Analysis and Evaluation of a Traditional Cultural Landscape as a basis for its Conservation Management
A case study in Vikos-Aoos National Park - Greece

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Dissertation

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TABLE OF CONTENTS

List of Tables

List of Figures

1 Introduction and study objectives

1.1 Traditional cultural landscapes and their value

There is a common assumption that human activities deplete natural resources all over the world. This is mainly attributed to the biodiversity loss connected with activities and practices related to industrial and urban development, construction of infrastructure, intensive agriculture and pastoralism, plantation forestry and massive tourism (GLOWKA et al. 1994, IUCN 1994). There are however cases, where the long-lasting human activities and their interaction with nature have created ecosystems with high conservation value for their fauna and flora. Such ecosystems are among others, old grasslands and meadows, specific forms of traditionally managed forests, or even mosaics of grasslands, cultivated fields and forests. These land mosaics, formed usually by traditional land use systems of low intensity, characterized by handwork with simple apparatus and animals, are known as traditional (or historical) cultural landscapes or shortly cultural landscapes (EWALD 1994, MEEUS 1995, PHILLIPS 1995, BURGGRAFF & KLEEFELD 1998).

These older forms of landscapes, which are the result of the long interaction of man with nature, being thus far from their natural state, are often considered of special ecological value as wildlife habitats and areas of high biodiversity that deserve conservation. Many of the ecosystems within these landscapes have evolved and continue to exist, because of human intervention, and along with the presence of various semi-natural habitats support many animal and plant species. Some of these species, which are often considered as rare or endangered are strictly associated with these anthropogenous ecosystems. In such cases the continuation of the traditional land uses and practices is considered essential for the conservation of these species (VOS & STORTELDER 1992, FARINA 1995, PINEDA & MONTALVO 1995, TUCKER & EVANS 1997, TSIAKIRIS 1999).

Butterflies represent a characteristic example; 65% of their total species number in Europe (576 species in total) live in traditional cultural landscapes (OECD 2001). Besides, about 12.500 vascular plant species in Europe are dependant on farming practices and occur in anthropogenous habitats (van DIJK 1991). The extensive and structurally diverse agricultural and grassland habitats support the largest number of bird species than any other major birds' habitat-types in Europe including 173 priority species (TUCKER & DIXON 1997). The traditional forest management in Britain is associated with the rich ground flora and dense invertebrate populations (mainly butterflies) of newly cut coppice forests, and the lichens and invertebrates of dead wood found in sites containing old pollards (KIRBY 1988).

In the Mediterranean region anthropogenous habitats such as the various garigue and rocky sites are important breeding, feeding or resting sites for 63 of the 100 priority bird species of the Mediterranean ecosystems, including many large raptors, such as *Circaetus gallicus, Aguila heliaca, A. chrysaetos, Gypaetus barbatus, Gyps fulvus* and *Neophron percnopterus* (ROCAMORA 1997). These bird species can be only sustained by the continuation of the traditional grazing regimes practiced in these areas (FARINA 1995b, KATSADORAKIS 1996, ROCAMORA 1997, TSIAKIRIS 1999). Also, the garigues are considered among the vegetation types with the highest numbers of vascular plant species including several rare species (BERGMEIER 1995, STRID & TAN 1997).

Apart from their ecological value, the cultural landscapes are also related to sustainable practices of land management that have survived for hundreds of years in such areas. For this reason these landscapes could function as living models of sustainable use of the natural resources and they could provide information useful for the future management of these and similar landscapes. The traditional cultural landscapes contain usually evidence of the local human history and tradition with a variety of structures and numerous past and present land practices. So, their importance as historical heritage and for the preservation of the cultural identity of the local communities is considered important. Also, due to their high aesthetics and the harmonious scenery that they usually present, the traditional cultural landscapes contribute greatly to the quality of life of all people by providing opportunities for recreation, education, inspiration, mental and physical renewal in a healthy environment, which further are sources of economic benefit for the local populations (PLACHTER & RÖSSLER 1995, KONOLD 1996, BURGGRAFF & KLEEFELD 1998, EUROPEAN COMMISSION 1998).

The Mediterranean cultural landscape in general, is considered of the areas with the highest biodiversity (NAVEH & LIEBERMANN 1993, RUNDEL et al. 1998, EEA 2004) and includes a variety of landscape types related to traditional land use systems. The main types of traditional cultural landscape in the Mediterranean region are the “dehesas” in Spain, the “montados” in Portugal, the “coltura promiscua” in Italy, the

"Mediterranean semi-bocage" in France, all related to the local traditional agro-silvo-pastoral system; the terraced landscapes with olive trees, or of former cereal cultivations; and the Mediterranean open land related to agro-pastoralism; with the last two landscape types reported also for Greece (MEEUS 1995).

Main elements of the Mediterranean cultural landscapes consist the small agricultural fields often on terraces and various other habitats found in-between the fields, such as strips of fallow land (grasslands), tree hedges, grazed shrublands and woodlands, and nearly-natural forests and forest fragments (FORMAN & GODRON 1986, VOS & STORTELDER 1992, NAVEH & LIEBERMAN 1993, IUCN 1994).

