevés were representative of mesophilous woods dominated by maple species such as *Acer opalus* ssp. *obtusatum* and *Acer pseudoplatanus*. Together with them, other species such as *Ulmus glabra*, *Fraxinus excelsior*, *Tilia platyphyllos* and *Carpinus betulus* can be found in the tree layer, while *Corylus avellana* tends to grow as a small tree or shrub. In the shrub layer *Euonymus latifolius*, *Sambucus nigra* and *Cornus mas* can also be found. In the herbaceous layer several species of the *Fagetalia sylvaticae* are present: *Melica uniflora*, *Mercurialis perennis*, *Galium odoratum* and *Euphorbia dulcis*.

This broadleaf ravine forest grows in specific conditions, such as on steep slopes with unstable and fertile soil in sub-mountain and hilly areas with northern exposures (Biondi *et al*., 2002).

Shrub vegetation

The shrub vegetation was classified in six associations belonging to four syntaxonomical alliances: *Berberidion vulgaris* (*Ribeso uvae-crispae-Rosetum dumalis*, *Roso pendulinae-Genistetum*

Tab. 4 - *Carpino betuli-Coryletum avellanae* Ballelli, Biondi & Pedrotti 1982

No. relevé	1	2	3	4	5	6	7	8	9	10
Date	17/05/06	17/05/06	17/05/06	19/05/06	10/05/06	10/05/06	09/05/06	09/05/06	13/05/06	07/05/06
Latitude	344560	343922	344273	351709	344092	344121	344652	344778	346630	352544
Longitude	4645411	4642612	4642614	4638195	4652364	4652706	4641575	4641510	4640022	4640757
Altitude (m)	1040	630	645	600	938	936	466	452	550	650
Aspect	NNW	NNW	N	W	E	SW	S	SW	W	E
Slope (°)	20	30	30	35	30	10	5	55	5	20
Rock (%)	10	10	5	10	20	10	10	70	-	-
Stone (%)	10	90	80	-	5	40	5	5	-	-
Area (m²)	100	100	150	100	100	100	120	150	150	150
Dominant tree layer (A)										
Height (m)	10 – 12	12 – 15	12 – 15	12 – 15	10 – 15	10 – 13	15 – 20	15 – 22	5 – 7	5 – 8
Cover (%)	30	95	80	30	95	85	70	90	100	100
Dominated tree layer (B)										
Height (m)	4 - 6	4 - 8	6 - 10	8 - 10	3 - 7	4 - 7	6 - 10	6 - 8	-	-
Cover (%)	90	20	60	85	10	30	100	55	-	-
Shrub layer (C)										
Height (m)	-	0.5-1.50	0.5-1.50	0.5-4	-	-	0.5-1.50	0.5-1.50	0.5-3	1 - 3
Cover (%)	-	10	10	15	-	-	15	25	20	15
Herbaceous layer (E)	-									
Cover (%)	70	40	70	70	50	50	20	70	50	85
Carpino betuli-Coryletum avellanae Ballelli, Biondi & Pedrotti 1982										
Corylus avellana L.	5,5	1,1	4,5	5,5	5,5	4,4	5,5	3,3	5,5	5,5
Primula vulgaris Huds. ssp.vulgaris	.	+	+	+	+	+	+	+	+	+
Carpinus betulus L.	+	4,4	5,5	2,2	+	+	3,1	2,1	+	
Galanthus nivalis L.	1,2	+	.	+	+	.	.	+	.	.
Corydalis cava (L.) Schweigg. & Körte ssp. cava	.	+	+	.	.	+	.	+	.	+
Pulmonario apenninae-Carpinenion betuli Biondi *et al*. 2002, *Erythronio dentis-canis-Carpinion betuli* (Horvat 1958) Marincek in Wallnofer, Mucina & Grass 1993										
Acer opalus Mill. ssp.obtusatum (Waldst. & Kit. Ex Willd.) Gams	1,1	.	+	+	1,1	1,1	+	+	.	.
Daphne laureola L.	+	.	.	+	+	+	.	+	.	+
Lathyrus venetus (Mill.) Wohlf.	+	.	+	2,1	1,1	.	+	.	+	.
Cyclamen hederifolium Aiton	+	+	+	.	.	.	.	.	.	.
Lonicera caprifolium L.	.	.	.	.	+	+	.	.	.	.
Ranunculus ficaria L.	+	.	.	.	.	.	.	.	.	.
Fagetalia sylvaticae Pawl. 1928										
Melica uniflora Retz.	1,1	.	+	+	1,1	.	+	+	+	+
Campanula trachelium L. ssp. trachelium L.	.	.	+	+	+	+	+	+	+	+
Lactuca muralis (L.) Gaertn.	+	+	2,1	.	1,1	.	+	+	.	+
Viola reichenbachiana Jord. Ex Boreau	+	.	+	+	.	.	1,1	.	+	+
Lilium bulbiferum L. ssp.croceum (Chaix) Jan	.	.	+	+	+	.	.	+	+	+
Sanicula europaea L.	+	.	.	2,1	+	.	+	.	.	.
Mercurialis perennis L.	2,3	.	+	+	.	.	.	.	2,1	.
Euphorbia dulcis L.	.	.	.	2,1	.	.	+	.	+	.
Aremonia agrimonoides (L.) DC.	+	.	.	+	.	+	.	.	.	.
Arum maculatum L.	.	.	.	+	+	.	.	.	.	.
Euonymus latifolius (L.) Mill.	.	.	.	.	.	.	1,1	1,1	.	.
Cardamine bulbifera (L.) Crantz	+	.	.	+	.	.	.	.	.	.
Listera ovata (L.) R. Br.	.	.	.	.	.	.	.	.	+	+
Saxifraga rotundifolia L. ssp. rotundifolia	+	.	+	.	.	.	.	.	.	.
Fagus sylvatica L. ssp.sylvatica	+	.	.	.	.	.	.	.	.	.
Festuca heterophylla Lam.	.	.	.	+	.	.	.	.	.	.
Euphorbia amygdaloides L.	.	.	.	2,1	.	.	.	.	.	.
Lilium martagon L.	+	.	.	.	.	.	.	.	.	.
Dactylorhiza maculata (L.) Soó	.	.	.	.	.	.	.	.	.	+
Luzula sylvatica (Huds.) Gaudin	+	.	.	.	.	.	.	.	.	.
Neottia nidus-avis (L.) Rich.	.	.	.	+	.	.	.	.	.	.
Querco-Fagetea Br.Bl. & Vlieger in Vlieger 1937										
Acer campestre L.	.	+	.	+	+	+	+	.	+	+
Anemone apennina L.	2,2	2,2	3,2	+	1,1	+	+	.	.	.
Hedera helix L.	.	1,1	.	2,1	.	.	2,3	3,3	.	1,3
Cornus sanguinea L.	.	.	+	.	1,1	+	1,1	.	.	1,1
Fragaria vesca L. ssp. Vesca	+	.	.	+	.	1,1	+	.	.	.
Cornus mas L.	.	+	.	2,1	.	1,1	.	.	1,1	.
Hepatica nobilis Schreb.	2,2	.	.	.	+	.	.	.	2,1	.
Melittis melissophyllum L. ssp. melissophyllum	.	.	+	.	+	.	.	.	+	.
Quercus pubescens Willd. ssp.pubescens	.	.	+	.	.	+	.	.	.	.
Hieracium ub alle L.	.	.	.	.	.	.	.	+	.	+
Ostrya carpinifolia Scop.	2,1	.	.	.	.	.	.	3,1	.	.
Ajuga reptans L.	.	.	+	.	.	.	+	.	.	.
Brachypodium sylvaticum (Huds.) P. Beauv.	.	.	.	.	.	.	+	+	.	.
Geum urbanum L.	.	.	+	.	.	.	+	.	.	.
Geranium robertianum L.	+	.	.	.	.	.	.	.	.	.
Cephalanthera longifolia (L.) Fritsch	.	.	.	.	.	.	.	+	.	.

Cephalanthera damasonium (Mill.) Druce	.	.	.	.	.	.	.	+	.	.
Carpinus orientalis Mill. ssp.orientalis	.	.	.	.	.	.	.	.	1,1	.
Polygonatum odoratum (Mill.) Druce	1,3	.	.	.	.	.	.	.	.	.
Luzula forsteri (Sm.) DC.	.	.	+	.	.	.	.	.	.	.
Carex flacca Schreb.ssp. flacca	.	.	.	.	+	.	.	.	.	.
Companions										
Euonymus europaeus L.	+	+	1,1	+	+	+	+	.	.	.
Viola suavis M. Bieb. Ssp.suavis	.	+	+	.	+	+	+	+	+	.
Crataegus monogyna Jacq.	.	+	.	+	+	+	1,1	.	+	.
Alliaria petiolata (M. Bieb.) Cavara & Grande	+	.	.	.	+	+	+	.	+	.
Fraxinus ornus L. ssp.ornus	.	+	.	.	+	+	.	1,1	+	.
Helleborus foetidus L. ssp.foetidus	+	.	.	.	+	+	+	.	.	+
Sesleria autumnalis (Scop.) F.W. Schultz	+	.	+	.	1,1	1,1	.	+	.	.
Aegopodium ub alleanz L.	.	.	.	1,1	.	.	+	.	+	3,2
Allium pendulinum Ten.	.	2,1	2,1	.	+	.	+	.	.	.
Arabis turrita L.	.	.	+	.	+	+	.	.	.	+
Salvia glutinosa L.	+	.	.	+	.	.	.	+	.	1,3
Silene italica (L.) Pers.	.	.	.	+	+	+	.	+	.	.
Tamus communis L.	.	.	.	+	.	.	.	+	+	+
Veronica hederifolia L.	+	+	+	.	+	.	.	.	.	.
Acer pseudoplatanus L.	.	1,1	.	2,1	.	.	.	+	.	.
Cardamine chelidonia L.	.	.	+	.	.	.	+	1,1	.	.
Cardamine impatiens L. ssp.impatiens	.	.	.	.	+	+	.	.	.	+
Chaerophyllum temulum L.	.	.	.	.	+	+	.	.	.	+
Cyclamen repandum Sm. ssp.repandum	.	1,1	2,1	.	.	.	.	.	+	.
Moehringia trinervia (L.) Clairv.	.	+	1,1	+	.	.	.	.	.	.
Polypodium vulgare L.	+	+	.	.	.	.	.	1,1	.	.
Tilia platyphyllos Scop.	.	.	.	.	.	.	+	1,1	+	.
Digitalis lutea L. ssp.australis (Ten.) Arcang.	.	.	.	.	.	+	.	+	.	.
Emerus majus Mill.	.	.	.	.	.	+	.	1,1	.	.
Piptatherum virescens (Trin.) Boiss.	.	.	.	.	.	.	.	+	.	+
Rubia peregrina L.	.	+	.	.	.	.	.	1,1	.	.
Stellaria media (L.) Vill.	+	.	+	.	.	.	.	.	.	.
Thalictrum aquilegiifolium L. ssp. aquilegiifolium	.	.	.	.	.	.	+	.	.	+
Veratrum nigrum L.	+	.	.	+	.	.	.	.	.	.
Populus alba L.	.	.	.	.	.	.	1,1	.	.	.

radiatae, *Viburno lantanae-Juniperetum communis*) in which communities with Eurosiberian and Apennine-Balcanic distribution are included, *Cytision sessilifolii* (*Spartio juncei-Cytisetum sessilifolii*), an endemic alliance of the hilly and sub mountain belt of Central Apennines on calcareous lithotypes (Biondi *et al*., 1988) and *Pruno-Rubion ulmifolii* (*Roso sempervirenti-Rubetum ulmifolii*) which identifies termophilous shrub communities characterised by a significant Mediterranean floristic component (Poldini *et al*., 2002), and *Daphno oleoidis-Juniperion alpinae* (*Daphno oleoidis-Juniperetum alpinae*) which includes the *Juniperus communis* ssp. *alpina* community of the Apennine calcareous mountains.

The first three alliances are grouped in the *Rhamno-Prunetea* class including shrub communities dynamically linked to deciduous woods, while the fourth one belongs to the *Pino-Juniperetea* class which in some continental and high mountain areas is linked to the coniferous forests as the most mature phase of the climatophilous series (Rivas-Martínez *et al*., 1991).

The multivariate analysis highlighted four clusters corresponding to *Ribeso uvae-crispae-Rosetum dumalis, Spartio juncei-Cytisetum sessilifolii, Roso sempervirenti-Rubetum ulmifolii*, *Daphno oleoidis-Juniperetum alpinae* associations. Based on the scientific literature we also added and discussed the *Roso pendulinae-Genistetum radiatae* and *Viburno lantanae-Juniperetum communis* associations.

I - *Spartio juncei – Cytisetum sessilifolii*
II - *Ribeso uvae-crispae-Rosetum dumalis*
III - *Daphno oleoidis-Juniperetum alpinae*
IV - *Roso sempervirenti-Rubetum ulmifolii*

The Principal Component Analysis (Fig. 21) confirmed the results of the classification and identified environmental gradients differentiating the shrub communities. In particular, along the first axis a climatic gradient can be identified from the sub-alpine community of the *Daphno oleoidis-Juniperetum alpinae* to the termophilous *Roso sempervirenti-Rubetum ulmifolii*.

Daphno oleoidis-Juniperetum alpinae Blasi, Gigli, Abbate & Stanisci 1989 (Table 8)

This association includes the *Juniperus communis* ssp. *alpina* communities of the Lazio mountains (Blasi *et al*., 1989), but it has been recognised on calcareous mountains of Central-Southern Apennines, between 1500 and 2000 m (Stanisci, 1997). Communities with *Juniperus communis* ssp. *alpina* and *Arctostaphylos uva-ursi* are distributed on steep slopes of the sub-alpine belt, where they can represent the mature stage of the vegetation series. They are dynamically linked to the *Sesleretalia* and *Brometalia erecti* grasslands. *Juniperus communis* ssp. *alpina* (Fig. 22),

Tab. 5 – *Cytiso sessilifolii – Quercetum pubescentis* Blasi, Feoli & Avena 1982

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12
Date	15/05/06	19/05/06	07/05/06	15/05/200	15/05/06	07/05/06	14/05/06	19/05/06	15/05/06	19/05/06	07/05/06	15/05/06
Latitude	338186	338893	345020	340995	348592	353024	353246	353601	354164	358338	357984	357868
Longitude	4652360	4652245	4643230	4646450	4637942	4635192	4635121	4635154	4634806	4637307	4637784	4637924
Altitude (m)	787	853	928	743	780	680	730	740	745	760	881	974
Aspect	SW	SW	S	E	SW	W	S	S	SW	SSE	SE	SSE
Slope (°)	20	25	5	15	20	30	15	10	35	45	20	25
Rock (%)	-	-	20	-	5	10	-	10	10	25	5	-
Stone (%)	30	10	10	10	10	20	15	-	-	2	15	10
Area (m²)	250	100	150	200	100	200	150	100	150	200	150	180
Dominant tree layer (A)												
Height (m)	13	10 – 12	23	7	8	7 – 10	6 – 8	12 – 15	10 – 12	12	10	4 – 7
Cover (%)	85	80	85	85	80	90	90	75	85	90	85	80
Dominated tree layer (B)												
Height (m)	4 – 8	4 – 6	3 – 4	-	-	3 – 5	-	6 – 8	-	3 – 6	-	-
Cover (%)	65	10	10	-	-		-	20	-	30	-	-
Shrub layer (C)												
Height (m)	0.6 -1.5	0.5 – 1.70	-	0.5 – 2	0.5 – 2	0.5 – 1.50	-	0.5 – 3	1 – 1.50	0.5 – 1.80	1.50 – 4	1 – 3
Cover (%)	20	10	-	40	10	5	-	60	10	30	20	20
Herbaceous layer (E)												
Cover (%)	45	60	80	60	85	60	70	50	80	40	80	90
Cytiso sessilifolii-Quercetum pubescentis Blasi *et al*., 1982												
Cytisophyllum sessilifolium (L.) O. Lang	+	+	+	2,2	+	+	1,1	+	1,1	2,1	+	1,1
Teucrium chamaedrys L.	.	+	.	+	+	+	+	+	+	+	+	+
Rosa canina L.	.	1,1	+	.	.	.	.	1,1	.	.	.	.
Juniperus oxycedrus L.	+	.	.	.	+	+	.	.	+	1,1	2,2	2,1
Cytisus spinescens C. Presl		+					+					
Carpinion orientalis Horvat 1958												
Fraxinus ornus L. ssp.ornus	4,4	+	+	2,2	1,1	1,1	1,1	+	+	2,1	1,1	+
Asparagus acutifolius L.	+	1,1	.	+		+	+	+	+	.	+	.
Sesleria autumnalis (Scop.) F.W. Schultz	+	2,2	.	.	3,2	3,2	1,2	.	1,1	.	3,1	2,1
Acer opalus Mill. ssp.obtusatum (Waldst. & Kit. Ex Willd.) Gams	+	+	2,1	.	.	+	.	.	.	+	+	.
Ostrya carpinifolia Scop.	1,1	2,4	.	.	+	+	2,1	.	+	.	.	.
Emerus majus Mill.	+	.	.	+	+	+	.	.	+	.	.	.
Silene italica (L.) Pers.	.	.	.	+	+	+	.	.	1,1	+	.	.
Melittis melissophyllum L. ssp. melissophyllum	+	.	+	.	+	.	+	.	.	+	.	.
Acer monspessulanum L. ssp.monspessulanum	.	.	.	.	1,1	+	+	1,1	.	.	.	.
Carpinus orientalis Mill. ssp.orientalis	.	.	.	.	.	1,1	.	.	.	.	.	.
Arabis turrita L.	.	.	+	.	.	.	.	.	.	.	.	.
Quercetalia pubescenti-petraeae Klika 1933 corr. Moravec in Béguin &Theurillat 1984												
Quercus pubescens Willd. Ssp.pubescens	5,4	4,4	.	5,5	3,3	3,1	3,1	4,1	5,1	5,1	5,1	5,1
Helleborus foetidus L. ssp.foetidus	+	+	+	+	+	+	+	.	+	+		+
Brachypodium rupestre (Host) Roem. & Schult.	+	.	.	2,2	1,3	1,2	3,2	3,1	2,2	1,1	2,1	.
Campanula trachelium L. ssp. trachelium L.		+	+		+		+					
Aristolochia lutea Desf.			1,2					+		+		
Cornus mas L.				+		+	+					
Sorbus domestica L.	+	+										
Stachys officinalis (L.) Trevis.						+	+					
Sorbus torminalis (L.) Crantz						+						+
Buglossoides purpurocaerulea (L.) I.M. Johnst.	+											
Hypericum perforatum L.									+			
Querco-Fagetea Br.Bl. & Vlieger in Vlieger 1937												
Cruciata glabra (L.) Ehrend.	+	+	+	+	2,1	+	+	.	.	.	+	+
Ruscus aculeatus L.	+	+	+	+	.	+	+	.	+	.	.	.
Hedera helix L.	.	.	+	1,1	.	.	1,1	1,1	1,1	1,1	.	.
Acer campestre L.	+	.	.	.	+	+	+	+	+	.	.	.
Cyclamen hederifolium Aiton	+	.	+	+	+	+	.	.	+	.	.	.
Lonicera caprifolium L.	+	.	.	+	.	.	.	+	+	.	.	+
Tamus communis L.	+	+	.	+	.	.	.	+	.	.	.	.
Anemone apennina L.	+	.	3,2	.	+	+	.	.	.	.	.	..
Hieracium ervidi L.	.	.	+	.	.	.	.	.	+	.	.	+
Cephalanthera longifolia (L.) Fritsch	.	.	.	+	.	.	+	.	.	.	.	1,1
Fragaria vesca L. ssp. Vesca	+	.	.	.	+	+	.	.	.	.	.	.
Luzula forsteri (Sm.) DC.	.	.	+	.	+	+	.	.	.	.	.	.
Lathyrus venetus (Mill.) Wohlf.	+	.	+	.	.	+	.	.	.	.	.	.
Clematis vitalba L.	.	.	.	.	.	.	.	.	+	+	.	.
Festuca heterophylla Lam.			+	+								
Lathyrus sylvestris L. ssp. Sylvestris	+	.	.	.	.	.	.	.	.	.	.	.
Cephalanthera damasonium (Mill.) Druce	.	.	.	.	.	.	.	.	.	.	+	.
Corylus avellana L.	.	.	1,2	.	.	.	.	.	.	.	.	.
Brachypodium sylvaticum (Huds.) P. Beauv.	.	.	.	.	.	.	.	.	.	.	.	+
Potentilla micrantha Ramond ex DC.	.	.	.	.	.	+	.	.	.	.	.	.
Primula vulgaris Huds. ssp.vulgaris	.	.	.	.	.	.	.	.	+	.	.	.
Companions												
Viola suavis M. Bieb. ssp.suavis	+	+	+	+	+	+	+	+	1,1	+	1,1	+
Carex flacca Schreb.ssp. flacca	1,2	1,1	.	1,1	+	+	.	.	+	1,1	.	+
Cerastium arvense L.	+	+	+	+	+	.	1,1	.	+	+	.	.

Galium corrudifolium Vill.	+	+	.	+	.	.	+	+	+	+	1,1	..
Ranunculus bulbosus L.	+	.	.	+	.	.	+	+	+	+	+	+
Carex halleriana Asso	+	1,1	.	.	+	.	.	.	+	2,1	+	2,1
Cyclamen repandum Sm. ssp.repandum	1,2	+	1,2	.	1,1	+	+	.	.	.	.	.
Crataegus monogyna Jacq.	+	+	.	+	.	+	.	.	+	.	.	.
Euonymus europaeus L.	+	.	+	+	.	.	.	+	.	+	.	.
Tanacetum corymbosum (L.) Sch. Bip.	.	.	.	.	.	+	+	.	+	+	.	+
Anthericum liliago L.	.	.	.	.	.	.	+	.	.	+	1,1	+
Asplenium trichomanes L.	+	.	.	+	.	.	.	+	+	.	.	.
Galium lucidum All.	.	.	.	+	+	+	.	.	.	.	.	1,1
Lotus corniculatus L.	.	.	.	+	1,1	+	.	.	.	.	.	+
Carex caryophyllea Latourr.	.	.	.	.	.	.	.	.	.	+	+	2,1
Primula veris L. ssp.suaveolens (Bertol.) Gutermann & Ehrend.	.	.	.	.	.	+	.	.		+	+	.
Ptilostemon strictus (Ten.) Greuter	1,2	+	.	.	.	.	.	.	.	.	.	+
Rubus ulmifolius Schott	+	.	.	.	.	.	+	1,1	.	.	.	.
Thymus longicaulis C. Presl ssp.longicaulis	.	.	.	+	+	.	.	.	+	.	.	.
Campanula rapunculus L.	.	.	.	.	.	+	.	.	+	.	.	.
Cornus sanguinea L.	+	.	.	+	.	.	.	.	.	.	.	.
Euphorbia cyparissias L.	.	.	.	.	.	.	.	.	.	.	1,1	+
Lilium bulbiferum L. ssp.croceum (Chaix) Jan	.	.	.	.	.	.	.	.	.	.	+	+
Prunus spinosa L. ssp.spinosa	+	.	.	.	.	.	.	3,1	.	.	.	.

Arctostaphylos uva-ursi (Fig. 23), *Daphne oleoides* and *Cotoneaster nebrodensis* are the characteristic species.

Ribeso uvae-crispae-Rosetum dumalis Attorre & Bruno 2003 (Tab. 9)

The association identifies a shrub plant community localised on concave morphologies between 1200 and 1500 m. Characteristic species are *Rosa dumalis*, dominant species, and *Ribes uva-crispa*, but many other *Rosa* sp.pl. can be found. This shrub vegetation represents the main pre-forest stage of the vegetation series in the lower belt of the beech woods and is dynamically linked to the *Anthoxantho odorati-Brachypodietum genuensis* grasslands and the *Cardamino kitaibelii-Fagetum sylvaticae* beech woods. Syntaxonomically the association is included in the *Berberidion vulgaris* alliance and replaces in the Apennines the *Corylo avellanae-Rosetum vosagiacae* association of the central European mountains.

Roso pendulinae-Genistetum radiatae Fortini, Blasi & Di Pietro 1999 (Tab. 10)

This association was identified for the Simbruini and Ernici mountains (Fortini *et al*., 1999) in order to classify the vegetation dominated by *Genista radiata* as a pre-forest stage of the beech woods. However, since the hemicryptophytes prevail on the phanerophytes this classification has been discussed and needs a further analysis. This vegetation can be found between 1600 and 2000 m, with southern-eastern exposures and is characterised by *Juniperus communis* ssp. *communis*, *Rosa pendulina* and *Amelanchier ovalis*.

Viburno lantanae-Juniperetum communis Cutini, Stanisci & Pirone 2002 (Tab. 11)

This association is ecologically similar to the previously described *Daphno oleoidis-Juniperetum alpinae*, but has a more localised distribution and is characterised by *Rhamnus alpina* ssp. *fallax, Viburnum lantana* and *Lonicera caprifolium*. These species allowed the classification of this association in the *Berberidion vulgaris* alliance as a pre-forest stage of beech woods.

Spartio juncei-Cytisetum sessilifolii Biondi, Allegrezza & Guitian 1988 (Tab. 12)

The association *Spartio juncei-Cytisetum sessilifolii* (Fig. 24) is the main community of the alliance *Cytision sessilifolii* and is widespread on hilly areas of Central-North Apennines (Biondi *et al*., 1988). It has already been recognised in the Simbruini mountains (Cutini & Blasi, 2002) and tends to colonise the abandoned terraces as a pre-forest stage of the deciduous woods dominated by *Ostrya carpinifolia* and *Quercus pubescens*. Cytisophyllum *sessilifolium*, *Emerus majus*, *Spartium junceum*, *Lonicera etrusca* and *Juniperus oxicedrus* ssp. *oxicedrus* are species characteristic of the association. The structure of this plant community is dominated by *Spartium junceum*, which limits the growth of herbaceous, heliophilous species, allowing, at the same time, the development of sapling of deciduous species such as *Fraxinus ornus* and *Quercus pubescens*.

Roso sempervirenti-Rubetum ulmifolii Blasi, Di Pietro & Fortini 2000 (Tab. 13)

This association is distributed on the basal belt of coastal carbonatic mountains of Central-South Italy (Blasi *et al*., 2000; 2002). In the study area, this vegetation can be found on the southern slopes, and it is characterised by the dominance of *Rubus ulmifolius*. This vegetation was previously classified in the Apennines endemic alliance *Cytision sessilifolii* (Biondi *et al*., 1988). However, ecological and biogeographical considerations seem to corroborate the classification in the *Pruno-Rubion ulmifolii* alliance. Characteristic species are *Brachypodium*

Tab. 6 – *Aceri obtusati-Quercetum cerridis* Ubaldi & Speranza 1982

No. relevé	1	2	3	4	5	6	7	8	9	10
Date	10/05/06	09/05/06	13/05/06	09/05/06	09/05/06	10/05/06	13/05/06	13/05/06	10/05/06	09/05/06
Altitude (m)	670	580	710	670	721	600	660	700	580	730
Aspect	SW	SE	SE	SE	SE	E	ENE	ENE	E	E
Slope (°)	25	40	30	25	40	30	30	30	3	30
Rock (%)	5	10	20	10	20	20	30	10	-	10
Stone (%)	5	40	20	10	5	30	20	10	-	20
Area (m²)	150	100	150	200	200	150	150	180	200	150
Dominant tree layer (A)										
Height (m)	15 - 20	8 - 10	10 - 12	10 - 15	20	8 - 10	7 -10	10 - 15	15 - 20	10 - 13
Cover (%)	85	90	95	80	90	90	90	90	80	60
Dominated tree layer (B)										
Height (m)	3 -	4 - 7	3 - 7	4 - 7	4 - 7	4 - 7	3 - 5	5 - 7	4 - 8	5 - 8
Cover (%)	95	85	70	30	60	70	70	40	70	90
Shrub layer (C)										
Height (m)	0.7 - 1.50	-	-	0.5 - 2.50	0.5 - 1	0.5 - 1.50	-	0.5 - 4	0.5 - 3	-
Cover (%)	5	-	-	10	20	10	-	10	40	-
Herbaceous layer (E)										
Cover (%)	40	30	30	80	70	50	50	60	50	50
Aceri obtusati-Quercetum cerridis Ubaldi & Speranza 1982										
Quercus cerris L.	4,4	4,2	3,3	3,3	5,1	4,4	4,4	3,3	4,1	2,2
Cyclamen hederifolium Aiton	+	+	+	.	.	.	+	+	+	.
Cornus mas L.	.	.	.	+	.	.	.	.	1,1	.
Sorbus torminalis (L.) Crantz	.	.	.	+	.	+	.	.	+	.
Cornus sanguinea L.	.	.	2,2	.	.	.	+	+	2,1	1,1
Lonicera caprifolium L.	.	.	.	.	+	.	.	.	.	.
Laburno Ostryenion carpinifoliae (Ubaldi 1995) Blasi, Di Pietro & Filesi 2004, *Carpinion orientalis* Horvat 1958										
Carpinus orientalis Mill. ssp.orientalis	5,5	4,4	.	2,2	.	5,5	2,2	+	1,1	+
Lathyrus venetus (Mill.) Wohlf.	+	.	+	1,1	.	+	+	+	2,1	+
Campanula trachelium L. ssp. trachelium L.	+	+	.	+	1,1	+	+	+	.	+
Lilium bulbiferum L. ssp.croceum (Chaix) Jan	.	.	+	+	.	+	+	+	.	+
Acer opalus Mill. subsp.obtusatum (Waldst.etKit.exWilld.)	.	+	.	+	.	+	+	+	.	.
Emerus majus Mill.	.	+	.	+	.	+	.	+	+	.
Daphne laureola L.	.	.	.	.	+	.	.	.	+	.
Ostrya carpinifolia Scop.	+	.	.	+	.	.	.	.	.	.
Sanicula europaea L.	.	.	.	.	.	.	+	.	.	.
Scutellaria columnae All.	.	.	.	+	.	.	.	.	.	.
Digitalis lutea L. ssp.australis (Ten.) Arcang.	.	.	.	.	.	+	.	.	.	.
Acer monspessulanum L. ssp. monspessulanum	.	+	.	+	2,1	+	.	.	2,2	.
Tilia platyphyllos Scop.									+	+
Quercetalia pubescentis-petraeae Klika 1933 corr. Moravec in Béguin et Theurillat 1984, *Querco-Fagetea* Br. Bl. et Vlieg 1937 em. Oberd. 1992										
Fraxinus ornus L. ssp.ornus	+	1,1	+	2,1	2,1	+	1,1	1,1	1,1	+
Melittis melissophyllum L. ssp. melissophyllum	+	+	+	+	1,1	1,1	1,1	1,1	.	+
Cruciata glabra (L.) Ehrend.	+	1,1	.	1,1	+	+	+	+	1,1	+
Cyclamen repandum Sm. ssp.repandum	1,1	+	+	1,1	.	+	1,1	+	+	+
Sesleria autumnalis (Scop.) F.W. Schultz	.	1,1	+	+	+	1,1	1,1	1,1	+	+
Viola suavis M. Bieb. ssp.suavis	+	+	+	+	.	+	+	+	.	1,1
Fragaria vesca L. ssp. vesca	.	+	+	+	.	+	+	+	+	+
Helleborus foetidus L. ssp.foetidus	+	+	.	.	+	+	+	+	+	+
Brachypodium rupestre (Host) Roem. & Schult.	.	+	+	2,1	3,2	.	2,2	2,2	+	+
Acer campestre L.	.	+	1,1	+	.	+	+	.	1,1	+
Quercus pubescens Willd. ssp.pubescens	1,2	1,1	.	2,3	.	1,1	.	1,1	+	.
Festuca heterophylla Lam.	+	.	+	.	.	+	+		1,1	+
Carpinus betulus L.	.	.	.	.	.	1,1	1,1	1,1	2,2	2,2
Melica uniflora Retz.	.	.	1,1	.	+	+	.	.	+	+
Tamus communis L.	.	+	.	+	.	1,1	.	+	.	+
Ruscus aculeatus L.	1,1	+	.	+	.	+	.	.	+	.
Silene italica (L.) Pers.	+	.	.	.	+	+	.	.	1,1	+
Hedera helix L.	.	.	+	.	.	.	+	.	+	2,1
Brachypodium sylvaticum (Huds.) P. Beauv.	+	.	+	.	.	1,1	.	.	+	.
Laburnum anagyroides Medik.	.	.	+	+	.	.	.	.	+	+
Corylus avellana L.	.	.	1,1	.	.	.	1,2	.	.	4,4
Sorbus aria (L.) Crantz	.	.	.	+	.	.	.	+	.	.
Viola reichenbachiana Jord. ex Boreau	.	.	.	.	.	.	.	.	.	+
Rosa arvensis Huds.	.	.	.	.	.	.	.	.	+	.
Primula veris L. ssp.suaveolens (Bertol.) Gutermann &	.	.	.	+	.	.	.	.	.	.
Buglossoides purpurocaerulea (L.) I.M. Johnst.	.	.	.	+	.	.	.	.	.	.
Hieracium murorum L.	.	.	.	.	.	.	.	.	+	.
Genista tinctoria L.	.	.	+	.	.	.	.	.	.	.
Ajuga reptans L.	.	.	.	.	.	.	.	+	.	.
Luzula forsteri (Sm.) DC.	.	.	.	.	.	.	.	.	1,1	.
Companions										
Anemone apennina L.	1,1	+	.	+	.	1,1	+	+	+	1,1

Ptilostemon strictus (Ten.) Greuter	+	+	.	1,1	+	+	+	+	+	.
Oenanthe pimpinelloides L	.	.	+	+	+	+	.	+	+	+
Aremonia agrimonoides (L.) DC.	.	.	1,1	.	+	.	+	+	+	+
Crataegus monogyna Jacq.	.	+	+	+	.	+	+	.	+	.
Aristolochia lutea Desf.	.	.	1,1	.	.	+	+	.	.	1,1
Carex flacca Schreb.ssp. flacca	.	+	.	+	+	.	+	.	.	.
Cephalanthera longifolia (L.) Fritsch	.	.	+	.	.	.	+	+	.	+
Calamintha nepeta (L.) Savi ssp.sylvatica (Bromf.) R.	.	+	.	+	.	.	.	+	.	.
Carex halleriana Asso	.	+	.	1,1	+	.	.	.	.	.
Clematis vitalba L.	.	.	.	.	.	.	+	+	.	.
Euonymus europaeus L.	.	.	.	.	.	+	+	.	.	.
Platanthera chlorantha (Custer) Rchb.	.	.	.	.	+	.	.	.	+	.
Rubus ulmifolius Schott	.	.	.	.	.	+	+	.	.	.
Tanacetum corymbosum (L.) Sch. Bip.	.	.	+	.	+	.	.	.	.	.
Veratrum nigrum L.	.	.	+	.	.	.	.	.	.	+
Acer pseudoplatanus L.	.	.	.	.	.	.	.	+	.	.
Alliaria petiolata (M. Bieb.) Cavara & Grande	.	.	.	.	.	+	.	.	.	.
Allium pendulinum Ten.	.	.	.	.	.	.	.	.	1,1	.
Anthericum liliago L.	.	+	.	.	.	.	.	.	.	.
Arum maculatum L.	.	.	+	.	.	.	.	.	.	.
Astragalus glycyphyllos L.	.	.	.	.	.	.	.	.	+	.
Cardamine bulbifera (L.) Crantz	.	.	1,1	.	.	.	.	.	.	.
Clinopodium vulgare L.	.	.	.	.	.	.	.	.	+	.
Crataegus laevigata (Poir.) DC.	.	.	.	.	.	.	.	.	1,1	.
Cyanus triumfetti (All.) Dostál ex Á. & D. Löve	.	1,1	.	.	.	.	.	.	.	.
Cystopteris fragilis (L.) Bernh.	.	.	+	.	.	.	.	.	.	.

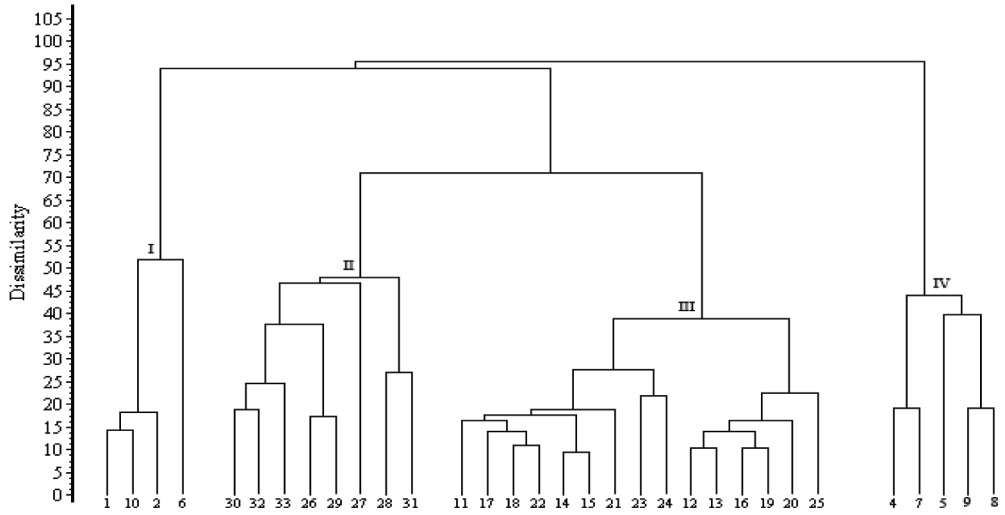


Fig. 20 - Dendrogram of the shrub vegetation.

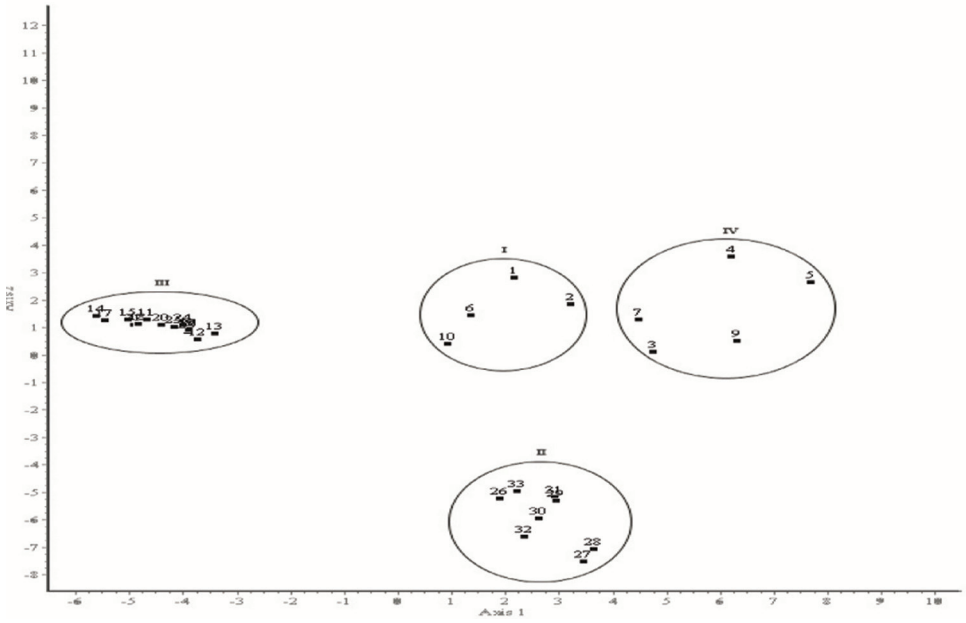


Fig. 21 - Principal Component Analysis of shrub vegetation.

Tab. 7 - *Aceretum obtusati-pseudoplatani* Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002

No. relevé	1	2
Date	15/05/06	18/05/06
Altitude (m)	450	510
Aspect	N	NE
Slope (°)	20	25
Rock (%)	10	5
Stone (%)	10	10
Area (m²)	80	100
Dominant tree layer (A)		
Height (m)	10 - 12	8 - 10
Cover (%)	80	85
Dominated tree layer (B)		
Height (m)	5 - 7	6 - 7
Cover (%)	20	10
Shrub layer (C)		
Height (m)	0.5-1.5	0.7-2
Cover (%)	10	10
Herbaceous layer (E)		
Cover (%)	40	30
Aceretum obtusati-pseudoplatani Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002		
Corydalis cava (L.) Schweigg. & Körte ssp. cava	1	+
Galanthus nivalis L.	1	1
Asperula taurina L. ssp. taurina	1	1
Acer opalus Mill. ssp. obtusatum (Waldst. & Kit. ex Willd.) Gams	2	1
Ruscus aculeatus L.	+	+
Arum italicum Mill. ssp. italicum	+	+
Cardamine enneaphyllos (L.) Crantz	+	+
Pulmonaria apennina Cristof. & Puppi	1	+
Tilio-Acerion Klika 1955		
Ulmus glabra Huds.	2	3
Acer pseudoplatanus L.	2	2
Phyllitis scolopendrium (L.) Newman ssp. scolopendrium	+	+
Saxifraga rotundifolia L. ssp. rotundifolia	1	+
Geranium robertianum L.	+	+
Fraxinus excelsior L. ssp. excelsior	.	+
Tilia platyphyllos Scop.	1	1
Fagetalia sylvaticae Pawlowski in Pawlowski, Sokolowski & Wallisch 1928		
Melica uniflora Retz.	1	+
Galium odoratum (L.) Scop.	1	2
Mercurialis perennis L.	1	+
Sanicula europaea L.	+	.
Euonymus latifolius (L.) Mill.	+	.
Salvia glutinosa L.	.	+
Euphorbia dulcis L.	2	1
Festuca heterophylla Lam.	+	.
Ranunculus lanuginosus L.	.	+
Carpinus betulus L.	1	1
Querco-Fagetea Br.-Bl. &Vlieger in Vlieger 1937		
Acer campestre L.	+	.
Corylus avellana L.	+	1
Hedera helix L.	1	1
Ostrya carpinifolia Scop.	1	1
Brachypodium sylvaticum (Huds.) P. Beauv.	+	+
Primula vulgaris Huds. ssp. vulgaris	.	+
Ajuga reptans L.	+	+
Campanula trachelium L. ssp. trachelium	+	.
Viola alba Besser dehnhardtii (Ten.) W. Becker	1	1
Lactuca muralis (L.) Gaertn.	+	1
Companions		
Rubus ulmifolius Schott	+	+
Clematis vitalba L.	+	.
Cornus mas L.	.	+
Sambucus nigra L.	1	+

Fig. 22 - *Juniperus communis* shrublands.

Fig. 23 - *Arctostaphylos uva-ursi* (L.) Sprengel.

rupestre, *Asparagus acutifolius*, *Rosa sempervirens* and *Hedera helix*. Other species, such as *Ulmus minor*, *Fraxinus ornus* and *Prunus spinosa*, are less frequent.

Forest edges

Two forest edge communities were found, but they have not been analysed statistically due to the small number of relevés.

Salvia glutinosa and *Aegopodium podagraria* community (Tab. 14)

This is a nitrophilous, sciaphilous forest edge vegetation characterised by the dominance of *Aegopodium podagraria* and *Salvia glutinosa*. This community is generally in contact with deciduous forests and in wood clearings. Similar vegetation has been already described for the Apennines (Allegrezza, 2003; Taffetani *et al*., 2004) but the lack of several species indicated as characteristic (e.g. *Stachys sylvatica*, *Circaea lutetiana* and *Scrophularia*

Tab. 8 - *Daphno oleoidis- Juniperetum alpinae* Blasi, Gigli, Abbate & Stanisci 1989

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Altitude (m)	1818	1850	1888	1825	1875	1820	1919	1863	1850	1900	1825	1838	1850	1825	1860
Aspect	SE	SW	E	S	S	S	E	NW	SE	SW	S	S	SW	SW	SW
Slope (°)	20	5	30	50	50	20	10	10	30	30	30	30	35	35	30
Area (m²)	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Cover (%)	75	75	80	70	75	75	75	80	70	45	50	55	60	65	55
Daphno oleoidis- Juniperetum alpinae Blasi *et al*. 1989, *Daphno oleoidis- Juniperion alpinae* Stanisci 1990, *Pino-Juniperetalia* Rivas-Martinez 1964, *Pino-Juniperetea* Rivas-Martinez 1964															
Juniperus communis L. ssp. alpina (Suter) Celak	4	3	3	4	4	3	4	4	3	3	4	4	5	5	3
Arctostaphylos uva-ursi (L.) Sprengel	.	.	+	2	2	1	+	.	+	.	.	+	2	.	2
Daphne oleoides Schreb.	.	.	1	.	.	.	1	1	1	.	1	.	.	.	1
Cotoneaster nebrodensis (Guss.) C. Koch	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Companions															
Viola eugeniae Parl. ssp. eugeniae	+	1	1	1	1	2	2	1	2	2	1	1	.	+	.
Carex macrolepis DC.	.	+	.	1	+	1	+	+	+	1	1	.	+	.	.
Helianthemum nummularium (L.) Miller ssp. obscurum (Celak.) J.Holub	.	.	+	.	+	1	+	.	+	1	2	+	+	1	.
Thlaspi praecox Wulfen	1	1	+	.	.	.	+	1	1	1	1	1	.	+	.
Polygala major Jacq.	+	.	.	1	1	+	+	1	.	+	+	.	.	.	+
Dactylorhiza sambucina (L.) Soò	1	1	.	+	.	+	+	.	.	+	.	+	.	.	+
Brachypodium genuense (DC.) Roemer et Schultes	2	.	.	.	1	.	.	1	.	+	.	.	1	2	1
Gentiana dinarica Beck	+	.	+	+	+	.	.	+	.	+	.	.	+	.	.
Hippocrepis comosa L.ssp. comosa	+	+	+	.	.	.	+	.	.	+	.	+	.	.	+
Ranunculus thora L.	.	+	+	.	+	.	1	1	.	+	.	.	.	+	.
Anthyllis montana L. ssp. atropurpurea (Vukot.) Pign.	+	.	+	+	.	.	.	+	.	.	.	+	.	+	.
Armeria majellensis Boiss	+	.	+	.	.	+	.	.	+	+	.	.	.	+	.
Bromus erectus Hudson	.	1	.	1	.	.	.	.	1	.	1	.	+	.	1
Luzula sylvatica (Huds.) Gaudin	+	.	+	.	1	.	1	.	1	.	.	.	.	.	2
Myosotis ambigens (Beg.) Grau	+	.	.	.	+	+	+	+	.	.	+	.	.	.	.
Sesleria juncifolia Suffren ssp.juncifolia	.	.	.	1	1	.	.	.	.	.	1	.	+	+	+
Cerastium tomentosum L.	+	.	.	+	.	+	.	.	+	+	.	.	.	.	.
Globularia meridionalis (Podp.) O. Schwarz	.	.	.	+	.	1	.	.	.	2	1	.	.	.	1
Helianthemum oelandicum (L.) DC. ssp. incanum (Willk.) G.Lòpez	.	+	.	1	1	.	.	.	.	.	.	+	+	.	.
Potentilla rigoana Th. Wolf	+	+	.	.	.	.	+	.	1	.	.	+	.	.	.
Anthyllis vulneraria L.	.	+	.	.	.	+	+	.	.	.	.	.	+	.	.
Asperula cynanchica L.	.	.	.	+	+	.	.	.	.	.	+	.	+	.	.
Carex kitaibeliana Degen ex Bech. ssp. kitaibeliana	1	.	+	.	.	.	.	.	.	.	.	+	.	.	1
Euphorbia cyparissias L.	.	.	.	.	+	.	.	.	.	+	.	.	+	+	.
Galium lucidum All.	.	.	.	+	.	.	+	.	.	.	+	.	.	.	+
Gymnadenia conopsea (L.) R.Br.	+	.	.	.	+	.	.	.	+	.	.	+	.	.	.
Lotus corniculatus L.	.	.	.	.	.	.	+	+	.	.	+	.	+	.	.
Thymus longicaulis Presl ssp.longicaulis	+	.	.	+	+	.	+	.	.	.	.	.	.	.	.
Biscutella laevigata L. ssp. laevigata	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+
Cynoglossum magellense Ten.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	+
Doronicum columnae Ten.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.
Gentiana verna L. ssp.verna	.	.	.	+	.	+	.	.	.	.	.	+	.	.	.
Hieracium bifidum Kit. ex Hornem.	.	+	.	.	.	.	.	.	+	.	.	.	.	+	.
Narcissus poeticus L.	.	+	.	.	.	+	.	.	.	.	.	+	.	.	.
Phyteuma orbiculare L.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+
Pulsatilla alpina (L.) Delarbre	.	+	.	.	.	.	.	+	.	.	.	.	.	+	.
Sedum rupestre L. ssp. rupestre	.	.	.	+	.	.	.	.	.	.	+	.	+	.	.
Coronilla minima L.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.
Cytisus spinescens C.Presl	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.
Dianthus monspessulanus L.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.
Erysimum pseudorhaeticum Polatschek	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
Gentiana lutea L.	.	.	.	.	.	+	.	.	.	.	.	.	.	1	.
Linum capitatum Kit.ex Schultz. ssp.serrulatum	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Senecio doronicum (L.) L.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.
Stachys alopecuros (L.) Bentham ssp. divulsa (Ten.) Grande	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.

scopolii) didn't permit us a clear phytosociological classification.

Urtico dioicae-Sambucetum ebuli Br.-Bl. in Br. Bl., Roussine & Nègre 1952 (Tab.15)

One relevé is classified in the *Urtico dioicae-Sambucetum ebuli* association. This is a nitrophilous vegetation dominated by *Sambucus ebulus*, a rhizomatous geophyte that forms dense populations at the edge of deciduous woods and wood clearings. Other species are *Urtica dioica*, *Galium aparine*, *Elymus* and *Aegopodium podagraria*. It grows in open areas, on humid soils with good water availability and high concentration of nitrates for the accumulation of organic material (Scoppola, 1998; Fanelli, 2002).

Tab. 9 - *Ribeso uvae-crispae-Rosetum dumalis* Attorre & Bruno 2003

No. relevé	1	2	3	4	5	6	7	8
Altitude (m)	1380	1420	1400	1350	1380	1370	1400	1390
Aspect	NE	S	SW	W	NW	SW	SE	S
Slope (°)	10	15	10	5	15	5	10	5
Area (m²)	50	30	30	50	50	40	30	30
Cover (%)	75	90	90	90	85	100	80	90
Ribeso uvae-crispae-Rosetum dumalis Attorre & Bruno 2003								
Rosa dumalis Bechst.	3	.	.	3	1	1	2	2
Ribes uva-crispa L.	.	1	2	1	.	1	1	1
Veratrum nigrum L.	1	.	+	+	1	.	.	.
Berberidion vulgaris Br.Bl. ex Tx. 1952								
Juniperus communis L.	.	1	.	.	.	1	1	.
Rosa nitidula Besser	.	2	.	1	.	1	.	.
Rosa andegavensis (Bast.) Desportes	.	.	.	.	.	.	.	1
Rosa villosa L.	.	.	1	.	.	.	.	.
Prunetalia spinosae Tx. 1952, *Rhamno-Prunetea spinosae* Rivas Goday & Borja Carbonell 1961 ex Tx. 1962								
Rosa squarrosa Rau	.	.	3	1	2	3	1	.
Rosa corymbifera Borkh.	1	3	2	.	2	.	2	.
Rubus hirtus Waldst. et Kit.	1	2	.	.	.	1	1	1
Crataegus monogyna Jacq. ssp. monogyna	.	.	1	.	1	1	1	.
Rosa balsamica Besser	1	.	.	1	1	.	.	.
Rubus ulmifolius Schott.	.	.	1	1	1	.	.	.
Rosa canina L.	.	.	2	1	.	.	.	1
Rubus idaeus L.	.	.	.	.	.	1	.	2
Rosa pounzinii Tratt.	.	.	.	.	.	1	.	.
Fagetalia sylvaticae Pawl. 1928, *Querco-Fagetea* Br. Bl. & Vlieg 1937 em. Oberd. 1992								
Aristolochia lutea Desf.	+	.	.	+	1	.	.	.
Anemone apennina L.	.	.	+	+	+	.	.	.
Fagus sylvatica L.	.	.	1	2	.	.	.	.
Epilobium montanum L.	.	.	.	.	.	.	+	+
Polygonatum multiflorum (L.) All.	.	.	.	.	+	.	.	+
Hepatica nobilis Miller	.	.	+	.	.	.	.	.
Thalictrum aquilegifolium L.	.	.	.	.	.	.	+	.
Acer pseudoplatanus L.	.	.	.	1	.	.	.	.
Anemone ranunculoides L.	.	.	.	+	.	.	.	.
Digitalis lutea L. australis (Ten.) Arcang.	.	.	.	.	.	.	.	+
Festuca heterophilla Lam.	.	.	.	.	.	.	+	.
Companions								
Fragaria vesca L.	+	1	+	+	1	.	.	.
Sanguisorba minor Scop. ssp. minor	+	.	.	.	.	+	+	+
Geum urbanum L.	.	+	+	.	.	+	+	.
Myosotis arvensis (L.) Hill	+	+	1	.	.	.	.	+
Galium verum L. ssp. verum	.	+	.	.	+	.	+	.
Hypericum perforatum L.	.	+	.	.	.	+	.	+
Silene latifolia (Miller) Greuter et Burdet ssp. alba	.	.	.	.	+	+	+	.
Geranium robertianum (Vill.) Nyman ssp. robertianum	1	+	.	+	.	.	.	.
Trifolium pratense L. ssp. pratense	.	.	.	.	.	+	+	+
Agrostis capillaris L.	.	+	.	.	.	.	.	+
Anthoxanthum odoratum L.	+	1	.	.	.	.	.	.
Campanula glomerata L. ssp. glomerata	+	+	.	.	.	.	.	.
Cerastium arvense L. ssp. arvense	.	.	.	+	.	+	.	.
Cruciata glabra (L.) Ehrh.	.	+	.	.	+	.	.	.
Galium aparine L.	.	+	.	.	.	+	.	.
Lathyrus pratensis L.	+	.	+	.	.	.	.	.
Linaria purpurea (L.) Miller	.	.	.	.	+	+	.	.
Lotus corniculatus L.	.	.	.	.	.	+	+	.
Malva moschata L.	.	.	+	+	.	.	.	.
Ornithogalum umbellatum L.	.	.	+	.	.	.	.	+
Primula veris L. ssp. suaveolens (Bertol.) Guter. et Ehren.	+	.	.	.	.	.	+	.
Prunella laciniata (L.) L.	.	.	.	+	.	+	.	.
Rumex acetosa L.	.	+	.	.	.	.	+	.
Acinos arvensis (Lam.) Dandy	.	.	.	.	+	.	.	+
Urtica dioica L.	.	.	.	+	+	.	.	.
Veronica chamaedrys L. ssp. chamaedrys	.	+	+	.	.	.	.	.
Sorbus aria (L.) Crantz ssp. aria	.	.	.	1	.	1	.	.
Corylus avellana L.	.	.	.	.	.	.	1	.
Ajuga reptans L.	.	.	.	.	+	.	.	.
Filipendula vulgaris Moench	.	.	.	.	.	.	+	.
Geranium pyrenaicum Burm.	.	.	.	.	.	.	.	+

Tab. 10 - *Roso pendulinae-Genistetum radiatae* Fortini, Blasi & Di Pietro 1999

No. relevé	1	2	3	4	5
Altitude (m)	1640	1620	1600	1570	1570
Aspect	SE	SE	SE	E	E
Slope (°)	45	40	35	35	30
Rock (%)	10	5	5	5	20
Stone (%)	5	10	20	10	10
Area (m²)	20	15	10	30	20
Cover (%)	70	80	70	75	80
Roso pendulinae-Genistetum radiatae Fortini, Blasi & Di Pietro 1999					
Genista radiata (L.) Scop.	5	5	4	4	4
Daphne oleoides Schreb.	.	.	.	1	+
Rosa pendulina L.	1	1	+	1	.
Amelanchier ovalis ssp. ovalis Medik.	1	+	.	.	+
Helianthemum nummularium (L.) Mill. ssp. grandiflorum (Scop.) Schinz & Thell.	.	.	.	+	.
Festuco-Brometea Br.-Bl. &Tx. 1943 ex Klika & Hadac					
Brachypodium genuense (DC.) Roem. & Schult.	+	1	1	1	1
Bromus erectus Huds.	1	1	1	1	1
Asperula purpurea (L.) Ehrend.	+	2	.	2	2
Carex macrolepis DC.	1	+	.	1	2
Centaurea parlatoris Heldr.	.	+	1	+	+
Polygala major Jacq.	.	1	.	1	1
Teucrium chamaedrys L.	1	1	1	.	.
Koeleria lobata (M. Bieb.) Roem. & Schult.	1	+	1	+	.
Galium lucidum All.	+	.	1	.	.
Globularia meridionalis (Podp.) O. Schwarz	.	2	.	1	.
Asperula aristata L. ssp. longiflora (Waldst. & Kit.) Hayek	.	+	.	.	+
Phleum hirsutum Honck.ssp. ambiguum (Ten.) Tzvelev	+	.	1	+	.
Allium sphaerocephalon L.	.	+	.	.	+
Avenula praetutiana (Parl. ex Arcang.) Pignatti	.	.	.	1	1
Sesleria juncifolia Suffren ssp. juncifolia	1	.	.	.	.
Companions					
Carduus nutans L.	+	1	1	1	1
Teucrium montanum L.	1	2	1	2	2
Sorbus aria (L.) Crantz ssp. aria	+	.	1	1	2
Knautia arvensis (L.) Coult.		+	+	+	1
Sedum sediforme (Jacq.) Pau	+	+	+		+
Cerastium tomentosum L.		.	.	+	+
Sanguisorba minor Scop. ssp. minor	+	+	1	+	+
Helianthemum oelandicum (L.) Dum. Cours. ssp. incanum (Willk.) G. López	+	.	.	.	1
Tanacetum corymbosum (L.) Sch. Bip.	+	+	.	1	1
Euphorbia myrsinites L. ssp. myrsinites	+	.	1	+	+
Stachys recta L. ssp. recta	+	+	1	.	+
Thymus praecox Opiz polytrichus (Borbás) Jalas	+	1	+	1	1
Laserpitium siler L.	+	1	.	.	.
Acer opalus Mill. ssp. obtusatum (Waldst. & Kit. ex Willd.) Gams	.	1	.	1	.
Thlaspi brachypetalum Jord.	.	.	.	+	+
Anthyllis vulneraria L. ssp. rubriflora (DC.) Arcang.	.	.	.	.	.
Erysimum pseudorhaeticum Polatschek	.	.	.	+	.
Campanula glomerata L.	+	.	.	.	.
Cerastium arvense L. ssp. arvense	.	.	1	.	.
Cuscuta epithymum (L.) L.	.	.	.	+	.
Bupleurum falcatum L. ssp. cernuum (Ten.) Arcang.	.	+	.	.	+
Viola eugeniae Parl. ssp.eugeniae	.	.	.	.	.
Cytisus spinescens C. Presl	1	.	.	.	.

Fig. 24 - *Spartio juncei – Cytisetum sessilifolii*.

Grasslands

The dendrogram (Fig. 25), obtained by classifying the grassland relevés, identified six groups.

The first group (I) refers to the *Anthoxantho odorati-Brachypodietum genuensis* association which describes the grassland with *Brachypodium genuensis* on calcareous slopes.

The second group is divided into two sub-groups: the first (IIa) identifies the discontinuous herbaceous vegetation of the high summits, above the tree-line, dominated by *Sesleria juncifolia* ssp. *juncifolia* (*Pediculari elegantis-Seslerietum tenuifoliae*) and the second one (IIb) the grasslands characterised

Tab. 11 - *Viburno lantanae-Juniperetum communis* Cutini, Stanisci & Pirone 2002

No. relevé	1	2
Altitude (m)	1160	1450
Aspect	N	E
Slope (°)	5	10
Area (m^2)	30	25
Cover (%)	100	95
Viburno lantanae-Juniperetum communis Cutini, Stanisci & Pirone 2002		
Juniperus communis L.	4	5
Viburnum lantana L.	1	1
Lonicera caprifolium L.	1	+
Ribeso-Juniperenion communis Cutini, Stanisci & Pirone 2002, *Berberidion vulgaris* Br.-Bl. Ex Tx. 1952		
Ribes uva-crispa L.	1	+
Rhamnus podagr L. ssp. fallax (Boiss.) Maire & Petitm.	1	1
Prunetalia spinosae Tx.1952, *Rhamno-Prunetea* Rivas Goday & Borja Carbonell 1961ex Tx. 1962		
Rosa canina L.	2	+
Prunus spinosa L. ssp. spinosa	1	1
Rubus idaeus L.	+	+
Querco-Fagetea Br.-Bl. & Vlieg. 1937 em. Oberd. 1992		
Fragaria vesca L. ssp. vesca	+	1
Daphne laureola L.	+	+
Fagus sylvatica L. ssp. sylvatica	1	+
Digitalis ferruginea L.	+	+
Companions		
Sanguisorba minor Scop.	1	+
Helianthemum nummularium (L.) Mill.	.	+
Bromus erectus Huds.	1	.
Brachypodium genuense (DC.) Roem. & Schult.	+	1
Galium lucidum All.	+	.
Filipendula vulgaris Moench	+	+
Thalictrum aquilegiifolium L. aquilegiifolium	+	.
Polygonatum multiflorum (L.) All.	.	1
Euphorbia cyparissias L.	+	+

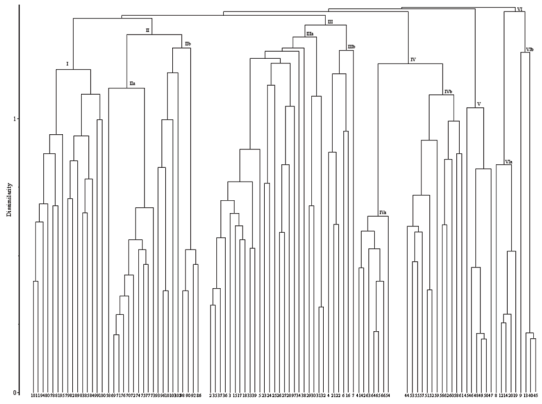


Fig. 25 - Dendrogram of grassland communities.

by *Bromus erectus* of the mountain belt (*Koelerio splendentis-Brometum erecti*).

The third group includes the xerophytic grasslands and is divided into two sub-groups: sub-group IIIa refers to the camephytic communities classified in the *Saturejo montanae-Brometum erecti* association and the sub-group IIIb identifies the therophytic herbaceous vegetation characterised by *Hypochoeris achyrophorus* and *Trifolium scabrum*.

The fourth group includes the mesophilous grasslands of the sinkholes (*Trifolio thalii-Festucetum microphyllae* - IVa) and the grasslands characterised by *Nardus stricta* and *Luzula spicata* (ex *Luzula italica*) of the alpine and mountain belts (*Luzulo italicae-Nardetum strictae* -IVb).

The fifth group includes the vegetation colonising the screes of the alpine and mountain belts and is classified in the *Galio magellense-Festucetum dimorphae* association. A peculiar aspect of this association is characterised by *Drypis spinosa* (*Drypido-Festucetum dimorphae*).

The last group (VI) refers to the mesophilous mown pastures belonging to the *Molinio-Arrhenatheretea* and divided into two sub-groups: the group VIa includes the relevés dominated by *Arrhenatherum elatius* and the group VIb includes the relevés of the *Colchico lusitani-Cynosuretum cristati* association.
Moreover, at very high altitudes on rocks and cliffs, relevès attributed to the *Arenario bertolonii-Cystopteridetum alpinae* and *Saxifrago australis-Trisetetum bertolonii* associations were sampled but not included in the multivariate analysis.

I: *Anthoxantho odorati-Brachypodietum genuensis*
IIa : *Pediculari elegantis-Seslerietum tenuifoliae*
IIb: *Koelerio splendentis-Brometum erecti*
IIIa : *Saturejo montanae-Brometum erecti*
IIIb :*Trifolio scabri-Hypochoeridetum achyrophori*
IVa: *Trifolio thalii-Festucetum microphyllae*
IVb: *Luzulo italicae-Nardetum strictae*
V: *Galio magellense-Festucetum dimorphae*
VIa: *Arrhenatheretum elatioris*
VIb: *Colchico lusitani-Cynosuretum cristati*

The elaboration of the relevés according to the Principal Component Analysis (Fig. 26) confirmed the results obtained by the classification: all the groups are well separated in the ordination space. In particular, along the second axis a moisture gradient going from the mesophilous grasslands classified in the *Molinio-Arrhenatheretea* to the more xeric communities of the *Elyno-Seslerietea* can be highlighted.

Camephytic grasslands

Saturejo montanae-Brometum erecti Avena & Blasi 1979 (Tab. 16)

The xeric camephytic grasslands were classified in the *Saturejo montanae-Brometum erecti* association, which is widespread in the limestone mountains of Central Italy and is particularly rich in species (Lucchese *et al.*, 1995). Characteristic species are *Satureja montana* ssp. *montana*, *Cytisus spinescens*, *Sideritis italica* and *Globularia bisnagarica*. The relevés are located mainly on escarpments with a

Tab. 12 - *Spartio juncei – Cytisetum sessilifolii* Biondi, Allegrezza & Guitian 1988

No. relevé	1	2	3	4
Data	16/05/06	16/05/06	18/05/06	18/05/06
Latitude	343229	343552	354282	348647
Longitude	4642686	4642718	4634730	4643363
Altitude (m)	550	630	740	916
Aspect	SW	NW	SW	-
Slope (°)	20	5	20	-
Area (m²)	10	10	10	5
Tree layer				
Height (m)	-		4	-
Cover (%)	-		3	-
Shrub layer				
Height (m)	2	1 – 4	0.5 - 2	0.5 - 4
Cover (%)	100	100	100	100
Herbaceous layer				
Cover (%)	5	5	3	5
Spartio juncei-Cytisetum sessilifolii Biondi, Allegrezza & Guitian 1988				
Spartium junceum L.	5,5	5,5	3,2	5,1
Cytisophyllum sessilifolius (L.) O.F. Lang	1,1	1,1	1,1	+
Cytision sessilifolii Biondi in Biondi, Allegrezza & Guitian 1988				
Juniperus communis L.	+	1,1	+	+
Lonicera etrusca Santi	+	.	+	.
Emerus majus Mill.	+	+		+
Prunetalia spinosae Tx. 1952, *Rhamno-Prunetea* Rivas Goday & Borja Carbonell 1961 ex Tx. 1962				
Crataegus monogyna Jacq.	+	2,1	+	+
Prunus spinosa L. ssp. spinosa	.	+	+	.
Euonymus europaeus L.	+	+	.	+
Cornus sanguinea L.	+	+	+	.
Malus sylvestris (L.) Mill.	.	+	.	.
Clematis vitalba L.	+	.	+	+
Rosa canina L.	.	+	.	.
Rosa sempervirens L.	+	+	+	+
Companions				
Rubus ulmifolius Schott	2,1	+	2,2	1,1
Rubia peregrina L.	1,1	+	+	.
Ulmus minor Mill.	+	+	.	+
Asparagus acutifolius L.	+	+	+	.
Brachypodium rupestre (Host) Roem. et Schult.	+	+	+	1,1
Fraxinus ornus L. ssp. ornus	+	.	+	+
Galium mollugo L. ssp. erectum Syme	.	+	.	.
Teucrium chamaedrys L.	+	.	+	+
Geranium lucidum L.	.	.	.	.
Hypericum perforatum L.	+	.	.	+
Acer campestre L.	.	+	.	.
Quercus pubescens Willd. ssp. pubescens	+	+	.	+
Urtica dioica L. dioica	.	.	.	.
Dactylis glomerata L.	.	.	+	+
Hedera helix L.	+	.	+	.
Geum urbanum L.	.	+	.	.
Silene latifolia Poir. ssp.alba (Mill.) Greuter et Burdet	+	.	.	.
Olea europaea L.	1,1	1,1	.	.
Sanguisorba minor Scop.	+	.	.	.
Sherardia arvensis L.	+	.	.	.

southern exposure and an average slope of 20° (Fig. 27).

The association was previously attributed to the *Phleo ambigui-Bromion erecti* (*Festuco-Brometea*), but later it was referred to the *Artemisio albae-Saturejion montanae* alliance *(Rosmarinetea officinalis)*, which includes the camaephytic plant communities of the inner sectors of the Apennines (Biondi, 1998). Together with *Bromus erectus* many other species characteristic of the alliance and order can be found. From a dynamic point of view, this grassland can be considered of secondary origin, colonising areas once occupied by forests, which have been eliminated by cutting and grazing. At lower altitudes and in more xeric conditions, many therophytic species belonging to the *Helianthemetea guttati* class are found.

Perennial grasslands

Pediculari elegantis-Seslerietum tenuifoliae (Furrer & Furnari 1960) Petriccione & Persia 1995 (Tab. 17)

The *Pediculari elegantis - Seslerietum tenuifoliae* association decribes the discontinuous herbaceous vegetation dominated by *Sesleria juncifolia* ssp. *juncifolia*, *Carex kitaibeliana*, *Helianthemum*

Tab. 13 - *Roso sempervirenti-Rubetum ulmifolii* Blasi, Di Pietro & Fortini 2000

No. relevé	1	2	3	4	5
Data	13/05/06	15/05/06	13/05/06	17/05/06	17/05/06
Latitude	353463	354357	345261	358189	353964
Longitude	4635204	4634664	4641307	4637508	4636320
Altitude (m)	750	740	494	810	870
Aspect	SE	SSW	-	-	SSE
Slope (°)	30	3	-	-	3
Area (m²)	10	15	10	10	8
Shrub layer					
Height (m)	1 - 3	0.5 – 1.70	1 - 3	1 - 3	1 - 3
Cover (%)	100	90	100	100	100
Herbaceous layer					
Cover (%)	10	5	10	90	50
Roso-Rubetum ulmifolii Blasi, Di Pietro & Fortini 2000					
Spartium junceum L.	+	.	+	2,1	1,1
Asparagus acutifolius L.	+	+	.	+	+
Hedera helix L.	+	+	1,3	1,1	+
Brachypodium rupestre (Host) Roem. & Schult.	.	+	+	1,1	.
Rosa sempervirens L.	2,2	2,2	+	.	+
Pruno-Rubion ulmifolii O. de Bolos 1954					
Rubus ulmifolius Schott	5,5	2,2	5,5	+	2,1
Rubia peregrina L.	.	+	.	.	.
Ulmus minor Mill.	.	.	+	+	+
Prunetalia spinosae Tx. 1952, *Rhamno-Prunetea* Rivas Goday & Borja Carbonell 1961 ex Tx. 1962					
Prunus spinosa L. ssp. spinosa	+	2,2	.	4,1	3,3
Fraxinus ornus L. ssp. ornus	.	+	+	+	+
Euonymus europaeus L.	+	+	.	.	+
Rosa canina L.	2,2	2,2	.	+	.
Malus sylvestris (L.) Mill.	+	.	+	.	+
Crataegus monogyna Jacq.	+	.	+	.	.
Emerus majus Mill.	.	.	.	+	+
Companions					
Clematis vitalba L.	1,1	1,1	2,2	+	1,1
Galium mollugo L. ssp. erectum Syme	+	+	+	1,1	2,1
Geranium lucidum L.	+	+	+	+	.
Quercus pubescens Willd. ssp. pubescens	+	+	.	+	.
Urtica dioica L. dioica	1,1	+	.	+	.
Acer campestre L.	+	+	.	.	.
Galium aparine L.	+	.	+	.	.
Teucrium chamaedrys L.	.	+	.	+	.
Cruciata laevipes Opiz	.	.	+	.	+
Helleborus foetidus L. ssp. foetidus	.	+	.	+	.
Myosotis ramosissima Rochel ex Schult. ssp. ramosissima	+	+	.	.	.
Poa sylvicola Guss.	+	+	.	.	.
Poa trivialis L.	.	.	+	.	+
Ranunculus lanuginosus L.	+	.	.	.	+
Dactylis glomerata L.	.	.	.	3,1	.
Geum urbanum L.	.	.	.	+	.
Hypericum perforatum L.	+	.	.	.	.
Silene latifolia Poir. Ssp.alba (Mill.) Greuter & Burdet	.	.	+	.	.
Anemone apennina L. ssp. apennina	.	.	+	.	.
Artemisia vulgaris L.	.	.	+	.	.
Cornus sanguinea L.	.	.	+	.	.
Sanguisorba minor Scop.	.	.	.	.	1,1
Sherardia arvensis L.	.	.	.	.	+

oelandicum ssp. *incanum* (Fig. 28). Generally it can be found on soils not well developed, along ridges or on steep slopes, between 2000 and 2300 m, exposed to strong wind and a reduced snow cover in the winter.
The association has been included in the *Seslerion apenninae* alliance, which is endemic of the Apennines, and into the *Seslerietalia tenuifoliae* order, geographically limited in the Apennines and northern Balkan mountains (*Elyno myosuroidis-Seslerietea coeruleae*).

Characteristic species are *Sesleria juncifolia* ssp. *juncifolia*, *Globularia meridionalis*, *Carex kitaibeliana* ssp. *kitaibeliana*, *Helianthemum oelandicum* ssp. *incanum*, *Asperula cynanchica*, *Anthyllis montana* and *Pedicularis elegans*.

Galio magellensis-Festucetum dimorphae Feoli - Chiapella 1983 (Tab. 18)

The *Galio magellensis-Festucetum dimorphae* association (Fig. 29) describes the vegetation colonising the screes of the sub-alpine and mountain belts of Central Italy. It can be found on mobile

Tab. 14 - *Salvia glutinosa* and *Aegopodium podagraria* community

No. relevé	1	2	3	4	5	6
Data	21/05/06	21/05/06	21/05/06	25/05/06	25/05/06	26/05/06
Latitude	351713	344186	344115	344684	344743	344843
Longitude	4638238	4641815	4641713	4641743	4641525	4644827
Altitude (m)	600	464	456	470	441	1155
Aspect	W	-	-	-	SW	W
Slope (°)	15	-	-	-	3	20
Area (m²)	4	7	5	8	8	10
Cover (%)	80	100	100	90	95	100
Aegopodium podagraria L.	3,1	2,3	3,1	3,3	3,3	1,1
Salvia glutinosa L.	2,1	1,1	1,3	1,1	2,2	5,5
Artemisietea Lohm. Preising & R. Tx ex Rochow 1951 and *Galio-Urticetea* Passarge ex Kopecky 1969						
Galium aparine L.	1,1	+	+	+	.	+
Ranunculus lanuginosus L.	.	+	+	+	.	.
Urtica dioica L. dioica	.	2,3	1,1	.	+	.
Chaerophyllum temulum L.	.	2,2	+	.	.	+
Chaerophyllum hirsutum L. ssp. hirsutum	+	+	.	.	+	.
Torilis arvensis (Huds.) Link	.	+	.	.	+	.
Elymus caninus (L.) L.	.	.	.	+	.	2,1
Sambucus ebulus L.	.	+	.	+	.	.
Geum urbanum L.	+	.	.	.	+	.
Lamium maculatum L.	.	+	.	.	.	+
Poa trivialis L.	.	.	+	.	.	+
Anthriscus nemorosa (M. Bieb.) Spreng.	.	.	.	+	+	.
Clematis vitalba L.	.	.	.	.	+	+
	.	.	.	.	.	.
Companions	.	.	.	.	.	.
Brachypodium sylvaticum (Huds.) P. Beauv.	1,1	+	+	+	+	.
Hedera helix L.	+	1,3	+	.	2,1	.
Parietaria officinalis L.	.	+	+	1,1	+	.
Rubus caesius L.	.	+	+	+	+	.
Eupatorium cannabinum L.	+	+	+	.	.	.
Cucubalus baccifer L.	.	+	1,1	.	.	.
Geranium robertianum L.	.	.	+	.	.	+
Glechoma hederacea L.	.	+	+	.	.	.
Poa sylvicola Guss.	.	+	.	.	.	+
Stellaria nemorum L. ssp. montana (Pierrat) Berher	.	.	+	+	.	.
Acer campestre L.	+	.	.	+	.	.
Fragaria vesca L. ssp.vesca	2,2	.	.	.	.	+
Viola reichenbachiana Jord. Ex Boreau	+	.	.	+	.	.
Cornus sanguinea L.	+	.	.	.	1,1	.
Melica uniflora Retz.	+	.	.	.	.	.
Lathyrus venetus (Mill.) Wohlf.	+	.	.	.	.	.
Hepatica nobilis Schreb.	.	.	.	.	.	+
Lactuca muralis (L.) Gaertn.	.	.	.	.	.	+
Tamus communis L.	.	+	.	.	.	.
Cruciata glabra (L.) Ehrend.	+	.	.	.	.	.
Helleborus foetidus L. ssp. foetidus	.	.	.	.	.	+
Euphorbia amygdaloides L.	+	.	.	.	.	.
Carex halleriana Asso	+	.	.	.	.	.
Sanicula europaea L.	+	.	.	.	.	.
Potentilla micrantha Ramond ex DC.	.	.	.	.	.	+
Geranium lucidum L.	.	1,2	.	.	.	.
Aquilegia vulgaris auct. Fl. Ital.	.	.	.	.	.	+
Arctium lappa L.	.	.	.	+	.	.
Campanula glomerata L.	.	.	.	.	.	+
Cardamine chelidonia L.	.	.	+	.	.	.
Cardamine impatiens L. ssp. impatiens	.	.	+	.	.	.
Laserpitium latifolium L.	.	.	.	.	.	1,1
Lotus corniculatus L.	+	.	.	.	.	.
Polygonatum odoratum (Mill.) Druce	.	.	.	.	.	+
Ranunculus bulbosus L.	+	.	.	.	.	.
Ranunculus repens L.	.	.	+	.	.	.
Rhagadiolus stellatus (L.) Gaertn.	.	+	.	.	.	.
Rubus idaeus L.	.	.	.	.	.	+
Rumex sanguineus L.	.	+	.	.	.	.
Sisymbrium officinale (L.) Scop.	.	+	.	.	.	.
Stellaria media (L.) Vill.	.	+	.	.	.	.
Thalictrum aquilegiifolium L. ssp. aquilegiifolium	.	.	.	.	.	+

Tab. 15 - *Urtico dioicae-Sambucetum ebuli* Br.-Bl. In Br. Bl., Roussine & Nègre 1952

No. relevé	13/05/06
Latitude	344530
Longitude	4646054
Altitude (m)	1066
Aspect	NW
Slope (°)	3
Area (m²)	10
Cover (%)	100
Urtico dioicae-Sambucetum ebuli Br.-Bl. in Br. Bl., Roussine & Nègre 1952	
Sambucus ebulus L.	5,1
Urtica dioica L. dioica	2,1
Arction lappae R. Tx. 1937, *Onopordietalia* Br.Bl. & R. Tx ex Klika et Hadac 1944, *Artemisietea vulgaris* Lohm. Preising & R. Tx ex Rochow 1951	
Galium aparine L.	+
Elymus caninus (L.) L.	+
Artemisia alba Turra	+
Chaerophyllum temulum L.	+
Aegopodium podagraria L.	+
Companions	
Salvia glutinosa L.	+
Clematis vitalba L.	1,1
Ranunculus lanuginosus L.	+
Deschampsia cespitosa (L.) P. Beauv.	+
Geranium lucidum L.	+
Geum urbanum L.	+
Poa trivialis L.	+
Agrimonia eupatoria L.	+
Arctium nemorosum Lej.	+
Cuscuta epithymum (L.) L.	+
Heracleum sphondylium L.	+

steep slopes, with medium and small-size clasts and it is characterised by rhizomatous geophytes and hemicryptophytes (Biondi *et al*., 1999).

Characteristic species are *Galium magellense, Festuca dimorpha, Lomelosia graminifolia* ssp. *graminifolia*. This association is vicarious in the Apennines of the *Festucetum dimorphae* of the maritime Alps in the west and the *Festucetum laxae* of the eastern Alps. Species such as *Galium magellense, Laserpitium siler, Robertia taraxacoides, Heracleum sphondylium*, differentiate this association from similar ones of the Alps.

Drypido-Festucetum dimorphae Bonin 1978 (Tab. 19)

At the base of the main scree of the mount Viglio the *Drypido-Festucetum dimorphae* association was found. Here, as well as in the near Abruzzi National Park (Di Pietro *et al*., 2004), it has a limited distribution, mainly on a mobile substratum with thin detritus. Besides *Festuca dimorpha* and *Drypis spinosa,* other species such as *Heracleum sphondylium*, *Cymbalaria pallida* and *Arenaria bertolonii* are found.

Luzulo italicae-Nardetum stictae Biondi, Ballelli, Allegrezza, Frattaroli & Taffetani 1992 (Tab. 20)

The association *Luzulo italicae-Nardetum strictae* describes the vegetation characterised by *Nardus stricta* and *Luzula spicata* that can be found on deep and acidic soils in the sub-alpine belt (Gigli *et al*., 1991; Biondi *et al*., 1999). This type of grasslands has been widely studied and debated: in 1995 Petriccione and Persia decided to classify this vegetation in the *Ranunculo pollinensis-Nardetum strictae* association (*Festucion macratherae -Festuco- Seslerietea*), motivating their choice on the base of the scarcity of species of the *Nardetea strictae* or *Nardo-Callunetea* classes. Our relevés as well as those published by Biondi *et al*., (1999) do not seem to justify such a classification. In fact, the pedological investigations conducted on these grasslands highlighted mesic and acidic conditions, so as to corroborate the inclusion of these associations in the *Nardetea strictae* (Zuccarello *et al*., 1999).

Characteristic species are: *Ranunculus pollinensis*, *Potentilla rigoana*, *Plantago atrata*, *Taraxacum apenninum*, *Luzula spicata*, *Crocus vernus*, *Ranunculus apenninus* and *Poa alpina* ssp. *alpina*.

Trifolio thalii-Festucetum microphyllae Petriccione & Persia 1995 (Tab. 21)

The *Trifolio thalii-Festucetum microphyllae* association represents the vegetation growing in the mesic sinkholes on deep soil close to the vegetation of the *Luzulo italicae-Nardetum strictae*. The exposure is slightly northern and the concave morphology allows the accumulation of pedogenetic material and the permanence of snow for many months. Characteristic species are *Festuca microphylla, Trifolium thalii, Ranunculus apenninus, Plantago atrata, Poa alpina, Taraxacum apenninum, Veronica serpyllifolia* and *Barbarea bracteosa*. Other species typical of the *Ranunculo pollinensis-Nardion strictae* are well represented, as well as species linked to grazing effects such as *Carlina acaulis, Cirsium tenoreanum, Euphorbia cyparissias*.

The *Trifolio thalii-Festucetum microphyllae* association is similar to the phytosociological table of Furrer and Furnari (1960) for Campo Imperatore in the near Abruzzi region and the *Taraxaco apennini-Trifolietum thalii* association described for the same area by Biondi *et al*. (1999).

Koelerio splendentis-Brometum erecti Biondi, Ballelli, Allegrezza, Frattaroli & Taffetani 1992 (Tab. 22)

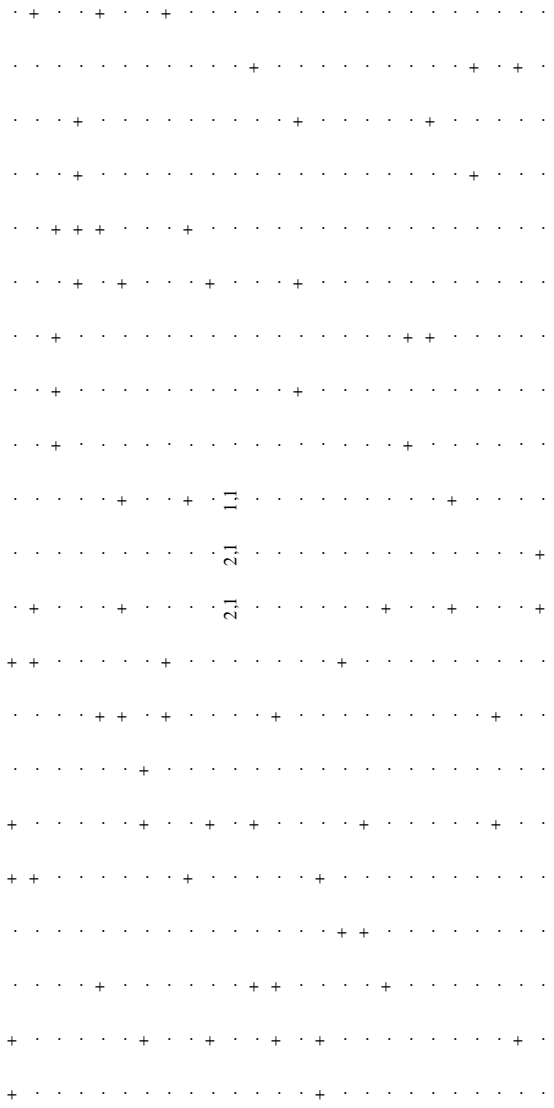
The grasslands with *Bromus erectus* present in the limestone escarpments of the mountain belt was classified in the *Koelerio splendentis-Brometum erecti* association (Attorre & Bruno, 2003). This association includes pastures with an almost continuous cover developing on rendiza-type soils above 1500 m and in southern exposures, up to 2000 m, which is the upper limit for *Festuco-Brometea* in Central Italy (Biondi *et al*., 1999).

Characteristic species are *Koeleria lobata*, *Valeriana tuberosa*, *Globularia meridionalis*, *Trifolium*

Tab. 16 - *Saturejo montanae-Brometum erecti* Avena & Blasi 1979

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Altitude (m)	680	695	1333	658	913	975	878	900	900	1200	1190	1215	915	920	920	1060	1065	1065	1080	1062	1040
Aspect	W	WS	S	SW	S	S	SSW	SW	W	SE	SE	SE	W	SW	SW	S	SSW	SSW	SW	S	SSE
Slope (°)	30	25	25	40	25	20	7	3	3	30	30	30	5	25	20	30	30	30	25	30	20
Rock (%)	10	10	20	5	25	20	-	-	25	10	20	-	-	-	-	5	10	20	30	20	-
Stone (%)	30	40	70	90	60	70	80	80	30	60	60	30	15	70	70	80	50	80	65	50	50
Area (m²)	15	20	8	30	10	25	6	20	5	20	25	20	9	12	10	12	25	25	30	25	30
Cover (%)	60	60	65	80	70	70	65	70	70	80	60	70	80	70	80	80	85	60	50	70	80
Saturejo montanae-Brometum erecti Avena & Blasi 1979																					
Satureja montana L.	3,3	2,2	2,2	2,3	2,2	2,1	+	+	+	+	+	+	+	+	+	2,1	+	3,1	2,1	3,1	2,2
Globularia bisnagarica L.	+	+	.	+	+	+	+	+	+	.	+	+	+	+	+	+	+	+	+	+	+
Cytisus spinescens C. Presl	.	+	.	.	.	+	.	.	+	+	.	+	+	+	+	+	+	1,1	+	.	+
Sideritis italica (Mill.) Greuter & Burdet	.	.	+	.	.	.	.	1,1	1,1	+	+	1,1	.	.	.	+	.	+	.	+	+
Artemisio albae-Saturejion montanae Allegrezza, Biondi, Formica & Ballelli 1997, *Rosmarinetalia officinalis* Br.-Bl.ex Molinier 1934, *Rosmarinetea officinalis* Rivas Martínez, Diaz, Prieto, Loidi & Penas 1991																					
Fumana procumbens (Dunal) Gren. & Godr.	.	+	.	+	.	+	+	1,1	+	.	.	.	2,1	1,1	1,1	.	+	+	1,1	+	+
Teucrium montanum L.	.	.	.	.	+	+	2,2	.	.	+	+	.	1,1	1,2	1,1	1,1	1,1	+	1,1	+	+
Convolvulus cantabrica L.	.	+	.	+	+	1,2	+	+	1,1	.	.	.	.	.	+	+	+	+	.	+	+
Leontodon rosani (Ten.) DC.	.	+	.	.	.	.	+	+	.	+	+	+	+	+	+	.	.	.	+	+	.
Thymus striatus Vahl	.	.	+	.	.	.	.	.	.	+	1,1	.	2,1	.	1,1	+	.	.	1,1	.	.
Helianthemum apenninum (L.) Mill. ssp. apenninum	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	1,1	.
Phleo ambigui-Bromion erecti (Biondi & Blasi 1982) ex Biondi *et al*. 1995																					
Galium lucidum All.	+	+	+	.	+	+	1,1	+	+	+	+	+	.	1,1	+	.	.	1,1	+	+	1,1
Phleum hirsutum Honck. ssp. ambiguum (Ten.) Tzvelev	+	+	+	1,1	+	1,1	2,1	2,1	1,1	1,1	.	2,1	.	.	.	+	+	.	.	+	1,1
Festuca robustifolia Markgr.-Dann.	.	+	1,3	+	1,1	+	1,1	.	.	+	+	+	+	.	.	+	1,1	.	+	1,1	1,1
Koeleria lobata (M. Bieb.) Roem. & Schult.	.	+	.	+	.	1,1	+	+	+	+	+	.	2,1	3,1	3,1	.	.	.	+	.	+
Inula montana L.	.	.	.	.	.	+	1,1	.	.	2,1	+	+	+	1,1	+	+	2,2	.	.	+	+
Helichrysum italicum (Roth) G. Don	.	.	.	+	1,1	+	+	+	.	.	.	+	.	+	+	.	.	+	.	+	+
Allium sphaerocephalon L.	.	.	+	.	.	.	+	.	.	.	+	+	.	.	+	+	.	+	.	+	+
Helianthemum oelandicum (L.) Dum. Cours. ssp. incanum (Willk.) G. López	.	.	1,1	.	.	.	.	.	.	+	.	.	+	+	.	+	.	.	+	+	.
Erysimum pseudorhaeticum Polatschek	.	.	+	+	.	.	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.
Galium corrudifolium Vill.	+	.	.	1,1	.	.	.	.	.	.	.	.	.	.	.	1,1	1,1	.	+	.	.
Cerastium tomentosum L.	+	.	+	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	+
Melica transsilvanica Schur ssp. transsilvanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	2,2	+	.	+	+
Potentilla hirta L.	1,1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	+
Dianthus sylvestris Wulfen	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+
Eryngium amethystinum L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+
Crepis lacera Ten.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Arabis collina Ten.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Onosma echioides (L.) L.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echium vulgare L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Centaurea deusta Ten.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Polygala major Jacq.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Brometalia erecti Br.-Bl. 1936, *Festuco-Brometea* Br.-Bl. &Tx. 1943 ex Klika & Hadac 1944																					
Bromus erectus Huds.	+	1,1	.	1,1	1,1	+	+	+	+	3,1	2,1	2,1	+	+	1,1	2,1	1,1	1,1	+	2,1	2,2
Seseli montanum L. ssp.montanum	.	1,1	2,1	1,3	1,1	.	+	1,1	.	+	+	+	.	+	+	+	+	+	+	1,1	+
Sanguisorba minor Scop.	+	+	.	+	.	+	+	+	.	+	+	+	+	.	.	+	+	+	.	.	+
Teucrium chamaedrys L.	+	1,1	.	+	1,1	+	1,1	1,1	.	1,1	.	.	.	.	.	1,1	1,1	+	.	+	1,1
Anthyllis vulneraria L. s.l.	.	.	.	+	+	.	.	.	.	+	+	1,1	.	.	+	+	+	+	.	+	.
Carex caryophyllea Latourr.	+	+	.	.	.	.	.	.	.	.	.	.	+	+	2,1	+	.	+	+	1,1	+
Helianthemum nummularium (L.) Mill. ssp.obscurum (Celak.) Holub	1,2	+	.	+	+	+	+	.	.	1,1	+	.	.	.	.	.	.	.	.	.	+
Eryngium campestre L.	+	.	.	+	+	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.

Plantago argentea Chaix	+	.	.	.	.	.	+	+	+	+	1,1	.	.	.	.	+	+	+	.	.	.
Dactylis glomerata L.	.	+	.	+	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	+
Hippocrepis comosa L. ssp. comosa	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	+	+	.	.	.	.
Hieracium pilosella L.	.	.	.	.	.	.	+	1,1	.	+	.	.	+	.	+	.	.	.	.	.	.
Knautia purpurea (Vill.) Borbás	.	.	.	1,1	1,1	1,1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium campestre Schreb.	+	+	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Polygala flavescens DC.	.	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
Brachypodium rupestre (Host) Roem. & Schult.	.	+	.	1,3	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Centaurium erythraea Rafn	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.
Ranunculus bulbosus L.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Ophrys apifera Huds.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	+	.
Lactuca perennis L. ssp. perennis	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Genista tinctoria L.	.	.	1,1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Hieracium piloselloides Vill.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Trachynetalia distachyae Rivas-Martinez 1978, *Helianthemetea guttati* Br.-Bl. 1940																					
Hypericum perforatum L.	+	+	.	+	.	+	+	+	+	+	.	.	.	.	.	+	+	.	.	+	+
Coronilla scorpioides (L.) W.D.J. Koch	+	+	.	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+
Reichardia picroides (L.) Roth	.	+	.	.	.	+	+	+	+	.	.	.	.	.	.	+	+	.	.	+	+
Bupleurum baldense Turra	.	.	.	+	+	+	+	1,1	+	+	+	.	.	.	.	.	.	.	.	.	+
Crupina vulgaris Cass.	+	+	.	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Cynosurus echinatus L.	+	+	.	.	.	.	+	+	+	.	.	.	.	.	.	.	+	.	.	.	.
Medicago minima (L.) L.	.	+	.	+	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Trachynia distachya (L.) Link	.	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Urospermum dalechampii (L.) F.W. Schmidt	.	.	.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+
Linum strictum L.	.	.	.	+	+	1,1	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Arenaria leptoclados (Rchb.) Guss.	.	.	.	+	+	.	+	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Sideritis romana L. ssp.romana	+	.	.	.	+	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hypochaeris achyrophorus L.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium scabrum L. ssp.scabrum	.	.	.	.	.	.	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.
Micromeria graeca (L.) Benth. ex Rchb. ssp.tenuifolia (Ten.) Nyman	.	.	.	.	.	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Geranium columbinum L.	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Stachys germanica L. ssp.salviifolia (Ten.) Gams	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Triticum ovatum (L.) Raspail	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sedum album L.	.	.	1,1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Trifolium stellatum L.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Xeranthemum inapertum (L.) Mill.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Petrorhagia prolifera (L.) P.W. Ball & Heywood	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Tordylium apulum L.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Catapodium rigidum (L.) C.E. Hubb. ex Dony	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Cerastium ligusticum Viv.	.	.	.	.	.	.	.	.	1,1	.	+	.	.	.	.	.	.	.	.	.	.
Companions																					
Aethionema saxatile (L.) R. Br.	+	+	.	+	+	+	1,1	+	.	+	+	.	.	+	+	+	+	+	+	+	+
Thesium humifusum DC.	.	+	.	+	+	+	+	+	.	+	+	.	+	+	+	+	+	+	+	+	+
Sedum rupestre L.	+	+	+	.	+	+	.	+	+	+	+	1,1	.	.	.	+	.	+	.	+	1,1
Stachys recta L.	+	+	1,2	+	.	+	.	.	.	.	.	.	.	+	+	+	+	+	+	+	+
Petrorhagia saxifraga (L.) Link	.	.	.	+	+	+	+	+	+	+	+	+	.	.	.	.	+	.	.	.	.
Acinos alpinus (L.) Moench	.	.	.	.	.	.	1,1	.	1,1	+	+	+	.	.	.	+	+	.	.	+	+
Sedum sexangulare L.	+	+	+	.	+	+	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.
Muscari comosum (L.) Mill.	+	+	.	.	.	.	.	.	+	.	+	.	.	.	+	+	.	.	.	.	+
Pimpinella saxifraga L.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	+	.	.	.	+	.	.
Anthericum liliago L.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.	+	.
Crepis neglecta L.	.	1,1	.	+	.	.	+	+	1,1	.	.	.	.	.	.	.	.	.	.	.	+
Cuscuta epithymum (L.) L.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	+	+
Orlaya grandiflora (L.) Hoffm.	+	+	.	+	.	.	.	.	2,1	.	.	.	.	.	.	.	.	.	.	.	+



montanum ssp. *rupestre* and *Pedicularis comosa*.

Anthoxantho odorati-Brachypodietum genuensis (Lucchese, Persia & Pignatti 1995) ex Attorre & Bruno 2003 (Tab. 23)

The *Anthoxantho odorati-Brachypodietum genuensis* association includes the grasslands characterised by *Brachypodium genuensis* on calcareous slopes where peculiar concave morphological features allow the accumulation of pedogenetic material and mesic conditions so as to support the growth of many species belonging to the *Molinio-Arrhenatheretea* (e.g. *Anthoxanthum odoratum*, *Cynosurus cristatus*, *Agrostis tenuis* and *Rumex acetosa*).

Characteristic species are *Anthoxanthum odoratum*, *Brachypodium genuense*, *Cirsium acaule* ssp.*acaule* and *Polygala vulgaris*.

Initially this association was identified by Lucchese (1987), with two sub-associations named *brometosum* e *nardetosum*. Subsequently the former sub-association has been defined as association with the name of *Potentillo rigoanae-Brachypodietum genuensis* (Lucchese *et al*., 1995), however Attorre & Bruno, (2003) decided to classified this type of vegetation in a different association, the *Anthoxantho odorati-Brachypodietum genuensis*.

With respect to the *Potentillo rigoanae-Brachypodietum genuensis*, which is also very widespread in the Central Apennines (Pirone, 1997; Blasi *et al*., 1998; Stanisci *et al*., 1999), the *Anthoxantho odorati-Brachypodietum genuensis* is differentiated by many species typical of the *Molinio-Arrhenatheretea* and by the fact that this grassland is characterised by a continuous herbaceous cover, while the vegetation ascribed to the *Potentillo rigoanae-Brachypodietum genuensis* association, by definition, develops on calcareous substrata with outcroping rocks. (Lucchese *et al*., 1995).

The lack of species from above belts suggested the inclusion of this association in the sub-alliance *Brachypodenion genuensis* (*Phleo ambigui-Bromion erecti* alliance), as suggested by Ciaschetti *et al*. (2006).

Arrhenatherium elatius community (Tab. 24)

These meadows of secondary origin, characterised by *Arrhenatherum elatius* together with *Galium mollugo* ssp. *erectus* and *Tragopogon pratensis*, are maintained by fertilization, irrigation and mowing.

Pedrotti (1963) classified the meadows with *Arrhenatherum elatius* of the Central Apennines into the *Arrhenatheretum elatioris* association described for the Alps by Braun-Blanquet, even if the absence of typical species such as *Knautia arvensis* was noticed. This species is present in our relevés, which however lack other characteristic species. For this reason we

Tab. 17 - *Pediculari elegantis- Seslerietum tenuifoliae* (Furrer & Furnari 1960) Petriccione & Persia 1995

No. relevé	1	2	3	4	5	6	7	8	9	10
Altitude (m)	1844	1888	1875	1950	1925	1985	1775	1910	1775	1835
Aspect	NW	SW	SW	E	E	SE	SW	SW	SW	SW
Slope (°)	20	35	30	45	30	20	20	30	40	30
Area (m²)	25	25	25	25	25	25	25	25	25	25
Cover (%)	60	60	55	50	55	50	50	50	55	50
Pediculari elegantis- Seslerietum tenuifoliae (Furrer & Furnari 1960) Petriccione & Persia 1995										
Sesleria juncifolia Suffren ssp.juncifolia	2	3	3	3	3	2	4	3	3	3
Globularia meridionalis (Podp.) O. Schwarz	.	2	1	2	2	2	+	2	2	1
Carex kitaibeliana Degen ex Bech. ssp. kitaibeliana	3	+	1	.	2	1	.	+	1	1
Helianthemum oelandicum (L.) DC. ssp.incanum (Willk.) G.Lòpez	1	1	.	1	2	1	.	2	1	2
Asperula cynanchica L.	+	.	.	+	+	.	.	+	+	1
Anthyllis montana L. ssp. atropurpurea (Vukot.) Pign.	.	+	.	+	+	1	.	2	.	+
Pedicularis elegans Ten.	+	.	+	+	1	.	.	.	.	.
Ranunculus thora L.	.	+	+	.	+	.	.	.	.	.
Cerastium arvense L. subsp. suffruticosum (L.) Ces.	.	.	.	.	.	1	.	.	.	.
Seslerion apenninae Bruno & Furnari 1969										
Polygala major Jacq.	.	+	1	+	.	+	.	+	.	+
Leucanthemum tridactylites (Kern. & Huter) Huter, Porta & Rigo	.	.	+	.	.	.	+	1	.	.
Myosotis ambigens (Beg.) Grau	.	.	.	.	+	.	.	+	.	+
Viola eugeniae Parl. ssp. eugeniae	1	.	1	.	.	.	+	.	.	.
Linum capitatum Kit.ex Schultz. ssp. serrulatum	1	.	.	.	.	.	.	.	.	1
Hieracium bifidum Kit. Ex Hornem.	.	.	.	.	.	.	.	.	.	+
Saxifraga paniculata Miller	+	.	.	.	.	.	.	.	.	.
Valeriana montana L.	.	+	.	.	.	.	.	.	.	.
Seslerietalia tenuifoliae Horvat 1930, *Elyno myosuroidis-Seslerietea coeruleae* Br.-Bl. 1948										
Edraianthus graminifolius (L.) A.DC. ssp. graminifolius	1	.	+	1	+	1	+	+	.	.
Draba aizoides L.	+	+	+	.	.	+	+	+	.	.
Biscutella laevigata L. ssp. laevigata	1	+	.	.	+	.	.	.	.	+
Gentiana dinarica Beck	+	+	.	+	.	.	+	.	.	.
Paronychia kapela (Hacq.) A. Kern	.	.	.	.	+	.	2	+	.	+
Trinia dalechampii (Ten.) Janchen	.	.	.	.	+	.	+	+	.	+
Helianthemum nummularium (L.) Miller ssp. obscurum (Celak.) J.Holub	.	+	1	.	.	+	.	.	.	.
Companions										
Cerastium tomentosum L.	1	.	+	1	.	+	+	1	.	.
Thymus longicaulis Presl ssp. longicaulis	+	.	.	.	+	+	3	2	.	2
Galium lucidum All.	.	.	.	.	+	.	1	+	+	+
Thlaspi praecox Wulfen	+	1	.	+	+	+	.	.	.	.
Avenula praetutiana (Parl.) Pign.	.	.	.	.	.	.	+	+	1	+
Brachypodium genuense (DC.) Roemer et Schultes	.	.	.	.	.	1	.	+	1	1
Bromus erectus Hudson	1	.	+	.	1	.	.	.	1	.
Coronilla minima L.	.	+	.	1	1	.	.	+	.	.
Dianthus sylvestris L. Wulfen ssp. sylvestris	+	.	+	.	.	+	+	.	.	.
Leontodon hispidus L.	+	+	.	.	.	.	.	+	.	1
Teucrium montanum L.	.	.	.	.	.	+	.	+	+	1
Allium sphaerocephalon L.	.	.	.	+	.	.	1	.	.	+
Anthyllis vulneraria L.	.	.	+	.	.	.	.	.	+	2
Festuca violacea Schleich. ex Gaudin	.	.	.	.	.	+	.	1	1	.
Oxytropis campestris (L.) DC.	.	.	.	.	.	.	1	+	+	.
Pulsatilla alpina (L.) Delarbre	.	.	+	.	.	.	+	.	1	.
Seseli montanum L.	.	+	.	.	+	.	.	.	.	+
Campanula scheuchzeri Vill.	.	.	.	.	.	.	1	.	.	+
Koeleria lobata (M.Bieb) Roem. & Schult.	+	.	.	.	.	.	.	.	.	+
Laserpitium siler L.	.	.	.	.	+	.	.	.	+	.
Phyteuma orbiculare L.	+	.	.	.	.	+	.	.	.	.
Sedum rupestre L. ssp. rupestre	.	.	.	+	.	.	.	.	.	+
Sempervivum arachnoideum L.	.	.	.	+	.	.	.	.	.	+

did not include our relevés in this association, nor in the *Festuco circummediterraneae-Arrhenatheretum elatioris* described by Allegrezza (2003). This latter association likely represents a drier aspect of the *Arrhenatherion* alliance, which is differentiated by plant species with a Mediterranean distribution such as *Festuca circummediterranea*.

Other species found in the Simbruini meadows are *Leucanthemum vulgare* ssp. *vulgare*, *Rhinantus minor*, *Trifolium pratense* and *Potentilla reptans*. They can be found in flat areas with deep and humid soils, frequently in contact with the meadows classified in the *Colchico lusitanici-Cynosuretum cristati* association.

Colchico lusitanici-Cynosuretum cristati Biondi & Ballelli 1995 (Tab. 25)

This plant community is characterised by a continuous herbaceous cover, high biomass and colonises deep brown soils (Fig. 30). The *Colchico lusitani-Cynosuretum cristati* association has been described for Central Italy (Biondi & Ballelli, 1995) and belongs to the *Cynosurion cristati* alliance

Tab. 18 - *Galio magellensis - Festucetum dimorphae* Feoli-Chiapella 1983

No. relevé	1	2	3	4	5	6
Altitude (m)	1900	1888	1913	1925	1988	1913
Aspect	N	N	NW	NW	NW	NW
Slope (°)	30	30	35	50	40	35
Area (m²)	25	25	25	25	25	25
Cover (%)	45	50	40	45	45	55
Galio magellensis - Festucetum dimorphae Feoli-Chiapella 1983						
Festuca dimorpha Guss.	1	2	2	4	4	3
Galium magellense Ten.	+	+	.	+	+	+
Lomelosia graminifolia (L.) Greuter & Burdet ssp. graminifolia	.	+	.	.	.	+
Festucion dimorphae Bonin 1969						
Arenaria bertolonii Fiori	+	+	.	+	+	+
Heracleum sphondylium L. ssp. orsinii (Guss.) H.Neumayer	1	.	2	1	.	1
Robertia taraxacoides (Loisel.) DC.	.	+	1	1	.	.
Cerastium tomentosum L.	.	+	+	.	1	.
Doronicum columnae Ten.	.	+	.	+	.	.
Laserpitium siler L.	.	+	.	.	+	.
Ranunculus brevifolius Ten.	+	.	.	.	+	.
Thlaspietalia rotundifolii Br.-Bl. in Br.-Bl. & Jenny 1926, *Thlaspietea rotundifolii* Br.-Bl. 1948						
Rumex scutatus L.	+	.	1	2	1	.
Valeriana montana L.	+	+	.	.	1	+
Scrophularia hoppii Koch	+	.	1	+	.	.
Companions						
Sedum rupestre L. ssp. rupestre	+	.	1	+	+	.
Allium sphaerocephalon L.	+	.	+	.	+	.
Biscutella laevigata L. ssp. laevigata	.	+	+	.	+	.
Linaria purpurea (L.) Miller	+	.	+	.	+	.
Linum alpinum Jacq.	+	.	.	+	.	+
Linum capitatum Kit.ex Schultz. subsp. serrulatum	.	+	.	1	.	+
Pulsatilla alpina (L.) Delarbre	+	.	.	1	.	1
Anthyllis vulneraria L.	.	.	+	.	+	.
Avenula praetutiana (Parl.) Pign.	.	.	+	.	+	.
Cymbalaria pallida (Ten.) Wettst.	+	.	.	.	.	+
Cynoglossum magellense Ten.	+	.	+	.	.	.
Dianthus sylvestris L. Wulfen ssp. sylvestris	.	.	+	.	+	.
Edraianthus graminifolius (L.) A.DC. ssp. graminifolius	.	.	+	+	.	.
Hieracium villosum Jacq.	.	.	+	.	+	.
Ligusticum lucidum Mill.	.	.	+	.	1	.
Minuartia verna (L.) Hiern ssp. verna	+	.	.	+	.	.
Pedicularis elegans Ten.	.	.	.	+	.	+
Senecio doronicum (L.) L.	.	.	.	+	.	+
Seseli montanum L.	.	.	.	+	.	+

(*Arrhenatheretalia*) which includes different types of meadows on fertile and humid soils. This association has been identified in other areas being characterised by *Bromus erectus* (Biondi *et al*., 2004) or *Festuca circummediterranea, Festuca rupicola* and *Bromus hordeaceus* (Allegrezza, 2003).

This vegetation can be found in small depressions, often close to the plant communities dominated by *Arrhenatherum elatius* and is regularly mowed.

The association is characterised by *Poaceae* such as *Lolium perenne*, *Cynosurus cristatus* and other palatable species: *Trifolium repens*, *Trifolium pretense* and *Trifolium campestre*.

Terophytic grasslands

Trifolio scabri-Hypochoeridetum achyrophori Lapraz ex Biondi, Ballelli, Izco & Formica 1997 (Tab. 26)

Close to the chamaephytic vegetation of the *Saturejo montanae-Brometum erecti* or the xerophytic grasslands belonging to the *Festuco-Brometea*, an annual, therophytic plant community dominated by *Hypochoeris achyrophorus* and *Trifolium scabrum* can be found in very dry areas with shallow soils, characterised by a very low water capacity.

This vegetation has been classified in the *Trifolio scabri-Hypochoeridetum achyrophori* association described by Lapraz (1982) for the grasslands of the maritime Alps and subsequently modified by Biondi *et al*. (1997). This association has been already identified in Central Italy (Blasi *et al*., 1990; Baldoni *et al*., 1996; Scoppola, 1999; Scoppola & Angiolini, 2001; Fanelli *et al*., 2010) and has been included in the *Helianthemetea guttati*, and, more specifically, in the *Trachynetalia distachyae* order (Rivas-Martínez *et al*., 2001), which identifies herbaceous plant communities growing on arid, basic soils (Rivas-Martínez, 1977) and *Hypochoerion achyrophori* alliance (Biondi & Guerra 2008). Characteristic species are *Hypochoeris achyrophorus*, *Trifolium scabrum*, *Linum strictum*, *Coronilla scorpioides* and *Melilotus sulcatus*.

Tab. 19 - *Drypido-Festucetum dimorphae* Bonin 1978

No. relevé	1	2
Altitude (m)	1970	1880
Aspect	N	NW
Slope (°)	30	35
Rock (%)	5	3
Stone (%)	80	70
Area (m²)	40	50
Cover (%)	30	20
Drypido-Festucetum dimorphae Bonin 1978		
Drypis spinosa L. ssp. spinosa	2	1
Festucion dimorphae Bonin 1969		
Festuca dimorpha Guss.	+	1
Heracleum sphondylium L. orsinii (Guss.) H. Neumayer	.	+
Cymbalaria pallida (Ten.) Wettst.	+	+
Arenaria bertolonii Fiori	1	.
Doronicum columnae Ten.	.	+
Robertia taraxacoides (Loisel.) DC.	1	+
Thlaspietalia rotundifolii Br.-Bl.in Br.-Bl. & Jenny 1926, *Thlaspietea rotundifolii* Br.-Bl. 1948		
Rumex scutatus L.	+	+
Adenostyles glabra (Mill.) DC. ssp. glabra	+	1
Campanula cochleariifolia Lam.	+	.
Companions		
Biscutella laevigata L.	+	1
Euphorbia cyparissias L.	1	+
Pulsatilla alpina (L.) Delarbre	+	.
Stachys alopecuros (L.) Benth.	.	+
Phyteuma orbiculare L.	.	+
Lotus corniculatus L.	+	+

Chasmophytic vegetation

This vegetation generally is characterised by few species growing in extreme environmental conditions with very low winter temperatures, a high temperature excursion and level of irradiation.

Two different associations have been identified belonging respectively to the *Thlaspietea rotundifolii* and *Asplenietea trichomanis* classes.

Saxifrago australis-Trisetetum bertolonii Biondi & Ballelli 1982 (Tab. 27)

This association includes calcareous cliff communities characterised by many camaephytic species. The presence of species such as *Campanula tanfanii*, *Potentilla apennina, Rhamnus pumila, Sedum dasyphyllum* ssp. *dasyphyllum, Saxifraga callosa* ssp. *callosa*, *Saxifraga paniculata* ssp. *paniculata, Saxifraga porophylla, Primula auricola, Potentilla caulescens* allows the identification of the *Saxifrago-Trisetum bertolonii* described by Biondi and Ballelli (1982) (Tab. 19). This classification can be considered valid even in the absence of *Trisetaria villosa* (=*Trisetum bertolonii*), a quite rare species in the Lazio region.

This association has been found on rocky cliffs between 1825 and 2200 m on several peaks (Viglio, Fanfulli, Tarino) (Fig. 31).

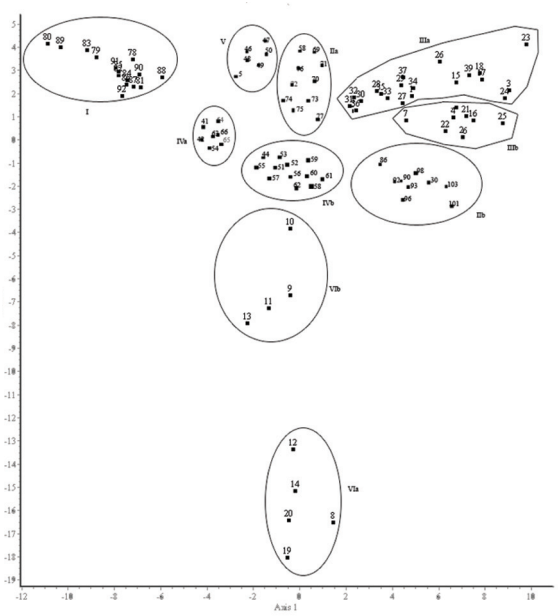


Fig. 26 -Scatterplot of grassland relevés along the first two axes of the Principal Component Analysis.

Fig. 27 - Camaephitic grassland with *Satureja montana* and *Bromus erectus*.

Fig. 28 - Herbaceous vegetation with *Sesleria juncifolia*.

Tab. 20 - *Luzulo italicae-Nardetum strictae* Biondi, Ballelli, Allegrezza, Frattaroli &Taffetani 1992

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Altitude (m)	1795	1843	1805	1755	1774	1817	1750	1900	1900	1875	1840	1900	1940	1900	1985	1790	1910	1950	1713
Aspect	S	SE	S	SE	SE	NE	NW	SE	N	NW	NW	W	SW	NW	SW	NE	NE	NW	NW
Slope (°)	7	15	12	18	4	7	8	15	13	15	25	25	25	30	25	25	25	30	30
Area (m²)	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Cover (%)	90	95	85	90	90	80	85	95	85	85	85	85	90	90	90	85	80	90	90
Luzulo italicae-Nardetum strictae Biondi *et al*. 1992																			
Potentilla rigoana Th. Wolf	2	2	1	+	1	.	.	+	+	1	1	+	.	+	2	2	2	+	2
Luzula spicata (L.) DC.	+	+	.	1	.	.	.	.	+	1	2	1	2	1	+	1	+	+	2
Carex kitaibeliana Degen ex Bech. ssp. kitaibeliana	+	.	1	1	.	.	.	2	1	+	1	.	+	2	.	1	.	+	1
Gentiana verna L. ssp. verna	.	.	+	+	.	+	.	1	.	+	+	.	+	+	.	+	+	+	1
Viola eugeniae Parl. ssp. eugeniae	1	2	2	2	.	2	1	.	.	.	.	.	.	.	1	1	1	+	1
Festuca violacea Schleich. ex Gaudin	+	.	1	.	.	.	.	.	2	3	1	1	2	.	.	1	+	2	1
Crocus vernus (L.) Hill	.	+	.	.	.	1	1	.	.	.	.	1	1	+	+	1	1	.	.
Phyteuma orbiculare L.	.	.	.	+	.	.	.	.	.	+	+	+	.	.	.	.	+	.	.
Ranunculo pollinensis-Nardion strictae Bonin 1972																			
Ranunculus pollinensis (Terr.) Chiov.	4	3	3	.	.	2	3	2	3	1	2	2	1	1	+	.	1	.	.
Plantago atrata Hoppe	.	+	.	+	.	.	.	1	2	1	1	+	1	1	1	.	2	.	1
Trifolium thalii Vill.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	+	+
Taraxacum apenninum	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.
Festuca laevigata Gaudin	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	+	1
Ranunculus apenninus (Chiov.) Pignatti	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Nardetalia strictae Oberdofer ex Preising 1949, *Nardetea strictae* Rivas-Goday ex Rivas-Goday & Rivas-Martinez 1963																			
Nardus stricta L.	3	3	1	1	2	1	+	.	.	+	1	2	+	+	3	4	4	3	2
Poa alpina L. ssp.alpina	2	1	+	+	.	.	+	2	1	+	1	3	2	2	2	.	.	.	.
Botrychium lunaria (L.) Swartz	.	+	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	+	.
Campanula scheuchzeri Vill.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	+	+
Companions																			
Hieracium pilosella L.	+	1	1	1	1	.	2	+	1	.	2	2	.	.	2	1	1	+	+
Anthoxanthum odoratum L.	+	.	+	1	+	+	.	+	.	1	.	2	1	+	1	.	.	.	.
Lotus corniculatus L.	.	.	1	.	+	.	+	+	1	+	.	1	.	+	1	+	.	.	+
Cerastium arvense L. ssp. suffruticosum (L.) Ces.	.	.	.	1	+	.	.	1	.	+	1	1	.	.	1	+	.	+	+
Trifolium pratense L.	.	.	.	+	.	1	.	+	.	+	.	.	.	.	+	2	2	1	1
Thymus longicaulis Presl ssp. longicaulis	.	.	.	.	.	.	.	1	+	.	1	2	+	.	1	+	.	+	1
Armeria canescens (Host) Ebel	.	.	.	.	.	+	1	.	1	+	.	.	.	.	.	1	1	+	1
Avenula praetutiana (Parl.) Pign.	.	.	+	.	+	.	+	.	1	+	+	+	.	.	.	+	.	.	.
Polygala amarella Crantz	.	.	1	1	.	2	.	+	.	.	+	.	+	.	+	.	+	.	.
Thlaspi praecox Wulfen	+	+	.	1	.	+	.	.	+	+	+	+	.	.	.	.	.	.	.
Asperula cynanchica L.	.	.	.	.	+	.	+	+	.	.	.	.	+	+	.	+	.	+	.
Bromus erectus Hudson	.	.	.	.	+	.	+	.	1	.	+	.	.	.	1	.	.	+	2
Minuartia verna (L.) Hiern ssp. verna	.	.	+	.	+	.	.	.	+	.	+	.	+	.	.	+	+	.	.
Anthyllis vulneraria L.	.	+	.	.	.	.	.	.	+	.	+	.	+	.	.	.	.	+	+
Ajuga tenorei Presl	+	.	1	.	.	1	.	.	.	.	+	.	.	+	+	.	.	.	.
Hippocrepis comosa L.ssp. comosa	.	.	.	.	.	+	.	+	+	.	.	+	+	.	+	.	.	.	.
Rumex acetosella L.	.	.	+	.	.	.	+	.	.	+	+	.	.	.	+	.	+	.	.
Acinos alpinus (L.) Moench	.	.	.	.	.	1	.	.	.	.	.	+	.	.	+	.	.	+	+
Achillea setacea Waldst. & Kit. ssp. setacea	.	.	+	.	+	.	1	.	.	.	.	+	.	+	.	.	.	.	.
Cynoglossum magellense Ten.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	+	.	+	+
Dianthus deltoides L. ssp. deltoides	.	.	+	1	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.
Erigeron epiroticus (Vierh.) Halàcsy	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	.	+

Galium verum L.	1	.	1	.	+	.	.	.	.	.	.	.	+	.	+	.	.	.	.
Trifolium repens L.	.	1	.	.	+	.	+	.	.	.	.	.	.	.	+	.	.	.	.
Alchemilla colorata Buser	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	+	.	.
Carduus carlinifolius Lam.	.	.	.	.	1	.	.	.	.	.	.	1	+	.	.	1	.	.	.
Gentiana lutea L.	.	.	.	+	.	.	.	.	.	.	1	.	.	1	.	.	+	.	.
Rumex nebroides Compd.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	+	1
Verbascum longifolium Ten.	.	.	1	.	.	1	2	.	.	.	.	.	.	.	.	.	.	+	.
Galium lucidum All.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	+
Agrostis capillaris L.	.	.	.	+	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.
Arabis collina Ten.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	.	.	.	.	.
Brachypodium genuense (DC.) Roemer et Schultes	.	.	.	2	.	2	.	.	.	.	.	.	.	.	+	.	.	.	.
Dactylorhiza sambucina (L.) Soò	.	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Bunium bulbocastanum L.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Carex caryophyllea Latourr.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Carlina acaulis L. ssp. simplex (Waldst. et Kit.) Nyman	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.
Cruciata laevipes Opiz	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hieracium bifidum Kit. Ex Hornem.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum richeri Vill. ssp. Richeri	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Knautia purpurea (Vill.) Borbàs	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon hispidus L.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Luzula multiflora (Ehrh.) Lej.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.
Narcissus poeticus L.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Rhinanthus wettsteinii (Sterneck) Soo	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+

Tab. 21 - *Trifolio thalii-Festucetum microphyllae* Petriccione & Persia 1995

No. relevé	1	2	3	4	5
Altitude (m)	1785	1790	1794	1754	1764
Aspect	N	N	NW	W	NW
Slope (°)	-	-	-	10	5
Area (m²)	25	25	25	25	25
Cover (%)	90	90	90	95	95
Trifolio thalii-Festucetum microphyllae Petriccione & Persia 19					
Taraxacum apenninum	+	+	1	2	+
Bellis perennis L.	+	+	+	+	.
Festuca microphylla (St.-Yves ex Coste) Patzke	2	1	+	1	+
Trifolium thalii Vill.	.	+	1	+	+
Veronica serpyllifolia L.	+	+	+	.	2
Barbarea bracteosa Guss.	.	+	+	.	+
Sagina subulata (Swartz) Presl	.	.	+	.	.
Ranunculo pollinensis-Nardion strictae Bonin 1972					
Crocus vernus (L.) Hill	3	2	2	2	2
Plantago atrata Hoppe	+	+	+	1	1
Potentilla rigoana Th. Wolf	+	2	+	1	+
Ranunculus pollinensis (Terr.) Chiov.	+	.	2	1	3
Ajuga tenorei Presl	.	+	.	1	.
Luzula spicata (L.) DC.	.	.	.	.	+
Nardetalia strictae Oberdofer ex Preising 1949, *Nardetea strictae* Rivas-Goday ex Rivas-Goday & Rivas Martínez 1963					
Poa alpina L. ssp. alpina	1	2	2	+	1
Nardus stricta L.	2	3	3	.	1
Companions					
Scilla bifolia L.	2	2	1	2	1
Minuartia verna (L.) Hiern ssp. verna	+	+	+	.	1
Acinos alpinus (L.) Moench	+	.	+	+	.
Alchemilla colorata Buser	+	.	+	.	+
Cerastium arvense L. ssp. suffruticosum (L.) Ces.	.	+	.	+	+
Polygala amarella Crantz	.	+	+	1	.
Festuca rubra L.	.	+	.	.	+
Gentiana verna L. ssp.verna	.	+	.	1	.
Hieracium pilosella L.	1	.	.	+	.
Rumex acetosella L.	+	.	.	+	.
Trifolium repens L.	1	+	.	.	.
Viola eugeniae Parl. ssp. eugeniae	.	.	.	2	1

Fig. 29 - Scree vegetation.

Arenario bertolonii-Cystopteridetum alpinae Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999 (Tab. 28)

The vegetation characterised by *Cystopteris fragilis* (ex *Cystopteris alpina*) grows in small and humid cracks and crevices in the subalpine belt (Biondi, 1999).

Characteristic species of the order and class in which this vegetation can be classified are: *Polystichum lonchitis* and *Cystopteris fragilis*.

This association is also vicarious in the Central-Southern Appenines of the *Cystopteridetum montanae*, which is widespread in Central Europe.

Tab. 22 - *Koelerio splendentis-Brometum erecti* Biondi, Ballelli, Allegrezza, Frattaroli & Taffetani 1992

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12
Altitude (m)	1390	1400	1420	1440	1400	1420	1360	1600	1620	1480	1500	1400
Aspect	NW	SE	SE	S	NE	S	SE	S	S	SW	S	S
Slope (°)	25	20	20	30	25	20	20	5	20	15	10	15
Area (m²)	60	50	50	60	60	50	50	40	50	50	40	40
Cover (%)	70	65	60	70	60	70	60	65	80	70	60	65
Koelerio splendentis-Brometum erecti Biondi *et al*. 1992												
Valeriana tuberosa L.	1	+	+	1	.	1	1	1	+	+	.	1
Koeleria lobata (M. Bieb.) Roem. & Schult.	1	2	+	+	.	1	.	.	+	+	1	2
Globularia meridionalis (Podp.) Schwarz	2	1	.	3	1	.	.	.	3	1	2	1
Trifolium montanum (Ten.) Nyman ssp. rupestre	.	.	.	+	.	+	+	.	.	.	.	
Pedicularis comosa L. ssp. comosa	.	.	.	.	.	.	+	.	.	.	.	
Phleo ambigui-Bromion erecti Biondi & Blasi ex Biondi *et al*. 1995												
Helianthemum oelandicum (L.) Dum. Cours. ssp. incanum (Willk.) G. López	2	2	.	.	+	1	1	+	1	3	1	2
Teucrium montanum L.	+	1	2	1	.	+	.	1	+	.	.	+
Cytisus spinescens C. Presl	1	.	1	1	1	1	+	+	.	.	.	.
Brachypodium genuense (DC.) Roemer et Schultes	2	3	2	2	.	.	.	1	1	.	.	.
Dianthus sylvestris (Wulfen) Greuter et Burdet ssp.longicaulis	.	+	.	.	+	+	.	.	+	.	1	+
Galium lucidum All.	+	.	+	.	2	.	1	.	+	.	.	+
Polygala major Jacq.	1	+	.	+	.	1	.	.	+	+	.	.
Inula montana L.	.	+	.	.	.	+	+	+	.	+	.	.
Globularia bisnagarica L.	+	.	.	.	.	+	2	1	.	.	.	+
Cyanus triumfetti (All.) Dostál ex Á. & D. Löve	+	.	+	.	.	+	.	+	.	.	+	.
Armeria majellensis Boiss. ssp. majellensis	.	.	+	+	.	+	.	.	.	+	.	.
Potentilla rigoana T. Wolf	.	+	+	.	.	+	.	.	.	+	.	.
Festuca robustifolia Markgr.-Dannenb.	.	.	1	.	.	.	.	.	1	1	2	.
Cerastium tomentosum L.	.	.	.	.	.	+	+	.	1	.	.	+
Eryngium amethystinum L.	+	+	+	.	+	.	.	.	.	.	.	.
Festuca circummediterranea Patzke	.	.	.	.	.	+	2	2	.	.	.	1
Trinia dalechampii (Ten.) Janchen	.	.	+	.	.	.	.	1	.	.	+	.
Centaurea parlatoris (Fiori) Dostal ssp. nigra	.	.	.	.	.	.	+	.	+	+	.	.
Avenula praetutiana (Parl.) Pign.	.	.	.	.	.	+	.	.	.	.	+	1
Phleum hirsutum Honck. ssp. ambiguum (Ten.) Tzvelev	.	.	+	.	+	.	.	1	.	.	.	.
Draba aizoides L.	+	.	.	.	.	+	.	.	.	.	.	+
Crepis lacera Ten.	.	.	.	.	.	.	+	.	.	.	+	.
Thymus striatus Vahl	.	.	.	.	1	.	.	.	.	.	1	.
Pimpinella tragium Vill.	.	.	.	.	.	+	.	.	.	+	.	.
Erysimum pseudorhaeticum Polatschek	.	.	.	.	+	.	+	.	.	.	.	.
Allium tenuiflorum Ten.	.	.	.	+	.	.	+	.	.	.	.	.
Alyssum montanum L.	.	.	.	.	.	.	.	.	.	.	.	+
Allium sphaerocephalon L.	.	.	.	.	.	.	.	.	.	+	.	.
Orchis anthropophora (L.) All.	.	.	.	.	+	.	.	.	.	.	.	.
Asperula purpurea (L.) Ehrend. ssp. purpurea	.	.	.	.	.	.	+	.	.	.	.	.
Brometalia erecti Br.-Bl. 1936, *Festuco-Brometea* Br.-Bl. & Tüxen ex Klika & Hadac 1944												
Ranunculus gramineus L.	1	1	+	.	2	1	.	2	+	+	+	.
Sanguisorba minor Scop. ssp. minor	+	+	1	+	+	+	2	+	+	.	.	.
Anthyllis vulneraria L.	1	1	1	+	+	.	1	.	+	1	+	.
Hippocrepis comosa L.	+	.	+	+	+	.	+	.	+	+	+	+
Bromus erectus Hudson ssp. erectus	+	.	1	.	2	.	1	1	1	1	2	.
Seseli montanum L.	.	.	.	+	+	.	+	+	+	+	.	1
Viola eugeniae Parl. ssp. eugeniae	.	+	+	1	.	.	+	.	.	.	+	1
Carex caryophyllea Latourr.	+	.	.	.	.	.	.	.	1	2	1	1
Thymus longicaulis C. Presl ssp. longicaulis	.	1	+	1	.	.	+	.	+	.	.	.
Asperula aristata (Presl.) Nyman ssp. scabra	.	.	+	.	.	.	+	+	.	.	+	.
Poa bulbosa L.	.	.	.	.	.	+	.	+	.	.	+	1
Helianthemum nummularium (L.) Miller ssp. obscurum (Cel.) J. Hol.	1	.	.	.	.	2	.	.	.	1	+	.
Hieracium pilosella L.	.	.	.	.	.	.	2	+	.	.	+	+
Teucrium chamaedrys L. ssp. chamaedrys	+	.	.	.	.	.	+	.	+	.	.	.
Plantago holosteum Scop.	.	+	.	.	.	+	.	.	+	.	.	.
Gymnadenia conopsea (L.) R. Br.	.	.	.	.	.	.	.	.	1	+	+	.
Scabiosa columbaria L. ssp. columbaria	.	.	.	+	.	.	.	.	+	.	.	.
Linum bienne Miller	.	.	.	.	.	.	1	+	.	.	.	.
Coronilla minima L.	.	.	.	+	.	.	.	.	.	.	.	+
Polygala flavescens DC.	.	+	.	.	.	.	.	.	.	.	+	.
Helianthemum nummularium (L.) Miller ssp. nummularium	.	.	.	1	1	.	.	.	.	.	.	.
Cerastium arvense L. ssp. arvense	.	.	.	.	.	.	+	+	.	.	.	.
Carlina vulgaris L. ssp. vulgaris	.	.	.	.	.	.	.	.	1	1	.	.
Trifolium ochroleucum Huds.	.	.	.	.	.	.	.	1	.	.	.	.
Trifolium campestre Schreber	.	.	.	+	.	.	.	.	.	.	.	.
Linum catharticum L.	.	.	.	.	.	.	.	.	.	.	.	+
Plantago lanceolata L.	.	.	.	.	.	.	.	.	.	.	.	+
Briza media L. ssp. media	.	.	.	1	.	.	.	.	.	.	.	.
Orchis ustulata L.	.	.	.	.	.	.	.	.	.	.	+	.
Carlina acaulis L. caulescens (Lam.) Schübl. & G. Martens	.	.	.	.	.	+	.	.	.	.	.	.
Plantago argentea Chaix	.	.	.	.	.	.	.	.	.	.	.	+
Knautia purpurea (Vill.) Borbas	.	.	.	.	.	.	.	.	.	.	+	.

Companions												
Muscari botryoides (L.) Miller ssp. botryoides	1	.	1	2	+	+	1	.	2	1	.	.
Myosotis ambigens (Bèguinot) Grau	+	+	.	1	.	.	+	1	.	1	.	+
Orchis morio L.	.	.	+	1	1	1	.	1	+	.	.	.
Thlaspi praecox Wulfen	+	+	.	.	+	.	.	+	.	+	+	.
Saxifraga granulata L. ssp. granulata	.	+	.	.	+	+	.	+	.	+	.	.
Cerastium ligusticum Viv.	+	.	.	+	+	.	.	+	.	+	.	.
Biscutella laevigata L. ssp. laevigata	.	1	.	.	+	.	.	.	+	+	.	.
Anthyllis montana (Vukot) Pign. ssp. atropurpurea	.	.	.	.	.	+	.	.	+	.	+	+
Ranunculus pollinensis (Terr.) Chiov.	.	.	.	.	.	+	.	.	.	+	+	+
Acinos alpinus (L.) Moench ssp. alpinus	.	.	.	.	+	.	+	+	.	.	.	+
Taraxacum officinale Weber	+	.	.	.	.	.	.	.	+	+	.	+
Orchis tridentata Scop.	.	+	.	+	.	.	.	.	.	+	.	.
Petrorhagia saxifraga (L.) Link ssp. saxifraga	.	+	+	.	.	.	.	+	.	.	.	.
Sedum acre L.	.	.	.	+	+	.	.	.	.	+	.	.
Ranunculus millefoliatus Vahl	+	.	.	.	.	+	.	.	.	.	.	.
Gentiana utriculosa L.	.	.	+	.	.	.	+	.	.	.	.	.
Leontodon cichoraceus (Ten.) Sanguin.	.	+	.	.	+	.	.	.	.	.	.	.
Gentiana verna L.	.	.	.	.	.	.	.	.	.	.	+	+
Bunium bulbocastanum L.	.	.	+	.	.	.	.	+	.	.	.	.
Cerastium glomeratum Thuill.	.	+	.	.	.	.	.	.	.	.	.	+
Dactylorhiza sambucina (L.) Soó	.	.	.	.	.	.	+	.	.	1	.	.
Orchis provincialis Balb.	+	.	.	.	.	1	.	.	.	.	.	.

Tab. 23 - A*nthoxantho odorati-Brachypodietum genuensis* (Lucchese, Persia & Pignatti 1995) ex Attorre & Bruno 2003

No. relevé	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Altitude (m)	1370	1340	1370	1420	1490	1300	1580	1330	1550	1400	1380	1350	1400	1390	1470
Aspect	NE	SW	S	W	SE	SE	S	E	S	SW	SW	W	NE	-	SE
Slope (°)	20	20	15	25	15	5	20	25	25	15	15	5	15	0	5
Area (m²)	40	50	50	60	40	50	60	50	50	40	50	60	40	50	50
Cover (%)	100	100	100	100	100	100	80	100	100	100	95	100	100	100	100
*Anthoxantho odorati-Brachypodietum genuensis (*Lucchese, Persia & Pignatti 1995) Attorre & Bruno 2003															
Anthoxanthum odoratum L.	1	1	+	+	+	.	.	1	.	+	+	+	+	1	+
Brachypodium genuense (DC.) Roemer et Schultes	2	1	3	2	1	2	2	2	.	1	.	.	.	.	.
Polygala vulgaris L.	+	+	+	+	.	.	+	.	+	1	+	.	.	+	.
Cirsium acaule (L.) Scop. ssp. acaule	.	.	.	+	+	1	.	.	.	.	.	1	.	.	2
Phleo ambigui-Bromion erecti Biondi & Blasi ex Biondi *et al*. 1995															
Potentilla rigoana T. Wolf	2	2	+	1	2	1	1	1	2	1	+	+	+	+	1
Armeria majellensis Boiss. ssp. majellensis	+	+	+	+	.	+	.	+	1	+	+	+	.	+	.
Festuca circummediterranea Patzke	1	2	1	.	3	2	2	2	.	1	1	2	.	.	1
Carlina acanthifolia All.	.	+	.	+	1	2	.	1	1	+	1	+	+	.	1
Eryngium amethystinum L.	1	+	+	1	.	+	.	1	.	1	.	.	1	+	1
Carlina acaulis (Waldst. et Kit.) Nyman ssp. simplex	+	.	+	+	+	+	.	.	.	1	.	+	.	+	.
Koeleria lobata (M. Bieb.) Roem. & Schult.	.	1	+	.	.	.	+	1	+	+	.	1	+	.	.
Leontodon cichoraceus (Ten.) Sanguin.	+	+	.	+	.	+	.	.	.	.	.	1	+	+	+
Centaurea parlatoris (Fiori) Dostal ssp. nigra	.	.	+	.	+	.	.	.	.	+	+	.	+	.	.
Phleum hirsutum Honck. ambiguum (Ten.) Tzvelev	+	+	.	.	.	.	.	+	.	1	.	.	+	.	.
Leontodon crispus Vill. ssp. crispus	.	.	.	.	+	.	.	.	.	+	1	+	.	.	.
Cytisus spinescens C. Presl	+	.	.	1	.	.	.	.	.	.	.	.	+	.	.
Erysimum pseudorhaeticum Polatschek	.	.	.	.	.	+	.	+	.	+	.	.	.	.	.
Inula montana L.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.
Avenula praetutiana (Parl.) Pign.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.
Alyssum montanum L.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Arabis collina Ten.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.
Gentianella columnae (Ten.) Holub	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1
Hieracium piloselloides Vill. ssp. piloselloides	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.
Linum tenuifolium L.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Galium lucidum All.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Crepis lacera Ten.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thymus striatus Vahl	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
Pimpinella tragium Vill.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Brometalia erecti Br. Bl. 1936, *Festuco Brometea* Br. Bl. & Tüxen 1943 ex Klika & Hadac 1944															
Thymus longicaulis C. Presl ssp. longicaulis	1	1	1	1	.	.	+	1	1	1	+	+	+	+	1
Achillea collina Becker ex Reichenb.	+	1	2	+	+	1	1	.	2	+	.	.	.	+	+
Carex caryophyllea Latourr.	+	1	.	+	+	1	.	1	.	1	2	+	+	1	.
Hieracium pilosella L.	1	1	2	1	1	+	.	+	.	+	1	2	.	2	.
Galium verum L. ssp. verum	+	.	+	.	.	+	+	+	1	.	1	+	1	+	.
Ranunculus millefoliatus Vahl	+	1	1	+	.	.	+	.	.	.	+	.	.	1	1
Euphrasia stricta D. Wolff	+	+	+	.	+	+	.	+	.	.	.	+	.	+	.
Prunella laciniata (L.) L.	+	+	+	+	+	.	.	.	.	.	.	+	.	.	+
Rhinanthus minor L.	.	.	.	+	.	.	+	.	.	+	+	.	.	+	+
Asperula aristata (Presl.) Nyman ssp. scabra	.	+	.	.	.	+	+	1	+	.	.	.	.	.	.
Bromus erectus Hudson ssp.erectus	1	1	.	.	.	1	+	.	.	.	.	+	.	.	.
Campanula glomerata L. ssp. glomerata	+	.	+	+	+	.	.	.	.	.	1	.	.	.	.

Hippocrepis comosa L.	+	+	.	+	.	.	.	.	.	.	.	+	+	.	.
Sanguisorba minor Scop. ssp. minor	+	.	.	+	.	.	+	+	.	1	.	.	.	.	.
Plantago argentea Chaix	.	.	+	.	.	.	.	.	.	+	+	.	.	+	.
Linum catharticum L.	.	.	.	+	.	+	.	+	.	+	.	.	.	.	.
Gentiana cruciata L.	+	+	.	+	.	.	.	.	.	.	+	.	.	.	.
Ononis spinosa L. ssp. spinosa	.	.	.	.	.	+	.	1	.	+	.	1	.	.	.
Leucanthemum vulgare Lam.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+
Medicago lupulina L.	1	.	+	.	.	.	+	.	.	.	.	.	.	.	.
Trifolium campestre Schreber	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.
Centaurium erythraea Rafn ssp. erythraea	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.
Cerastium arvense L. ssp. arvense	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.
Gentiana lutea L. ssp. lutea	.	.	+	.	.	1	.	.	.	.	.	.	.	.	.
Prunella vulgaris L.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Scabiosa columbaria L. ssp. columbaria	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.
Filipendula vulgaris Moench	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.
Anthyllis vulneraria L.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Genista tinctoria L.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.
Primula veris L. ssp. suaveolens (Bert.) Gut. et Ehr.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Ranunculus gramineus L.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Trifolium ochroleucum Huds.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trinia dalechampii (Ten.) Janchen	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Molinio-Arrhenatheretea Tüxen 1937															
Lotus corniculatus L.	+	1	+	+	+	+	1	+	1	1	1	1	1	.	+
Veronica serpyllifolia L. ssp. serpyllifolia	+	+	+	+	1	.	.	.	+	+	.	+	1	+	+
Trifolium pratense L. ssp. pratense	+	.	1	+	.	+	1	1	1	.	.	.	+	+	+
Agrostis capillaris L.	.	.	+	+	+	1	1	1	.	.	.	1	1	+	.
Cynosurus cristatus L.	.	.	2	.	.	+	.	.	.	1	+	+	+	+	1
Plantago media L.	.	.	1	.	1	+	+	+	.	.	.	1	.	.	+
Bellis perennis L.	+	1	.	.	.	+	.	.	+	.	.	+	+	.	.
Taraxacum officinale Weber	.	.	.	.	+	.	.	.	+	+	+	+	.	.	+
Trifolium repens L. ssp. repens	.	+	1	.	.	1	1	+	1	.	.	.	.	.	.
Poa pratensis L.	.	.	.	.	.	+	.	+	.	.	.	.	+	.	.
Rumex acetosa L.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.
Leontodon hispidus L.	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.
Briza media L. ssp. media	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Narcissus poeticus L. ssp. poeticus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Companions															
Luzula campestris (L.) DC.	1	1	1	1	1	1	.	.	.	+	+	+	2	.	2
Viola eugeniae Parl. ssp.eugeniae	1	1	1	+	1	.	.	.	+	2	1	+	.	+	1
Dianthus deltoides L. ssp. deltoides	.	+	1	.	+	+	+	.	+	+	.	1	+	.	.
Gentiana utriculosa L.	+	.	+	1	1	.	.	.	.	+	1	+	1	+	.
Rumex acetosella L. ssp. acetosella	.	.	+	+	+	.	.	+	.	+	+	+	+	.	1
Knautia purpurea (Vill.) Borbas	+	+	.	+	.	1	+	.	.	.	+	.	.	+	+
Poa bulbosa L.	.	1	.	1	+	1	1	.	+	.	.	.	.	2	1
Asphodelus albus Miller ssp. albus	.	+	1	.	.	.	+	.	.	+	+	1	.	.	.
Cerastium ligusticum Viv.	+	.	+	.	.	.	+	+	+	+	.	.	.	.	.
Cirsium eriophorum (L.) Scop.	.	+	1	.	.	+	1	1	1	.	.	.	.	.	.
Plantago lanceolata L.	+	1	1	+	.	.	+	1	.	.	.	.	.	.	.
Potentilla detommasii Ten.	+	.	+	+	+	.	.	.	.	.	.	.	1	1	.
Colchicum lusitanum Brot.	.	.	.	.	1	+	.	+	.	.	.	.	.	1	1
Laphangium luteoalbum (L.) Tzvelev	.	.	.	+	.	+	+	.	.	.	.	+	.	.	+
Hypericum perforatum L.	.	.	.	.	+	.	.	.	.	+	+	+	.	.	+
Ranunculus pollinensis (Terr.) Chiov.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	1
Acinos arvensis (Lam.) Dandy s.l.	.	+	+	.	.	.	.	.	+	+	+	.	.	.	.
Aira caryophyllea L. ssp. caryophyllea	.	+	.	.	.	.	.	.	.	.	.	+	.	+	+
Festuca rubra L. commutata (Gaudin) Markgr.-Dann.	.	.	.	.	+	.	.	.	.	+	.	.	.	1	2
Minuartia verna (L.) Hiern ssp. verna	.	+	.	.	.	.	.	+	.	+	.	+	.	.	.
Ornithogalum umbellatum L.	+	.	.	+	.	.	+	.	.	+	.	.	.	.	.
Verbascum longifolium Ten.	.	+	.	.	.	.	1	.	1	.	.	.	+	.	.
Bunium bulbocastanum L.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.
Carduus nutans L. ssp. nutans	.	.	1	.	.	.	.	+	.	.	.	.	1	.	.
Cerastium glomeratum Thuill.	.	1	.	.	.	.	.	.	.	.	+	.	+	.	.
Cruciata laevipes Opiz	.	.	.	.	1	.	.	.	1	.	.	.	.	.	+
Saxifraga granulata L. ssp. granulata	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Scleranthus polycarpos L.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.
Arenaria serpyllifolia L.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.
Capsella rubella Reuter	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.
Erophila verna (L.) Chevall. ssp. verna	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.
Myosotis arvensis (L.) Hill	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.
Bistorta officinalis Delarbre	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.
Plantago major L. ssp. major	.	.	.	.	.	.	1	.	.	.	.	.	.	1	.
Ranunculus bulbosus L. ssp. bulbosus	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Acinos alpinus (L.) Moench	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.
Senecio scopolii Hoppe et Hornsch.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.
Stachys tymphaea Hausskn.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.

Tab. 24 - *Arrhenatherium elatius* community

No. relevé	1	2	3	4	5
Data	19/05/06	22/05/06	22/05/06	27/05/06	27/05/06
Latitude	359941	355739	358579	358370	359903
Longitude	4637592	4636574	4637379	4637238	4637597
Altitude (m)	893	728	750	740	900
Aspect	-	-	S	-	-
Slope (°)	-	-	3	-	-
Rock (%)	-	-	-	-	-
Stone (%)	-	-	-	-	-
Area (m^2)	9	8	10	10	15
Cover (%)	100	100	100	100	100
Arrhenatherion Br.-Bl. 1925					
Arrhenatherum elatius (L.) P. Beauv. ex J. & C. Presl	3,1	4,1	4,1	4,1	4,1
Galium mollugo L. ssp. erectum Syme	.	+	+	+	1,1
Tragopogon pratensis L.	+	+	+	+	
Knautia arvensis (L.) Coult.	.	+	1,1	3,1	1,1
Arrhenatheretalia R.Tx. 1931, *Arrhenatheretea* Tx. 1937					
Trifolium pratense L.	+	1,2	2,1	1,1	+
Leucanthemum vulgare Lam. ssp. vulgare	+	+	1,1	+	+
Rhinanthus minor L.	2,1	2,1	+	+	+
Potentilla reptans L.	+	+	+	+	+
Lotus corniculatus L.	+	+	+	+	+
Daucus carota L.	.	+	1,1	+	+
Trifolium repens L.	2,1	.	+	+	
Anthoxanthum odoratum L.	+	+	.	.	+
Dactylis glomerata L.	.	+	+	.	.
Lolium perenne L.	+	.	+	.	.
Plantago lanceolata L.	.	+	+	.	.
Trifolium resupinatum L.	+	+	.	.	.
Ranunculus velutinus Ten.	.	+	+	.	.
Galium verum L.	.	+	+	.	.
Holcus lanatus L.	.	+	.	.	.
Centaurea jacea L. ssp. angustifolia Gremli	.	.	.	+	.
Centaurea jacea L. ssp. gaudini (Boiss. & Reut.) Gremli	.	.	.	.	1,1
Festuca rubra L.	.	.	1,1	.	.
Companions					
Bellardiochloa variegata (Lam.) Kerguélen	+	+	+	+	+
Cerastium ligusticum Viv.	+	+	+	2,2	1,1
Melilotus sulcatus Desf.	2,1	+	1,1	+	+
Bromus squarrosus L.	.	+	+	+	1,1
Loncomelos narbonensis (Torn. in L.) Raf.	+	+	+	+	.
Muscari comosum (L.) Mill.	+	.	+	+	+
Sanguisorba minor Scop.	+	.	1,1	+	1,1
Trifolium campestre Schreb.	+	+	+	.	+
Vicia sativa L. ssp.nigra (L.) Ehrh.	+	+	+	.	+
Potentilla recta L.	.	.	+	1,1	+
Agrimonia eupatoria L.	.	.	+	+	+
Myosotis arvensis (L.) Hill ssp.arvensis	+	.	+	+	.
Trifolium incarnatum L.	3,2	.	.	+	+
Valerianella eriocarpa Desv.	+	+	.	.	+
Bromus hordeaceus L.	1,1	.	.	+	.
Bromus sterilis L.	.	.	.	+	+
Convolvulus arvensis L.	.	.	.	+	+
Draba muralis L.	.	.	.	+	+
Medicago sativa L.	.	.	+	+	.
Petrorhagia prolifera (L.) P.W. Ball & Heywood	+	.	+	.	.
Polygala flavescens DC.	+	.	.	.	+
Ranunculus bulbosus L.	+	.	.	.	+
Sherardia arvensis L.	+	+	.	.	.
Trifolium bocconei Savi	1,1	.	.	.	+
Vulpia myuros (L.) C.C. Gmel.	+	+	.	.	.
Festuca arundinacea Schreb.	.	1,1	.	.	.
Mentha longifolia (L.) Huds	.	.	.	.	2,1
Myosotis ramosissima Rochel ex Schult. ssp.ramosissima	.	.	.	.	1,1

Tab. 25 - *Colchico lusitanici-Cynosuretum cristati* Biondi & Ballelli 1995

No. relevé	1	2	3	4
Data	23/05/06	23/05/06	28/05/06	06/06/06
Latitude	355778	355796	355791	357613
Longitude	4636567	4636576	4636676	4637116
Altitude (m)	736	735	743	744
Aspect	SW	SSW	SW	-
Slope (°)	5	3	5	-
Rock (%)	-	-	-	-
Stone (%)	-	-	-	-
Area (m^2)	9	8	8	10
Cover (%)	100	100	100	100
Colchico-Cynosuretum Biondi & Ballelli 1995 - *Cynosurion cristati* R.Tx. 1947				
Cynosurus erfogliat L.	2,1	1,1	1,1	2,1
Trifolium repens L.	+	+	+	+
Colchicum lusitanum Brot.	.	+	+	+
Lolium perenne L.	+	.	.	1,2
Tragopogon pratensis L.	+	.	+	.
Achillea collina Becker	.	1,1	.	+
Arrhenatherion Br.-Bl. 1925, *Arrhenatheretalia* Pawl. 1928, *Molinio-Arrhenatheretea* Tx. 1937				
Trifolium pratense L.	1,2	1,2	2,2	+
Rhinanthus minor L.	+	+	1,2	+
Anthoxanthum odoratum L.	+	.	+	2,1
Festuca rubra L.	2,1	1,1	+	.
Dactylis glomerata L.	+	+	+	.
Ranunculus velutinus Ten.	1,2	+	.	3,1
Lotus corniculatus L.	.	.	1,1	1,1
Festuca arundinacea Schreb.	.	1,1	1,1	.
Plantago lanceolata L.	+	+	.	.
Leucanthemum vulgare Lam. ssp. vulgare	.	.	+	+
Galium verum L.	.	+	+	.
Bromus hordeaceus L.	+	.	.	.
Companion				
Daucus carota L.	+	+	+	+
Holcus lanatus L.	+	+	+	2,2
Anacamptis pyramidalis (L.) Rich.	+	+	+	.
Brachypodium rupestre (Host) Roem. & Schult.	+	3,2	3,2	.
Carex distans L.	2,1	1,1	+	.
Trifolium resupinatum L.	+	.	+	+
Agrimonia eupatoria L.	.	+	+	.
Bellardiochloa variegata (Lam.) Kerguélen	+	.	.	+
Bromus squarrosus L.	.	.	+	+
Carex flacca Schreb.ssp. flacca	+	+	.	.
Centaurea jacea L. ssp. angustifolia Gremli	.	+	+	.
Dorycnium herbaceum Vill.	.	+	2,3	.
Linum bienne Mill.	+	.	+	.
Lotus tenuis Waldst. & Kit. Ex Willd.	2,1	1,2	.	.
Melilotus sulcatus Desf.	.	+	+	.
Ononis spinosa L.	.	+	+	.
Trifolium campestre Schreb.	+	.	+	.
Alopecurus rendlei Eig	.	.	.	3,3
Blackstonia erfogliata (L.) Huds.	.	.	+	.
Carex divulsa Stokes	.	.	.	+
Cerastium ligusticum Viv.	.	.	+	.
Cnidium silaifolium (Jacq.) Simonk. Ssp. Silaifolium	.	+	.	.
Hordeum bulbosum L.	.	.	.	+
Lathyrus cicera L.	.	+	.	.
Leontodon rosani (Ten.) DC.	.	+	.	.
Linum catharticum L.	.	.	+	.
Medicago polymorpha L.	.	.	+	.
Ophrys apifera Huds.	.	+	.	.
Polygala flavescens DC.	.	.	+	.
Trifolium bocconei Savi	.	.	.	+
Trifolium ochroleucum Huds.	.	.	+	.
Valerianella eriocarpa Desv.	.	.	+	.
Verbena officinalis L.	+	.	.	.

Tab. 26 - *Trifolio scabri-Hypochoeridetum achyrophori* Lapraz ex Biondi, Izco Ballelli & Formica 1997

No. relevé	1	2	3	4	5	6	7	8	9
Data	20/05/06	20/05/06	20/05/06	22/05/06	22/05/06	23/05/06	23/05/06	23/05/06	23/05/06
Latitude	343298	343701	353297	358174	358194	352709	343811	343829	344248
Longitude	5E+06	5E+06	5E+06	5E+06	5E+06	5E+06	5E+06	5E+06	5E+06
Altitude (m)	545	669	730	815	800	671	684	700	900
Aspect	-	SSW	S	SSW	E	S	-	-	SW
Slope (°)	-	3	15	10	5	3	-	-	30
Rock (%)	50	-	-	-	-	-	-	-	5
Stone (%)	20	90	3	90	75	90	70	60	80
Area (m²)	2	5	6	7	7	7	8	10	10
Cover (%)	50	50	95	90	90	95	90	100	70
Trifolio scabri-Hypochoeridetum achyrophori Lapraz ex Biondi, Izco, Ballelli & Formica 1997									
Trifolium scabrum L. ssp.scabrum	1,2	+	2,2	+	1,1	1,1	2,1	2,1	+
Linum strictum L.	+	+	+	+	+	+	+	.	.
Coronilla scorpioides (L.) W.D.J. Koch	+	+	.	.	.	+	.	.	+
Melilotus sulcatus Desf.	.	+	1,1	+	.	+	.	.	.
Hypochoeris achyrophorus L.	+	+	+	+	+	+	+	+	+
	.	.	.	.	.	.	.	.	.
Trachynion distachyae Rivas-Martínez 1978									
Bupleurum baldense Turra	+	+	+	+	.	+	.	+	+
Cynosurus echinatus L.	+	+	.	.	.	+	1,1	1,1	.
Trigonella gladiata M. Bieb.	.	.	.	+	.	.	.	.	.
Trachynetalia distachyae Rivas-Martínez 1978, *Helianthemetea guttati* Br.-Bl. 1940									
Catapodium rigidum (L.) C.E. Hubb. ex Dony	+	.	+	+	+	+	1,1	+	+
Medicago minima (L.) L.	.	1,1	1,1	+	1,1	2,2	2,2	3,1	+
Arenaria leptoclados (Rchb.) Guss.	+	+	+	+	+	+	+	+	.
Convolvulus cantabrica L.	1,1	+	1,1	2,1	+	+	1,1	+	.
Trachynia distachya (L.) Link	+	+	+	1,1	3,1	1,1	.	+	+
Triticum ovatum (L.) Raspail	.	.	1,1	2,2	1,1	3,2	+	+	.
Trifolium stellatum L.	.	+	+	.	.	+	+	1,1	+
Urospermum dalechampii (L.) F.W. Schmidt	.	+	+	+	.	+	.	.	+
Sideritis romana L. ssp.romana	.	+	+	.	.	+	+	.	.
Reichardia picroides (L.) Roth	.	.	.	.	.	+	+	.	.
Micromeria graeca (L.) Benth. ex Rchb. ssp.tenuifolia (Ten.) Nyman	2,3	.	.	.	.	.	.	.	+
Scorpiurus muricatus L.	.	.	+	+	.	.	.	.	.
Carthamus lanatus L.	.	.	.	.	.	+	.	.	.
Hippocrepis biflora Spreng.	.	.	+	.	.	.	.	.	.
Alyssum alyssoides (L.) L.	.	+	.	.	.	.	.	.	.
Medicago rigidula (L.) All.	.	.	.	.	.	.	.	+	.
Calamintha nepeta (L.) Savi	.	.	+	.	.	.	.	.	.
Brometalia erecti Br.-Bl. 1936, *Festuco-Brometea* Br.-Bl. et Tx. 43									
Petrorhagia saxifraga (L.) Link	.	+	+	+	+	+	+	+	
Trifolium campestre Schreb.	.	+	+	+	.	+	1,1	+	
Sanguisorba minor Scop.	+	+	.	+	+	.	+	.	+
Teucrium chamaedrys L.	+	1,1	.	2,1	+	+	.	.	+
Leontodon rosani (Ten.) DC.	.	.	+	.	2,1	.	+	.	
Inula montana L.	+	1,1	.	.	.	.	.	.	+
Fumana procumbens (Dunal) Gren. & Godr.	.	.	.	1,1	+	.	.	.	2,1
Helianthemum nummularium (L.) Mill. ssp.obscurum (Celak.) Holub	.	.	.	+	+	.	.	.	
Prunella laciniata (L.) L.	.	.	.	+	+	.	.	.	
Carex caryophyllea Latourr.	.	+	.	.	.	.	.	.	+
Bromus erectus Huds.	.	.	.	.	.	.	.	.	+
Scabiosa columbaria L.	.	+	.	.	.	.	.	.	
Eryngium amethystinum L.	.	+	.	.	.	.	.	.	
Hieracium pilosella L.	.	2,1	.	.	.	.	.	.	
Silene otites (L.) Wibel	.	.	.	.	.	.	+	.	
Poa bulbosa L.	.	.	+	.	.	.	.	.	
Ononis diffusa Ten.	.	+	.	.	.	.	.	.	
Brachypodium rupestre (Host) Roem. & Schult.	.	.	.	.	.	.	.	.	+
Crupina vulgaris Cass.	.	.	.	.	.	+	.	.	
Dianthus sylvestris Wulfen	.	+	.	.	.	.	.	.	
Companion									
Crepis neglecta L.	.	+	+	.	+	+	+	+	.
Alyssum montanum L.	.	.	+	+	+	+	+	.	.
Dactylis glomerata L.	.	.	.	+	.	+	+	1,1	+
Galium corrudifolium Vill.	+	.	+	+	+	+	.	.	.
Eryngium campestre L.	.	.	+	+	+	+	.	.	.
Phleum hirsutum Honck. ssp. ambiguum (Ten.) Tzvelev	.	.	.	.	+	+	+	+	.
Sedum sexangulare L.	.	+	+	.	+	+	.	.	.
Sherardia arvensis L.	.	.	+	+	+	.	.	+	.
Aethionema saxatile (L.) R. Br.	+	+	.	.	.	.	.	.	+
Helianthemum oelandicum (L.) Dum. Cours. ssp. incanum (Willk.) G. López	+	+	.	.	.	.	.	.	+
Hypericum perforatum L.	.	.	.	+	.	.	+	.	+
Medicago orbicularis (L.) Bartal.	.	.	+	.	.	.	+	1,1	.
Plantago lanceolata L.	.	.	+	+	.	+	.	.	.

Satureja montana L.	.	1,1	+	.	.	.	+	.	.
Seseli montanum L. ssp.montanum	.	+	.	.	.	.	+	.	+
Thymus striatus Vahl	.	+	.	2,1	.	.	.	.	2,1
Carlina corymbosa L.	.	.	+	.	.	+	.	.	.
Centaurea solstitialis L. ssp. solstitialis	.	.	.	.	.	.	1,1	+	.
Coronilla minima L.	.	.	.	+	+	.	.	.	.
Euphorbia exigua L. ssp. exigua	.	.	+	.	+	.	.	.	.
Euphorbia falcata L. ssp. falcata	+	.	.	+	.	.	.	.	.
Filago vulgaris Lam.	.	.	.	.	.	.	+	2,1	.
Galium lucidum All.	.	+	.	.	.	.	.	.	+
Globularia bisnagarica L.	.	.	.	.	.	+	.	.	+
Hippocrepis comosa L. ssp. comosa	2,2	.	.	.	.	.	.	.	+
Lotus corniculatus L.	.	.	.	+	1,1	.	.	.	.
Ajuga chamaepitys (L.) Schreb.	+	.	.	.	.	.	.	.	.
Allium roseum L.	.	.	.	.	.	+	.	.	.
Arabis collina Ten.	.	+	.	.	.	.	.	.	.
Arabis hirsuta (L.) Scop.	.	+	.	.	.	.	.	.	.
Bromus squarrosus L.	.	.	.	.	.	+	.	.	.
Carduus pycnocephalus L. ssp.pycnocephalus	.	.	.	.	.	+	.	.	.
Carex flacca Schreb.ssp. flacca	.	.	.	+	.	.	.	.	.
Carlina vulgaris L.	.	+	.	.	.	.	.	.	.
Centaurea ambigua Guss. ssp.ambigua	.	.	.	.	.	.	+	.	.
Centaurea deusta Ten.	.	.	.	.	.	.	+	.	.
Centaurium erythraea Rafn	.	.	.	.	.	.	.	.	+
Cerastium ligusticum Viv.	.	.	.	.	.	.	+	.	.
Cuscuta epithymum (L.) L.	.	+	.	.	.	.	.	.	.
Cytisus spinescens C. Presl	.	.	.	.	.	.	.	.	1,1
Erysimum pseudorhaeticum Polatschek	.	.	.	.	.	.	+	.	.
Euphorbia helioscopia L. ssp. helioscopia	.	.	.	.	.	.	.	+	.
Euphorbia myrsinites L. ssp. myrsinites	+	.	.	.	.	.	.	.	.
Festuca robustifolia Markgr.-Dann.	.	.	.	.	.	.	.	.	1,1
Parentucellia viscosa (L.) Caruel	1,1	.	.	.	.	.	.	.	.

Tab. 27 - *Saxifrago australis-Trisetetum bertolonii* Biondi & Ballelli 1982

No. relevé	1	2	3
Altitude (m)	1850	1730	1810
Aspect	SW	S	W
Area (m^2)	15	10	8
Cover (%)	50	60	60
Rockiness (%)	20	25	20
Saxifrago australis-Trisetetum bertolonii Biondi & Ballelli 1982,			
Saxifraga callosa Sm. ssp. callosa	3	2	3
Campanula tanfanii Podlech	1	+	+
Saxifraga porophylla Bertol. ssp. porophylla	.	1	1
Potentilla apennina Ten. ssp. apennina	1	1	+
Potentilletalia caulescentis Br.-Bl. in Br.-Bl. & Jenny 1926, *Asplenietea*			
Rhamnus pumila Turra	1	2	+
Silene pusilla Waldst. & Kit. ssp. pusilla	1	+	.
Sedum dasyphyllum L.	.	+	1
Primula auricula L. ciliata (Moretti) Lüdi	+	.	+
Saxifraga paniculata Mill.	.	1	+
Asplenium ruta-muraria L. ssp. ruta-muraria	1	.	2
Ceterach officinarum Willd.	+	2	.
Cystopteris fragilis (L.) Berhn.	.	1	+
Potentilla caulescens L.	.	+	.
Asplenium trichomanes L.	+	.	+
Companion			
Edraianthus graminifolius (L.) A. DC.	1	+	1
Sesleria juncifolia Suffren ssp. juncifolia	.	2	.
Lomelosia graminifolia (L.) Greuter & Burdet ssp. graminifolia	+	+	+

Fig. 30 - *Colchico lusitanici-Cynosuretum cristati*.

Tab. 28 - *Arenario bertolonii-Cystopteridetum alpinae* Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999

No. relevé	1	2
Altitude (m)	1950	1870
Aspect	E	SE
Rock (%)	-	-
Stone (%)	-	-
Area (m^2)	1	2,5
Cover (%)	90	80
Arenario bertolonii-Cystopteridetum alpinae Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999		
Cystopteris fragilis (L.) Bernh.	4	3
Arenaria bertolonii Fiori	1	1
Petasition paradoxi Berger 1922, *Polystichetalia lonchitis* Rivas Martínez, T.E. Diaz, F.Prieto, Loidi & Penas 1984, T*hlaspietea rotundifolii* Br.-Bl. in Br.-Bl. & Jenny 1926		
Valeriana montana L.	1	+
Polystichum lonchitis (L.) Roth	1	1
Festuca dimorpha Guss.	1	+
Adenostyles australis (Ten.) Nyman	+	+
Campanula cochlearifolia Lam	+	.
Companion		
Campanula scheuchzeri Vill.	1	+
Asplenium trichomanes L.	+	.
Arabis alpina L. ssp. caucasica (Willd.) Briq.	.	+
Sedum magellense Ten.	+	.
Asplenium viride Hudson	+	.
Asplenium ruta-muraria L. ssp. ruta-muraria	.	1

Fig. 31 - *Saxifrago australis-Trisetetum bertolonii*.

Sintaxonomical scheme

QUERCO-FAGETEA Br. Bl. &Vlieg 1937 em. Oberd. 1992
+Fagetalia sylvaticae Pawloski in Pawloski, Sokolowschi & Wallisch 1928
*Fagion sylvaticae Luquet 1926
**Geranio nodosi-Fagenion sylvaticae Gentile1974
Cardamino kitaibelii-Fagetum sylvaticae Ubaldi et al. ex Ubaldi 1995
*Erythronio dentis-canis-Carpinion betuli (Horvat 1958) Marincek in Wallnofer, Mucina & Grass 1993
**Pulmonario apenninae-Carpinenion betuli Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002
Carpino betuli-Coryletum avellanae Ballelli, Biondi & Pedrotti1980
*Tilio-Acerion Klika 1955
Aceretum obtusati-pseudoplatani Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002
+Quercetalia pubescenti-petraeae Klika 1933 corr. Moravec in Béguin & Theurillat 1984
*Carpinion orientalis Horvat 1958
**Laburno anagyroidis-Ostryenion carpinifoliae (Ubaldi 1995) Blasi, Di Pietro & Filesi 2004
Melittio melissophyllae-Ostryetum carpinifoliae Avena, Blasi, Scoppola & Veri 1980
Aceri obtusati-Quercetum cerridis Ubaldi & Speranza 1982
*Cytiso sessilifolii-Quercenion pubescentis Ubaldi 1995
Cytiso sessilifolii-Quercetum pubescentis Blasi, Feoli & Avena 1982

QUERCETEA ILICIS Br.-Bl. ex A. & O.Bolòs 1950
+Quercetalia ilicis Br.-Bl.ex Molinier 1934
*Fraxino orni-Quercion ilicis Biondi, Casavecchia & Gigante 2003
Cyclamino hederifolii-Quercetum ilicis Biondi, Casavecchia & Gigante 2003

NARDETEA STRICTAE Rivas-Goday ex Rivas-Martínez 1963
+Nardetalia strictae Oberdorfer ex Preising 1949
*Ranunculo pollinensis-Nardion strictae Bonin 1972
Trifolio thalii-Festucetum microphyllae Petriccione & Persia 1995
Luzulo italicae-Nardetum strictae Biondi, Ballelli, Allegrezza, Frattaroli & Taffetani 1992

ASPLENIETEA TRICHOMANIS Oberd.1977
+Potentilletalia caulescentis Br.-Bl. in Br.-Bl. & Jenny 1926
*Saxifragion australis Biondi & Ballelli ex Brullo 1983
Saxifrago australis-Trisetetum bertolonii Biondi & Ballelli 1982

THLASPIETEA ROTUNDIFOLII Br.-Bl. 1948
+Thlaspietalia rotundifolii Br.-Bl. in Br.-Bl. & Jenny 1926
*Festucion dimorphae Bonin 1969
Galio magellensis - Festucetum dimorphae Feoli-Chiapella 1983
Drypido-Festucetum dimorphae Bonin 1978
+Polystichetalia lonchitis Rivas Martínez, T.E. Diaz, F.Prieto, Loidi & Penas 1984
*Petasition paradoxi Berger 1922
Arenario bertolonii-Cystopteridetum alpinae Biondi, Ballelli, Allegrezza, Taffetani, Frattaroli, Guitian & Zuccarello 1999

ELYNO MYOSUROIDIS- SESLERIETEA COERULEAE Br.-Bl. 1948
+Seslerietalia tenuifoliae Horvat. 1930
*Seslerion apenninae Bruno & Furnari 1969
Pediculari elegantis- Seslerietum tenuifoliae (Furrer & Furnari 1960) Petriccione & Persia 1995

FESTUCO-BROMETEA Br.-Bl. & Tx. 1943 ex Klika & Hadac 1944
+Brometalia erecti Br.- Bl. 1936
*Phleo ambigui-Bromion erecti Biondi & Blasi 1982 ex Biondi, Ballelli, Allegrezza & Zuccarello 1995
Anthoxantho odorati-Brachypodietum genuensis (Lucchese, Persia & Pignatti 1995) ex Attorre & Bruno 2003

Koelerio splendentis-Brometum erecti Biondi, Balzelli, Allegrezza, Frattaroli & Taffetani 1992

ROSMARINETEA OFFICINALIS Rivas Martínez, Diaz, Prieto, Loidi & Penas 1991
+Rosmarinetalia officinalis Br.-Bl.ex Molinier 1934
*Artemisio albae-Saturejion montanae Allegrezza, Biondi, Formica & Ballelli 1997
Saturejo montanae-Brometum erecti Avena & Blasi 1979

HELIANTHEMETEA GUTTATI Br.-Bl. 1940
+Trachynetalia distachyae Rivas-Martínez 1978
*Hypochoerion achyrophori Biondi & Guerra 2008
Trifolio scabri-Hypochoeridetum achyrophori Lapraz ex Biondi, Ballelli, Izco & Formica 1997

MOLINIO-ARRHENATHERETEA Tx. 1937
+Arrhenatheretalia R.Tx. 1931
*Arrhenatherion Br.-Bl. 1925
Popolamento a *Arrhenaterium elatius*
*Cynosurion cristati R.Tx. 1947
Colchico lusitanici-Cynosuretum cristati Biondi & Ballelli 1995

PINO-JUNIPERETEA Rivas-Martínez 1964
+Pino-Juniperetalia Rivas-Martínez 1964
*Daphno oleoidis- Juniperion alpinae Stanisci 1990
Daphno oleoidis- Juniperetum alpinae Blasi, Gigli, Abbate, Stanisci 1989 em. Blasi, Gigli & Stanisci 1990

RHAMNO-PRUNETEA SPINOSAE Rivas Goday & Borja Carbonell 1961 ex Tx. 1962
+Prunetalia spinosae Tx. 1952
*Berberidion vulgaris Br.Bl. ex Tx. 1952
**Berberidenion vulgaris Géhu, De Foucault & Delelis-Dusollier 1983
?Roso pendulinae-Genistetum radiatae Fortini, Blasi & Di Pietro 1999
Ribeso uvae-crispae-Rosetum dumalis Attorre & Bruno 2003
**Ribeso-Juniperenion communis Cutini, Stanisci, Pirone 2002
Viburno lantanae-Juniperetum communis Cutini, Stanisci, Pirone 2002
*Cytision sessilifolii Biondi in Biondi, Allegrezza & Guitian 1988
Spartio juncei-Cytisetum sessilifolii Biondi, Allegrezza & Guitian 1988
*Pruno-Rubion ulmifolii O. de Bolos 1954
**Pruno-Rubenion ulmifolii O. Bòlos 1954
Roso sempervirenti -Rubetum ulmifolii Blasi, Di Pietro & Fortini 2000

GALIO-URTICETEA Passarge ex Kopecky 1969
Incerta sedis
Popolamento a *Salvia glutinosa* e *Aegopodium podagraria*

ARTEMISIETEA VULGARIS Lohm. Preising & R. Tx ex Rochow 1951
+Onopordetalia acanthii Br.Bl. & R. Tx ex Klika & Hadac 1944
*Arction lappae R. Tx. 1937
Urtico dioicae-Sambucetum ebuli Br.-Bl. in Br. Bl., Roussine & Nègre 1952

Other syntaxa quoted in the text

Festucetum dimorphae Barbero 1968; *Festucetum laxae* (Aichinger, 1933) Wraber; *Festucion macratherae* Avena & Bruno 1975 corr. Petriccione & Persia 1995; *Taraxaco apennini-Trifolietum thalii* Biondi, Ballelli, Allegrezza, Frattaroli & Taffetani 1992; *Cystopteridetum montanae* (Hoepflinger, 1957) Richard 1972; *Corylo avellanae-Rosetum vosagiacae* Oberdofer 1957; *Corylo-Populion tremulae* (Br.-Bl. ex O. Bolos 1973) Riva-Martinez & Costa 1998; *Urtico-Aegopodietum* Oberdofer 1964 in Gors 1968 *Cystopteridetum montanae* (Hoepflinger, 1957) Richard 1972; *Trifolio-Geranietea Muller* 1962

Synphytosociological analysis

For a comprehensive analysis of the landscape, a dynamic-integrated synphytosociological procedure was used, because it allows a more effective interpretation of the relative importance of ecological factors determining the heterogeneity of landscape mosaic. The analysis of vegetation, using the phytosociological and synphytosociological approach (Géhu & Rivas-Martínez, 1981; Theurillat, 1992; Biondi, 1994; 1996), allowed the identification of the vegetation communities, previously identified by Blasi *et al.* (1998) only for the North sector of the massif, and, through the interpretation of their dynamic relationship, of the vegetation series characterising the landscape.

The vegetation series identified in the study area are listed below. They were named according to the associations that potentially represent the more mature vegetation stage in the area. Nomenclature follows Blasi *et al.* (2010).

Cytiso sessilifolii-Querco pubescentis sigmetum
Neutro-basophilous Central Apennine series of downy oak.

The vegetation series developed on small areas, characterized by medium slope, low altitude and plenty of surface debris.

The woodland seems to represent the more mature vegetation community of the series. Dinamically linked to it is a shrubland forest edge classified into the *Spartio juncei-Cytisetum sessilifolii* association of the *Cytision sessilifolii* alliance, the more widespread shrubland alliance in the North-West Apennines. The herbaceous communities that replace the forest are the chamaephitic grasslands of *Artemisio albae-Saturejion montanae* alliance, and, where the soil is thinner, therophytic formations of the *Trifolio scabri-Hypochoeridetum achyrophori* can be found

The *Cytiso sessilifolii-Quercetum pubescentis* is replaced by turkey oak woodlands (*Aceri obtusati-Quercetum cerridis*) on lower slopes and deeper soils. It is not possible to exclude that this last type of woodland represents the real terminal stage of the series, replaced by downy oak woods due to anthropogenic disturbances.

Ciclamino hederifolii-Querco ilicis sigmetum
Neutro-basophilous peninsular series of holm oak.

The *Ciclamino hederifolii-Quercetum ilicis* association represents the more mature vegetation of the calcareous, edapho-xerophilous series of Holm oak. It develops on limestone substratum with outcropping rocks, on very steep slopes and generally south-western exposures, where it receives hot and humid winds from the Tyrrhenian coast.

The shrubland communities of the series belong to the *Cytision sessilifolii* alliance, while the grasslands, which develop on stony slopes, are garrigues of the *Saturejo montanae-Brometum erecti* or therophytic communities belonging to the *Trifolio scabri-Hypochoeridetum achyrophori*. However, it has been also hypothesised that the Holm oak forest is not the final step of a distinctive vegetation series, but the result of the overexploitation of wood resources that, in turn, has caused an aridification proces. In fact, this process could have favoured the holm oak with respect to the hornbeam, which should represent the real final step of the vegetation series (the other elements of the series coincide).

Melittio melissophylli-Ostryo carpinifoliae sigmetum
Neutro-basophilous Central Appennine thyrrhenian series of Hop hornbeam.

The Hop hornbeam (*Ostrya carpinifolia*) series developes on limestone substratum in the sub-mountain areas. Sometime it can be substituted by *Quercus cerris* woodland on gentler slopes and deeper soils, or by *Quercus pubescens* in more xeric conditions, on thin soils and southern exposures. The more mature vegetation is a woodland dominated by *Ostrya carpinifolia*, accompanied by other tree species such as *Fraxinus ornus*, *Acer opalus* ssp. *obtusatum* and *Quercus pubescens*. In the herbaceous layer of the woodlands, exposed to S-SW, we can find species of *Prunetalia spinosae,* which highlight a dynamic link with two pre-forest stage associations: *Spartio juncei-Cytisetum sessilifolii* (*Cytision sessilifolii*) and *Roso sempervirenti-Rubetum ulmifolii* (*Pruno-Rubion ulmifolii*) where edaphic humidity is higher. Grasslands of this vegetation series are chamaephytic and xerophytic garrigues of *Saturejo montanae-Brometum erecti*, probably originated from a deforestation process (Blasi *et al*., 1998).

Carpino betuli-Corylo avellanae sigmetum
Peninsular hygrophilous series of European hornbeam.

The more mature vegetation of the series is the hornbeam and core woodlands (*Carpino betuli-Coryletum avellanae*). It develops on the bottom of cold and narrow valleys, characterised by mesic conditions and deep and humid soils.

A woodland with *Quercus cerris* and *Acer opalus* ssp. *obtusatum* (*Aceri obtusati-Quercetum cerridis*) is spatially in contact with the European hornbeam woody vegetation.

The more frequent forest edge vegetation of the series is a community dominated by *Salvia glutinosa* and *Aegopodium podagraria*.

Cardamino kitaibelii-Fago sylvaticae sigmetum

NEUTRO-BASOPHILOUS CENTRAL APPENNINE SERIES OF BEECH.

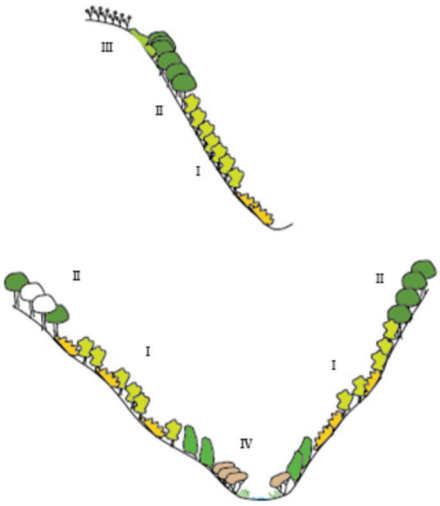
The final stage of this neutro-basophilous series of the central Apennines is the beech wood (*Cardamino kitaibelii-Fagetum sylvaticae*). It is a microtherm forest community, generally with a monospecific tree layer and poor shrubland and herbaceous layers, located between 1200 and 1800 m.

In the study area, all the dynamic stages of the succession are represented (Fig. 32): the pre-forest shrubland communities of *Ribeso uvae-crispae-Rosetum dumalis* and *Viburno lantanae-Juniperetum communis*, and secondary grasslands of *Phleo ambigui-Bromion erecti* (*Anthoxantho odorati -Brachypodietum genuensis* and *Koelerio splendentis-Brometum erecti*). Also the meadows of *Molinio-Arrhenatheretea* seem to be part of the series. In fact, they are located at the same altitude of Hop hornbeam woodlands, but at the bottom of cold and narrow valleys, where the beech can be found at a lower altitude.

DAPHNO OLEOIDIS-JUNIPERION NANAE SIGMETUM
SOUTHERN-CENTRAL APENNINE NEUTRAL-BASYPHILOUS SHRUBLAND SERIES OF ALPINE JUNIPER.

This vegetation series is located in the sub-alpine belt of the Simbruini mountains, above the tree line. The more mature vegetation is represented by the community with *Juniperus communis* ssp. *alpina* and *Arctostaphylos uva-ursi*, which seems dynamically linked to the grasslands here identified: the *Luzulo italicae-Nardetum strictae* and the *Trifolio thalii-Festucetum microphyllae* associations on deep, acidic soil and where snow persists for a longer period; and the *Pediculari elegantis-Seslerietum tenuifoliae* association growing on poorly developed and dry soils of ridges and unstable, stony slopes. This community could probably evolve into the juniper shrubland if the grazing pressure continues to decrease.

Fig. 32 - Neutro-basophilous Central Apennine series of beech - *Cardamino kitaibelii-Fago sylvaticae sigmetum*.



I – Melittio melissophylli -Ostryo carpinifoliae *sigmetum*
II – Cardamino kitaibelii - Fago sylvaticae *sigmetum*
III – Daphno oleoidis – Juniperion nanae *sigmetum*
IV – Carpino betuli - Corylo avellanae *sigmetum*

Fig. 33 - Different *sigmeta* along a typical mountain transect (above) and along a section of Aniene Valley.

Ecological Landscape Classification of the Simbruini Mountains

Introduction

The Ecological Landscape Classification (ELC) is a process used to identify land areas with homogeneous physical and biological characteristics at a user-defined scale of detail (Claessen *et al*., 1994; Runhaar & Udo de Haes, 1994; Sims *et al*., 1996; Bailey, 1996; Carter *et al*., 1999; Omernik, 2004). It involved many geographers and ecologists (Christian & Stewart, 1968; Loveland & Merchant, 2004), and has been adopted as an analysis tool in a large number of applications, such as habitat and rare species conservation (Lindenmayer & Cunningham 1996), biodiversity monitoring (Leathwick *et al*., 2003), catchment areas and water basins management (Claessen *et al*., 1994), environmental monitoring (Hirvonen, 2001), ecological assessment (Bunce *et al*., 1996) and land use change analysis (Gallant *et al*., 2004).

The existence of homogeneous land areas can be easily perceived through direct observation, and these are generally characterised by relatively similar physical parameters such as topography, climate and soil type, determining the presence of analogous vegetation typologies. The problem of quantifying and mapping the distribution of these homogeneous units has determined, in the past century, the elaboration of many different methodologies and classification

approaches.

The most notable classification examples are based on a hierarchical subdivision approach known as "environmental units classification" (Christian & Stewart, 1964, Wright, 1971). This approach has been largely used and has determined the definition of various nomenclature schemes. Some examples are provided in Table 29.

These classification frameworks have been criticised both for theoretical and practical reasons (Bailey, 1988; Zonneveld, 1995; Omerinik, 2004). In particular, the following issues have been highlighted:

Lack of agreement on the definition of classification units;

Dishomogeneous nomenclature;

Reluctance towards the adoption of a definitely holistic approach and dominance of sectorial and/or reductive points of view (geology, geomorphology, pedology and vegetation);

Lack of agreement on the techniques to be used in order to identify homogeneous units: in particular, doubt on whether to use a quantitative or a qualitative approach;

Difficulties in defining the boundaries of classification units, particularly in the case of hierarchically inferior units;

Difficulties in applying the classification schemes to different contexts respect to the ones they were developed for.

An attempt to overcome the difficulties in the nomenclature and the differences generated by a sectorial approach to the classification and mapping of land units has been represented by the project for the identification of Ecoregions in North America (McMahon *et al*., 2001). The strong points of these projects were the following:

Identification of regions with a similar mosaic of biotic, abiotic, terrestrial and aquatic components, with the human species included as a part of the biological pattern, avoiding to establish an *a priori* hierarchy of parameters, in order to let the relative influence of each variable independently fluctuate depending only on the considered region and not on the hierarchical classification level;

Creation of an interdisciplinary group commissioned to the elaboration and validation processes;

Usage of an univocal nomenclature, based on four hierarchical levels identified by roman numbers from I to IV;

Implementation of projects aimed to assessing the efficiency of the ecoregions with regards to the environmental parameters determining the need for an ecological landscape classification.

Nevertheless, it is worth to notice that in spite of the efforts undertaken towards the homogenization and standardization of classification systems, a lot remains to be done in order to achieve an universally applicable and trustworthy system meeting the concrete exigencies of ecosystem management based on a systemic approach. As a matter of fact, even the world ecoregions classification realized by WWF reveals to be focused on conservation: starting from a declared ecosystem approach, whose aim was to identify "relatively large land areas represented by terrestrial, marine and freshwater environments and characterised by a system of natural communities sharing specific

Table 29 – Examples of hierarchical landscape classification.

Christian and Stewart (1964)	
Land System	Area geomorphologically and geographically homogeneous
Land Unit	Area characterised by a specific geomorphology
Site	Area homogeneous in terms of geomorphology, pedology and vegetation
Vinogradov (1967)	
Land System	Group of Land Units
Land Unit	A natural system of *facies* characterised by the same topo-ecological sequence
Facies	Biocenosis characterised by homogeneous ecological conditions (aspect, lithology, microclimate)
Bailey (1983)	
Domain	Area with homogeneous climatic characteristics
Division	Domain unit determined by precipitation and temperature trends
Province	Division unit Identified on the basis of dominating vegetation and geomorphologic characteristics
Section	Identified mainly on the basis of geomorphologic characteristics
Vos and Stortelder (1992)	
Land System	Area homogeneous by grouping Land Units on the basis of macroclimatic and litohlogic parameters
Land Unit	Area homogeneous by grouping Ecotopes through a hierarchical classification based on climatic, geomorphologic, vegetation and land use parameters
Ecotope	Units with homogeneous physiography, land use, vegetation and humus
Klijn and Udo de Haes (1994)	
Ecozone	Defined on the basis of climatic and geologic characteristics
Ecoprovince	Defined on the basis of climatic, geologic and geomorphologic characteristics
Ecoregions	Defined on the basis of climatic, geologic, geomorphologic and water table characteristics
Ecodistrict	Defined on the basis of climatic, geologic, geomorphologic, water table and surface flow characteristics
Ecosection	Defined by water table, surface flow and soil
Ecoseries	Defined by water table and soil
Ecotope	Defined on the basis of vegetation types and soil
Blasi *et al*. (2000)	
Land Region	Identified on the basis of climatic characteristics
Land System	Identified on the basis of lithologic characteristics
Land facet	Identified on the basis of geomorphologic and bioclimatic characteristics
Environmental unit	Identified on the basis of potential natural vegetation

animal and plant associations and environmental dynamics and conditions", it actually resulted in the definition of zones typified by a particular richness in terms of biological diversity.

Considering this reference framework related to the approaches aimed to the definition and mapping of Land Units (*sensu* Zonneveld, 1995), in the present study a methodology has been applied that focuses on the classification of land units resulting homogeneous at the scale of analysis, represented by the Simbruini mountains. This kind of classification starts from the practical purpose of guiding the field surveys, supporting the ecological evaluation of identified areas and providing a tool for planning and environmental management. In this perspective, landscape classification becomes a simplified description of the processes determining the environmental heterogeneity itself; then again the landscape patterns identified by means of the ecological analysis acts as a basis for the classification process.

This approach is based on the growing availability at a global scale of digital ecological data (raster and vector) significant for the ELC, and on the development and spreading of Geographic Information Systems as well.

Many different quantitative techniques have been applied in the context of ELC, such as classification and regression trees (Franklin, 2003), multivariate analysis (Mora & Iverson, 2002; Hargrove & Hoffman, 2004; Wolock *et al*., 2004), neural networks and Bayesian classifiers (Bryan, 2006). Various problems related to the classification process are still to be faced, the most important being the existence of continuous gradients hindering the identification of thresholds and limits, the typology and quality of the considered biophysical variables and their weight in the classification process itself. Moreover, a compromise is needed between the necessity to identify a small number of classes, in order to make them useful for planning, and the importance of maintaining low the internal heterogeneity of the land units, that is to say a compromise between classification complexity and class homogeneity.

In this study, we tested the efficiency of a maximum likelihood classifier applied to biophysical variables available through the web for the whole planet. Moreover, a statistical criterion has been applied to determine the optimal number of classes. In this way, it has been possible to provide a methodology for Ecological Landscape Classification that can be applied at a global level and at different scales. Basing on this process, the scale of the resulting classified map depends on the spatial resolution of the remote sensing data (e.g. LANDSAT, MODIS, AVHRR). The methodology herein presented will be extended to the whole national territory in order to come abreast of the efforts undertaken by the scientific community towards a homogeneous ecological classification (Blasi *et al*., 2004), representing an useful instrument for its validation.

Materials and methods

Environmental variables

The environmental variables (topographic, climatic and remote sensing data) used in this study have been chosen evaluating their importance in ecological processes (Fig. 34).

In particular, slope and curvature profiles have been elaborated basing on a Digital Elevation Model with 90 m pixel resolution obtained from NASA Shuttle Radar Topography Mission website (http://srtm.csi.cgiar.org/). To produce slope and curvature raster maps, we used the "Slope" and "Curvature" modules of the Spatial Analyst extension in ArcGIS 9.2. Slope represents the angle of descent of the side, expressed in degrees, while curvature has positive values for convex and negative for concave surfaces (zero for flat areas). The yearly solar radiation was computed as the sum between diffused and direct radiation inferred on the basis of slope, aspect and latitude (Skidmore, 1997), using Solar Analyst extension in ArcView 3.2.

Climatic and bioclimatic data with 1 m pixel resolution have been downloaded from WorldClim website http://www.worldclim.org (see Hijmans *et al*. 2005 for further specifications). In particular, the mean annual temperature, the yearly precipitation and a moisture index have been used for the present study. The moisture index was calculated basing on the following expression (Box, 1981):

Moi = P/ETp

where

P = yearly precipitation

ETp = potential evapotranspiration, calculated on the basis of Jensen-Haise equation (Jensen and Haise, 1963):

ETp = (SR/2450) (0.025T + 0.08)

where

RS = yearly solar radiation

T = mean annual temperature

Remote sensing data have been obtained through elaboration of a Landsat 7 ETM+ scene acquired on June 9, 2001 and obtained from Global Land Cover Facility website (http://landcover.org/index.shtml). In particular, the following variables have been computed:

- Normalised Difference Vegetation Index (NDVI), obtained from a spectral transformation of the Red (RED) and Near Infrared (NIR) bands:

$$NDVI = \frac{NIR - RED}{NIR + RED}$$

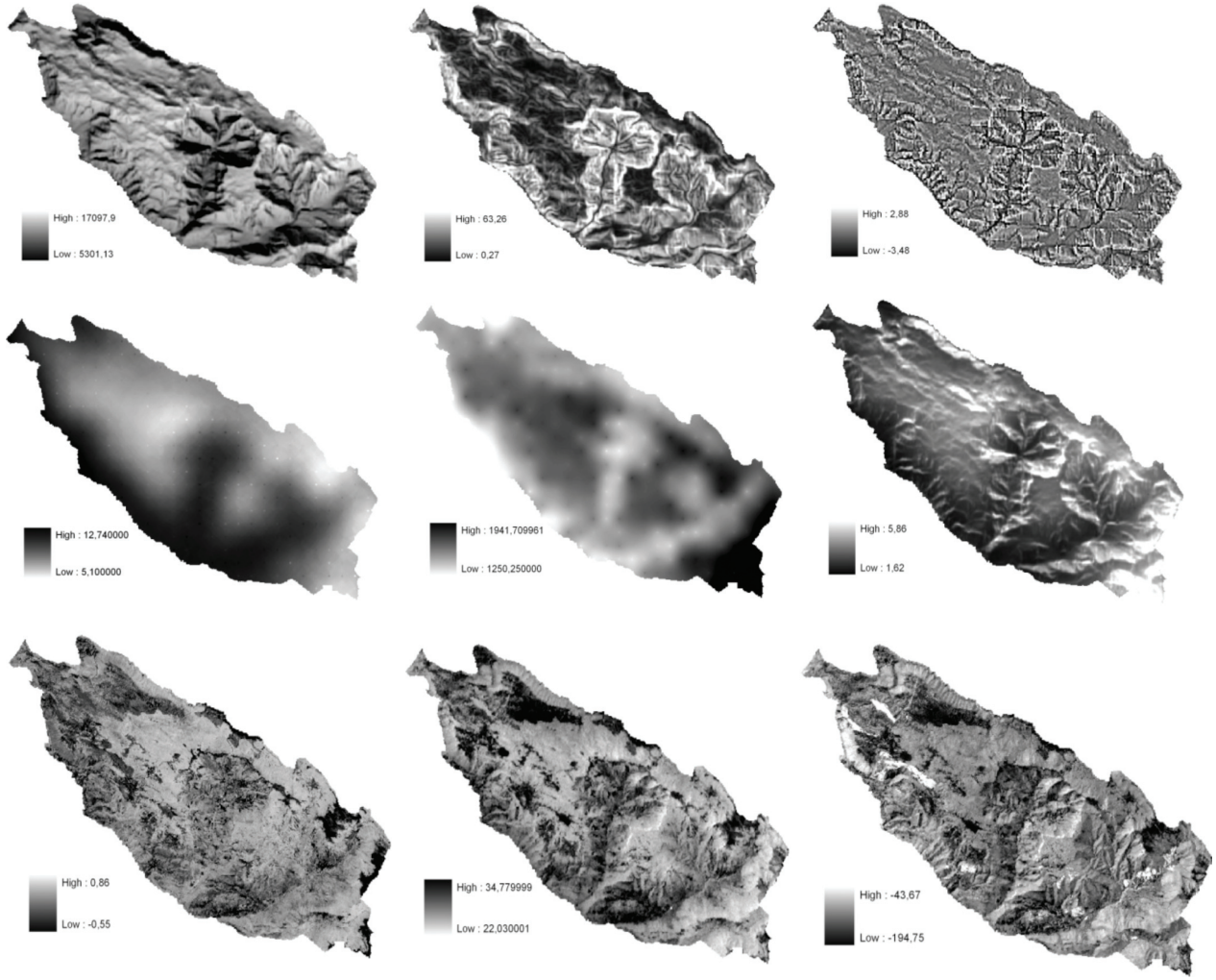


Fig. 34 - Thematic maps of the environmental variables used for the ecological landscape classification of the Simbruini Mountains: A - Solar Radiation, B - Slope, C - Curvature, D - Mean annual temperature, E - Yearly precipitation, F - Moisture index, G - NDVI, H - Surface temperature, I - Soil moisture index.

NDVI values range between -1 and 1. This index is widely employed to distinguish vegetation from other types of soil coverage and land use, and in many vegetation studies it has been correlated to important parameters such as Leaf Area Index, biomass and chlorophyll content.

- Soil moisture index, obtained by means of the "Tasseled Cap" transformation (Huang *et al*., 2002), expressed by the third component of the transformation performed by multiplying six bands of the satellite image with band-specific coefficients.

- Surface temperature: originating from the interaction between the atmosphere and the Earth's surface, it is one of the key parameters for biophysical processes, and its importance has been recognized in ecological and bio-geological studies (Running *et al*., 1994). Surface temperature was computed using the method proposed by Zhang *et al*. (2006).

Classification

The maximum likelihood classifier has been employed to identify homogeneous areas basing on the distribution of the considered environmental variables. This operation proceeds as explained in the following lines. A number of groups are set by the user and the procedure is started. For this preliminary classification the distance between two groups is defined as the likelihood that would be lost by merging these groups. To calculate the significance, continuous variables are assumed as a having normal distribution (after an appropriate normalization e.g. by means of a Box-Cox function), while for the categorical ones a multinomial distribution is postulated. An iterative algorithm is then used to find the subdivision between k groups of maximum likelihood. To choose an optimal number of groups, information criteria such as Akaike (AIC) or Bayesian (BIC) can be employed. Both of the two are

obtained by means of a penalization (for the number of parameters involved in the model) of the maximum likelihood found. It is well known in statistic literature that the best criterion to choose an optimal number of groups, when dealing with high numerousness, is to search for the minimum obtainable BIC value. Therefore, the proposed methodology consists in finding the optimal classifications for a number of groups ranging from k=2 to a maximum value (even a very elevated one), and then selecting the one with the minimum BIC value. Since the BIC often shows a parabolic trend respect to k (i.e. it decreases to a minimum point and then starts to grow again), and it possibly decreases very slowly with high k values, in many cases a sub-optimal classification can be obtained with a consistently smaller number of groups. For example, it is possible to choose as a final result, instead of the classification with the minimum BIC value, the one with the minimum number of groups in which the final BIC value is at least 99.9%, 99% or 95% of the total obtained.

Results and discussion

Basing on the BIC criterion described above, an optimal classification has been obtained with 184 groups. The sub-optimal ones comprehend 125 groups (99.9%), 46 groups (99%) and 8 groups (95%).

There is not an objective criterion to choose which classification must be adopted: the selection depends on various factors such as the scale adopted, or the management and planning purposes of the study. Anyway, it is worth to underline that, despite this choice is subjective it is based on a transparent and explicit methodology (Hangrove & Hoffman, 2004). Basing on these criteria, the classification comprehending 8 land units has been selected (Fig. 35). For each group, we report the statistics related to the environmental variables involved in the classification process. Moreover, by overlaying the land units classification and the vegetation map (Attorre *et al.,* 2005), it has been possible to identify the dominant vegetation and land use types in each land unit (Table 30).

The prevailing land unit is represented by the high-mountain *Fagus sylvatica* woodlands, while the smallest in extension is the peak grasses mosaic, also characterized by the lowest coverage as expressed by the relative NDVI value. An interesting result is the identification of mesophilous woodlands, prevalently facing north as can be inferred from the radiation value, the lowest of all the groups. This land unit comprehends in its plant diversity some of the most interesting features of the whole area, such as the beech woodlands of "Fosso Fioio", located in the northern part of the natural park where the peculiar environmental conditions allowed the wide spread of *Abies alba* specimens, introduced in a nearby reforestation area. This phenomenon appears coherent with the observations conducted in the south-central Italian beech woods, in which *Abies alba* has been found in the lower, thermophilous belt (Gentile, 1969). Another particular feature is represented by the *Aceretum obtusati-pseudoplatani* woodland that occupies a limited area but finds in this land unit their own ecological optimum.

It can be also noticed that some of the land unit types identified by means of the proposed methodology (e.g. the high mountain beech woodlands and the peak grass vegetation) appear homogeneous and show spatial boundaries easily distinguishable as well, while in other cases (like happens for the transition area between beech and hop-hornbeam woodlands) the typologies are heterogeneous and seem to confirm that, if the vegetation continuum theory is correct, it can result very difficult to identify unarguable classes and limits (Austin & Smith, 1989).

In conclusion, the use of a maximum likelihood classifier based on biophysical variables represented a powerful instrument for the ecological landscape classification of a mountain massif area. Despite the limitations related to the assumptions connected with this method, a good quality of the data and the intrinsically continuous nature of some environmental gradients opened new possibilities towards reliable classifications at regional and national scale. Moreover, since such data are available for the whole planet, this approach provides a useful instrument for territorial analysis and support to field research, even in ecologically diverse contexts and at different spatial scales.

Landscape change analysis

Introduction

Current landscape is the result of a long, slow but continuous process of anthropogenic modification of the environment that overlaps with natural processes. It follows that different elements of the landscape and their changes in time can be determined by a combination of environmental factors and human activities, operating at different spatial and temporal scales (Forman & Godron, 1986; Forman, 1995).

The landscape change analysis is the process through which information on the same territory from different periods is compared in order, to determine the localization and the nature of changes in time and to obtain identify those factors that have a significant influence on that process (Marchetti & Gusmeroli, 1994; Blasi *et al*., 2001a, 2001b, 2003; Carranza *et al*.,

Environmental unit	**Alpine vegetation**	**Montane beech woods**	**Montane calcareous grasslands**	**Mixed deciduous woods**	**Mesophilous woods**	**Hophornbeam woods**	**Mixed Sclerophyll and deciduous woodse**	**Agricoltural mosaic with grasslands**
Area (ha)	730.08.00	8394.08.00	4799.09.00	4068.04.00	1764.05.00	6157.06.00	1791.06.00	2360.07.00
Area %	02.04	27.09.00	16.00	13.05	05.09	20.05	06.00	07.09
Altitude (m)± DS	1769±149	1512±138	1400±166	1304±148	1110±186	958±179	905±171	848±177
Slope (°)± DS	22.6± 8.1	15.3± 8.5	10.9± 7.6	18.1± 8.4	30.4± 5.1	21.3± 7.8	24.8± 6.0	10.3± 4.2
Radiation (KJ/M2/day)± DS	13672±1534	13661±152	14549±871	14364±973	9548±869	12996±1567	13959±809	13405±775
Average temp (°C)± DS	6.8±0.4	7.4±0.6	7.9±0.7	8.6±0.7	9.5±1.0	10.4±0.8	10.5±0.7	10.8±0.6
Annual precip (mm)± DS	1758±93.1	1605±91.6	1539±68.4	1551±54.7	1496±58.5	1455±56.1	1456±50.3	1422±59.7
Moisture index ± DS	3.4±0.4	3.00±0.4	2.5±0.2	2.4±0.2	3.3±0.3	2.2±0.33	2.0±0.1	2.0±0.1
NDVI± DS	0.1±0.1	0.5±0.1	0.2±0.1	0.4±0.1	0.4±0.1	0.3±0.15	0.4±0.1	0.4±0.1
Superficial temp (°C)± DS	26.8±1.4	24.98±0.77	28.7±1.4	25.8±0.8	25.6±1.1	27.6±1.82	26.6±1.0	27.6±1.0
Main habitats (Area. %)	Pediculari-Seslerietum	Cardamino-Fagetum (84.8)	Phleo -Bromion (49.2)	Cardamino - Fagetum (40)	Melittio-Ostryetum (46.1)	Melittio-Ostryetum (55.5)	Melittio-Ostryetum (36.6)	Spartio-Cytisetum (26.1)
	Daphno-uniperetum (25)	Phleo-Bromion (6.4)	Cardamino-Fagetum (20.9)	Melittio-Ostryetum (26.6)	Cardamino-Fagetum (39.8)	Spartio-Cytisetum (15.3)	Cyclamino - Quercetum ilicis (25.7)	Terraces (23.2)
	Galio-Festucetum dimorphae (14)	Pediculari-Seslerietum (2.1)	Melittio-Ostryetum (13.3)	Phleo-Bromion (11.1)	Aceri-Quercetum cerridis (7.2)	Saturejo-Brometum (9.3)	Spartio-Cytisetum (12.9)	Melittio - Ostryetum (11.5)
	Cardamino-Fagetum (11)	Berberidenion (1.7)	Berberidenion (3.8)	Reforestations (8.9)	Spartio-Cytisetum (4.1)	Aceri-Quercetum cerridis (6.9)	Roso -Rubetum ulmifolii (8.2)	Saturejo - Brometum (9.5)
	Luzulo-Nardetum (9.5)		Pediculari-Seslerietum (2.9)	Spartio-Cytisetum (4.4)	Saturejo-Brometum (2.3)	Terraces (4.3)	Saturejo-Brometum (6.5)	Cytiso-Quercetum
			Urban areas (1.5)	Berberidenion (4.1)	Aceretum obtusati-pseudoplatani (0.5)	Cyclamino-Quercetum ilicis (2.3)	Cytiso - Quercetum pubescentis (4.7)	Roso sempervirenti - Rubetum (3.2)
Main land cover type (Area %)	3213 Alpine grasslands (61)	3115 Beech woods (84.8)	3211 Calcareous grasslands (49.2)	3115 Beech woods -40	3113 Broadleaf mesophilous woods (46.6)	3113 Broadleaf mesophilous woods (55.5)	3113 Broadleaf mesophilous woods (36.6)	3223 Xerophilous shrubs (26.1)
	3221 Alpine shrubs -25	3211 Calcareous grasslands (6.4)	3115 Beech woods (20.9)	3113 Broadleaf mesophilous woods (26.6)	3115 Beech woods (39.8)	3223 Xerophilous shrubs (15.3)	3111 Holm oak woods (25.7)	243 Agricoltural areas (23.2)
	3115 Beech woods -11	3213 Alpine grasslands (2.1)	3113 Broadleaf mesophilous woods (13.3)	3211 Calcareous grasslands (11.1)	3112 Deciduous oak woods (7.2)	3211 Calcareous grasslands (9.3)	3223 Xerophilous shrubs (12.9)	3113 Broadleaf mesophilous woods (11.5)
		3221 Alpine shrubs (1.7)	3221 Montane shrubs (3.8)	3122 Rimboschimenti di conifere (8.9)	3223 Xerophilous shrubs (4.1)	3112 Deciduous oak woods (6.9)	3222 Termophilous shrubs (8.2)	3211 Calcareous grasslands (9.5)
			3213 Alpine grasslands (2.9)	3223 Xerophilous shrubs (4.4)	3211 Calcareous grasslands (2.3)	3222 Termophilous shrubs (4.3)	3211 Calcareous grasslands (6.5)	3112 Deciduous oak woods (6.1)
			11 Urban areas (1.5)	3221 Montane shrubs (4.1)		3111 Holm oak woods (2.3)	3112 Deciduous oak woods (4.7)	3222 Termophilous shrubs (3.2)

Table 30 - Environmental, vegetation and land use characteristics of the Land Units identified by means of the ecological landscape classification of the Simbruini Mountains.

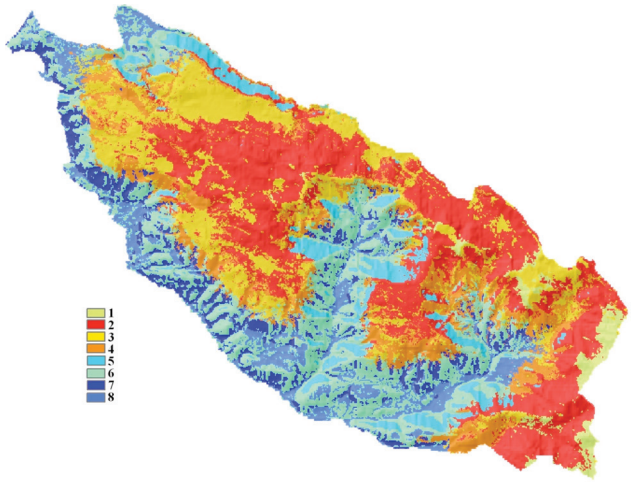


Fig. 35 - Simbruini Mountains Land Units map. 1 - Alpine vegetation; 2 - Mountain beech woods; 3 - Calcareous mountain grasslands; 4 - Beech/Hop hornbeam transitional woodlands; 5 - Mesophilous woodlands; 6 - Hop hornbeam woodlands; 7 - Sclerophyllous and deciduous mixed woodlands and shrublands; 8 - Agricultural mosaic with grasslands and shrublands.

2003).

The methodology adopted in this work to analyse these changes is based on metrics of the spatial structure of the landscape. The variability of these metrics in a period of reference can give quantitative information on the transformations of landscape.

Materials and methods

The analysis of the landscape changes of the Simbruini mountains has been carried out using photointerpretation of georeferenced aerial photos from 1950 and from 2000. Land cover maps were thus produced using the software Arcview 3.2. Several indexes of landscape analysis have been applied on the land cover maps using Fragstat 3.3 software (McGarical et *al*., 2002). In particular, the following land cover categories were considered:

1. Urbanized areas
2. Agricultural areas
3. Terraces
4. Reforestations
5. Closed grasslands
6. Open grasslands with protruding rocks
7. Shrublands
8. Open woods (with a cover of between 40 % and 70%)
9. Closed woods (with a cover >70%)

Indexes for the analysis of the spatio-temporal pattern of landscape were used:

1. Patch number (NP).
2. Patch density (DP), it is the number of patches for area. 3. Index of the largest patch (IPG), it quantifies the percentage of total landscape occupied by the largest patch. It is a dominance measure and can have values between 0 and 100.
4. Shape Index (Shape), this is equal to 1 when the patch is compact (with a square shape or similar) and increases with the irregularity of the patch.
5. Fractal dimension (Frac), it is another Shape Index and it is comprised between 1 and 2. It approximates 1 for patches with a simple shape and 2 for those with a more convoluted shape.
6. Index of landscape shape (IFP), it is a measure of aggregation: it is equal to 1 when the landscape is made up of one patch only or the patch is as compact as possible, and it increases as the patches become more disaggregated
7. Shannon Diversity Index (SHDI).
8. Simpson Diversity Index (SIDI).
9. Cohesion Index (Coes), this is comprised between 0 and 100 and increases with the increase of the patches' aggregation level.

Results and discussion

Table 31 shows the metrics of the categories of the 1950 land cover map (Fig. 36). The categories more widespread are closed woods (8421.5 ha, 27.9 %) and shrublands (7588 ha, 25%), a smaller percentage of land is covered by rocky grasslands (3513.3 ha, 11%).

Closed grasslands are the most fragmented element of the landscape with 159 patches, followed by open woods (121) and shrubs (117).

The patch density (DP) does not evidence the dominance of one category on the others, as it is also confirmed by the IPG index that shows how the landscape was characterised by a strong fragmentation without the presence of dominant patches. The IFP index, that is the measure of aggregation of the land cover typologies, presents similar values, between 10 and 18, for almost all of the categories, except for the urbanized and agricultural areas which tend to be more aggregated.

The two shape indexes (Shape and Frac) have low values indicating the morphological regularity of the land cover tyes.

Surprisingly, agricultural areas show high values for both the indexes. In fact this land cover type, being shaped by anthropic activity, should be regular. However, this result can be explained by the fact that agriculture was a marginal activity and mainly influenced by the geomorphological characteristics of the territory. The cohesion index (Coes) shows how the shrubs and woods are less fragmented than the other typologies.

	Area	Area %	NP	DP	IPG	Shape ± ds		Frac ± ds		IFP	Coes
Agricultural areas	627,5	2,1	8	0,0	1,0	2,0	0,5	1,11	0,04	4,9	96,1
Urbanized areas	20,5	0,1	6	0,0	0,0	1,3	0,3	1,05	0,04	2,9	78,6
Open woods	6814,5	22,6	121	0,4	8,6	1,7	0,9	1,08	0,06	17,7	98,0
Closed woods	8421,5	27,9	103	0,3	9,2	1,9	1,0	1,09	0,06	17,6	98,1
Shrubslands	7588,8	25,2	117	0,4	6,4	1,7	1,1	1,08	0,06	18,5	98,3
Closed grasslands	1018,8	3,4	159	0,5	0,4	1,4	0,5	1,07	0,06	16,4	89,3
Open grasslands	3513,3	11,6	63	0,2	2,6	1,9	0,9	1,09	0,07	13,8	96,4
Terraces	2169,0	7,2	53	0,2	2,2	1,7	0,8	1,08	0,06	10,9	96,6

Table 31 – Values of the landscape indexes in 1950

	Area	**Area %**	**NP**	**DP**	**IPG**	**Shape ±ds**		**Frac ±ds**		**IFP**	**Coes**
Agricultural areas	1162,2	3,9	83	0,3	0,8	1,7	0,9	1,08	0,1	15,3	93,8
Urbanized Areas	300,2	1,0	55	0,2	0,2	1,4	0,5	1,06	0,1	9,8	87,1
Open Woods	227,0	0,8	12	0,0	0,6	1,5	0,8	1,06	0,1	5,5	95,0
Closed Woods	19786,3	65,8	171	0,6	61,2	1,5	1,3	1,06	0,1	20,0	99,8
Shurblands	2808,7	9,3	293	1,0	2,7	1,5	0,7	1,07	0,1	22,8	93,9
Closed grasslands	1468,0	4,9	215	0,7	0,4	1,4	0,6	1,06	0,1	19,8	89,8
Open grasslands	3375,0	11,2	193	0,6	2,8	1,5	0,9	1,07	0,1	21,4	96,5
Reforestation	789,2	2,6	46	0,2	0,8	1,6	0,7	1,07	0,1	9,9	93,9
Terraces	133,0	0,4	20	0,1	0,1	1,6	0,4	1,09	0,0	7,2	83,7

Table 32 - Values of the landscape indexes in 2000.

Year	**NP**	**DP**	**IPG**	**Shape ±ds**		**Frac ±ds**		**IFP**	**SHDI**	**SIDI**	**IA**
1950	630	2,1	9,2	1,7	0,9	1,08	0,06	20,1	1,7	0,8	89,5
2000	1088	3,6	61,2	1,5	0,8	1,07	0,00	22,1	1,2	0,5	88,6

Table 33 - Landscape indexes values for 1950 and 2000.

In 2000 (Tab. 32, Fig. 37) the typology "closed wood" becomes the dominating element of the Simbruini Mountains' landscape, occupying, with almost 20000 ha, more than 60 % of the area, as it is also confirmed by the high value of the IPG index (61.2) for this category of land cover. This result confirms the trend that has characterised the landscape of the Apennines in the last fifty years. The dominance of closed woods is, in fact, due to the progressive reduction of pastoral activity that has, in turn, triggered the processes of natural reforestation. This has led to a progressive homogenization of the landscape threatening natural habitats strongly tied to these activities.

Noteworthy is also the low percentages of agricultural (3.9%, 1162 ha) and urbanized (1.0%, 300 ha) areas in 2000. They have increased, but never become a characterising elements of the Simbruini mountains landscape. This result is due to the process of depopulation of the Massif, whose population decreased from 17000 in 1950 to about 12000 fin 2000, and to the fact that the new constructions are built essentially for summer and winter skiing touristic purposes.

Worthy of note is also the strong reduction of the terraces which covered more than 2000 ha in 1950 and only 133 hectares in 2000. Terraces have been abandoned since they are not an economically sustainable technique of cultivation any more, and once they are abandoned they tend to be colonized by shrubs. Another interesting element are the Reforestations (789.2 ha, 2.6%), the result of a significant introduction of conifers, especially *Pinus nigra*, starting from the 1950s.

By comparing the two landscapes (Tab. 33) it is possible to infer that in spite of an increase in the number of patches, from 630 to 1088, the landscape of the Simbruini mountains is progressively homogenizing.

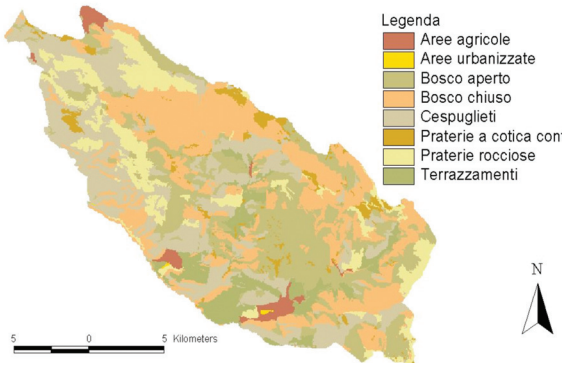


Fig. 36 - 1950 land use map of the Simbruini Mountains.

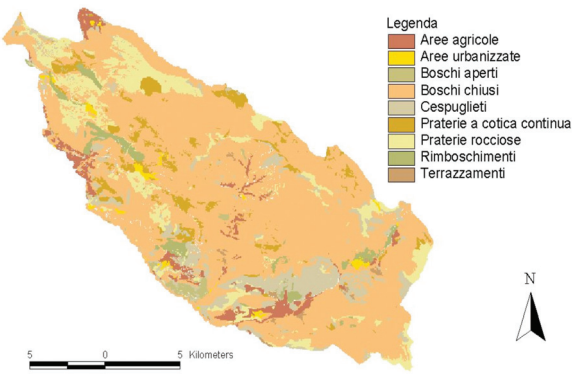


Fig. 37 - 2000 land use map of the Simbruini Mountains.

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Appendix 1

Localities and date of relevés for which geographic coordinates are not reported in the respective phytosociological table.

Tab. 1 *Cardamino kitaibelii-Fagetum sylvaticae*
R. 1 Camposecco (28.05.2002); r. 2 Campaegli (27.02.2002); r. 3 Camposecco (28.05.2002); r. 4 Livata (08.06.2002); r. 5 Campominio (14.06.2002); r. 6 Campominio (14.06.2002); r. 7 Livata (08.05.2002); r. 8 Livata (08.05.2002); r. 9 Campobuffone (23.05.2002); r. 10 Campominio (15.06.2002); r. 11 Campaegli (27.05.2002); r. 12 Campobuffone (23.05.2002).

Tab. 6 *Aceri obtusati-Quercetum cerridi*
R. 1 Vallepietra (13.06.2006); r. 2 Ril. 2 Jenne (15.06.2006); r. 3 Vallepietra (15.06.2006); r. 4 Fiume Simbrivio (13.05.2006); r. 5 Fiume Aniene (23.05.2006); r. 6 Vallepietra (13.06.2006); r. 7 Fiume Simbrivio (15.06.2006); r. 8 La Cimata (22.05.2006); r. 8 Jenne (13.06.2006); r. 9 Simbrivio river (15.06.2006); r. 10 Vallepietra (23.05.2006).

Tab. 7 -*Aceretum obtusati-pseudoplatan*i
R. 1 Fiume Aniene (23.05.2006).

Tab. 8 - *Daphno oleoidis- Juniperetum alpinae*
R. 1 Monte Viglio (07.03.2006); r. 2 Monte Cotento (12.07.2006); r. 3 Monte Cotento (07.03.2006); r. 4 Monte Cotento (07.03.2006); r. 5 Monte Cotento (07.03.2006); r. 6 Monte Cotento (07.03.2006); r. 7 Monte Tarinello (25.06.2006); r. 8 Monte Tarinello (25.06.2006); r. 9 Monte Tarinello (25.06.2006); r. 10 Monte Tarinello (25.06.2006); r. 11 Monte Viglio (27.06.2006); r. 12 Monte Viglio (27.06.2006); r. 13 Monte Tarinello (25.06.2006); r. 14 Monte Tarino (01.07.2006); r. 15 Monte Tarino (01.07.2006).

Tab. 9 - *Ribeso uvae-crispae-Rosetum dumalis*
R. 1 Piano Iavone (19.05.2002); r. 2 Femmina Morta (02.06.2002); r. 3 Camposecco (27.05.2002); ril. 4 Livata (07.06.2002); r. 5 Livata (08.06.2002); r. 6 Camposecco (29.05.2002); r. 7 Campaegli (26.05.2002); r. 8 Campobuffone (22.05.2002).

Tab. 10 – *Roso pendulinae-Genistetum radiatae*
R. 1 Monte Autore (02.07.2006); r. 2 Monte Autore (02.07.2006); r. 3 Monte Autore (05.07.2006); r. 4 Prato di Campoli (27.06.2006); r. 5 Prato di Campoli (27.06.2006).

Tab. 11 – *Viburno lantanae-Juniperetum communis*
R. 1 Colle Cesarolo (10.05.2006); r. 2 Colle Cesarolo (10.05.2006).

Tab. 16 - *Saturejo montanae-Brometum erecti*
R. 1 Subiaco (19.05.2006); r. 2 Subiaco (19.05.2006); r. 3 Jenne (21.05.2006); r. 4 Monte Autore (19.05.2006); r. 5 Monte Autore (21.05.2006); r. 6 Vallepietra (25.05.2006); r. 7 Vallepietra (25.05.2006); r. 8 Camerata (23.05.2006); r. 9 Camerata (23.05.2006); r. 10 Vallevona (21.05.2006); r. 11 Vallevona (21.05.2006); r. 12 Jenne (23.05.2006); r. 13 Jenne (19.05.2006); r. 14 Vedute di Faito (27.05.2006); r. 15 Vedute di Faito (27.05.2006); r. 16 Jenne (20.05.2006); r. 17 Subiaco (19.05.2006); r. 18 Monte Cotento (02.06.2006); r. 19 Monte Cotento (02.06.2006); r. 20 Monte Viglio (17.06.2006); r. 21 Monte Viglio (17.06.2006).

Tab. 17 - *Pediculari elegantis- Seslerietum tenuifoliae*
R. 1 Monte Viglio (14.06.2005); r. 2 Monte Viglio (14.06.2005); r. 3 Monte Viglio (14.06.2005); r. 4 Monte Tarino (16.06.2005); r. 5 Monte Viglio (14.06.2005); r. 6 Monte Tarino (16.06.2005); r. 7 Monte Viglio (14.06.2005); r. 8 Monte Tarino (14.06.2005); r. 9 Monte Viglio (14.06.2005); r. 10 Monte Viglio (14.06.2005).

Tab. 18 - *Galio magellensis - Festucetum dimorphae*
R. 1 Monte Viglio (17.06.2006); r. 2 Monte Viglio (17.06.2006); r. 3 Monte Viglio (17.06.2006); r. 4 Monte Fragara (19.06.2006); r. 5 Monte Ginepro (21.06.2006); r. 6 Monte Viglio (17.06.2006).

Tab. 19 - *Drypido-Festucetum dimorphae*
R. 1 Monte Viglio (17.06.2006); r. 2 Monte Viglio (17.06.2006).

Tab. 20 - *Luzulo italicae-Nardetum strictae*
R. 1 Monte Viglio (17.06.2006); r. 2 Monte Viglio (17.06.2006); r. 3 Monte Viglio (17.06.2006); r. 4 Monte Tarino (19.06.2006); r. 5 Monte Tarinello (19.06.2006); r. 6 Monte Viglio (17.06.2006); r. 7 Monte Viglio (17.06.2006); r. 8 Monte Cotento (12.06.2006); r. 9 Monte Cotento (12.06.2006); r. 10 Monte Viglio (17.06.2006); r. 11 Pizzo Deta (21.06.2006); r. 12 Pizzo Deta (21.06.2006); r. 13 Pizzo Deta(21.06.2006); r. 14 Monte Tarino (19.06.2006); r. 15 Monte Tarino (19.06.2006); r. 16 Monte Viglio (17.06.2006); r. 17 Monte Viglio (17.06.2006); r. 18 Monte Viglio (17.06.2006); r. 19 Monte Viglio (17.06.2006).

Tab. 21 - *Trifolio thalii-Festucetum microphyllae*
R. 1 Monte Viglio (23.06.2005); r. 2 Monte Tarino (21.06.2005); r. 3 Monte Viglio (23.06.2005); r. 4 Pizzo Deta (16.06.2006); r. 5 Monte Viglio (23.06.2006); r. 6 Monte Tarino (21.06.2006).

Tab. 22 - *Koelerio splendentis-Brometum erecti*
R. 1 Piano lavone (18.05.2002); r. 2 Campobuffone (22.05.2002), r. 3 Livata (07.05.2002); r. 4 Campobuffone (22.05.2002); r. 5 Campaegli (26.05.2002); r. 6 Camposecco (27.05.2002); r. 7 Livata (07.05.2002); r. 8 Campominio (14.06.2002); r. 9 Campominio (14.05.2002); r. 10 Femmina morta (02.06.2002); r. 11 Camposecco (28.05.2002); r. 12 Livata (08.06.2002).

Tab. 23. *Anthoxantho odorati·Brachypodietum genuensis*
R. 1 Piano lavone (19.05.2002); r. 2 Fosse di Livata (05.06.2002); r. 3 Fosse di Livata (05.06.2002); r. 4 Femmina morta (02.06.2002); r. 5 Campobuffone (23.05.2002); r. 6 Campo della Pietra (10.06.2002); r. 7 Campominio (15.06.2002); r. 8 Camposecco (28.05.2002ril.); r. 9 Campobuffone (23.05.2002); r.10 Camposecco (28.05.2002); r. 11 Livata (08.06.2002); r. 12 Campaegli (27.05.2002); r. 13 Campobuffone (23.05.2002); r. 14 Campaegli (27.05.2002); r. 15 Campobuffone (23.05.2002).

Tab. 27 - *Saxifrago australis-Trisetetum bertolonii*
R. 1 Monte Viglio (17.06.2006); r. 2 Monte Tarino (19.06.2006); r. 3 Monte Fanfilli (21.06.2006).

Tab. 28 **-** *Arenario bertolonii-Cystopteridetum alpinae*
R. 1 Monte Viglio (17.06.2006); r. 2 Monte Tarino (19.06.2006).