1.2 Changes and threats to cultural landscapes

Cultural landscapes face nowadays problems arising from changes in the land uses and are related either to land use intensification or abandonment. On fertile and / or lowland sites where productive or industrial activities prevail, such as agriculture and forestry, or urbanism, industrialization and massive tourism, the intensification of the land uses leads to simple and homogeneous landscapes. This is usually followed by severe ecological changes, for example in soil fertility, water and nutrient cycle and the wildlife habitats in general. These processes affect the stability of the ecosystem and are related to landscape degradation and loss of biodiversity. On the other side, on marginal, usually remote, mountainous areas, the traditional land use systems are considered unprofitable and are increasingly abandoned. This process also affects the ecosystems and the landscape by altering their composition, structure and functions, and is again associated with loss in landscape and biological diversity (van DIJK 1991, IUCN 1994, EWALD 1995, FARINA 1995, TUCKER & EVANS 1997, EUROPEAN COMMISSION 1998, KORNECK et al. 1998).

In the Mediterranean areas particularly, the widespread land abandonment with increasing urbanisation is regarded as the main cause of increased fire regime and intensity, which along with intensive agricultural practices, overgrazing, exotic forest plantations and extended tourist activities lead to landscape degradation and habitat loss. At the montane areas the land abandonment and the subsequent forest invasion is followed by the disappearance of some landscape elements, such as small fields and open shrublands and woodlands. This procedure alters the mosaic-like structure of the cultural landscape to a more homogeneous and coarse one with subsequent changes in the ecosystems and their fauna and flora (VOS & STORTELDER 1992, PAPANASTASIS 1993, PINEDA & MONTALVO 1995, RUNDEL 1998, FARINA 1998, NAVEH 1998, MITCHLEY & ISPIKOUDIS 1999, GROVE & RACKHAM 2001, NCESD 2002).

1.3 Landscape conservation

The worldwide concern on biodiversity loss and the resulted actions to hinder it, along with the recognition of the values, the multi-lateral role of the cultural landscapes and the changes taking place on them, set off the need for their protection. As a result, the preservation of cultural landscapes has been incorporated among the priorities of biodiversity conservation both at national and international levels. Moreover, the restoration where necessary of traditional landscapes with high ecological value and often with high biological diversity is also considered of high priority (IUCN 1994, EUROPEAN COMMISSION 1997, NCESD 2002).

At national scale the landscape conservation can be achieved in two complementary ways. The best examples of the cultural landscapes should be incorporated to a National system of protected areas and they should be properly managed (IUCN 1994, PHILLIPS 1995). On the other side, the call for sustainable development sets among the priorities at national level the integrated land management, which should be carried out at the landscape level with the aim to protect both its natural and cultural character and at the same time to support the economic development of the local communities (LUCAS 1992, UNCED 1992, IUCN 1994, SPELLERBERG 1996, YPEXODE 2002).

The need for the efficient protection, management and planning of the landscape was officially recognized in Europe at the European Landscape Convention (ELC) held in Florence in 2000. With this aim, according to the Convention, and beside the necessary legislative actions (in law, policy, participatory procedures), each country should identify its own landscapes; analyze their characteristics and the processes transforming them; and assess them taking into account the particular values assigned to them by the interested parties and the population concerned (COUNCIL OF EUROPE 2000).

In Greece the post-war socio-economic changes, which have followed similar trends with the most European countries and led to land use intensification in lowland and urban areas and abandonment to montane and remote areas, have strongly influenced the ecosystems and the landscapes of the whole territory. These processes are nowadays related to land degradation (soil erosion and pollution, desertification) and other severe environmental problems (i.e. water and air pollution), as well as to the deterioration of the traditional landscapes and their associated ecological, social and cultural values (PAPANASTASIS 1993, ISPIKOUDIS et al. 1993, NCESD 2002).

Having ratified the Convention on Biodiversity, Greece faces the challenge to conserve its rich flora and fauna and the great diversity of its landscapes and ecosystems. The deficiencies in the organization and administration of the protected areas in Greece, associated with the lack of proper guarding and management, along with the pressures of economic activities upon the environment in general, create obstacles to effective nature conservation (KASIOUMIS et al. 1998, NCESD 2002, MARAGOU 2004). As a solution to the problem, and for harmonizing to the Habitats Directive (92/43), a National System of Protected Areas has been recently established (Law 2742/1999, Law 3044/2002; YPEXODE 2002), while new regulations related to the finance and management of Protected Areas are expected to be ready soon (YPEXODE 2005). These, along with new enactments in the agricultural policy related to the new CAP reform (MINISTRY OF AGRICULTURE 2004a&b) create a promising framework for the nature conservation in Greece.

1.4 Landscape identification, analysis and evaluation

In Europe the efforts to formulate the basic framework for assessing landscapes, in order to establish conservation priorities and strategies for sustainable development, had succeeded to develop a categorization of the various landscape types (typology). Through an analytical process 30 major “pan-European” landscape types were identified and described by taking into account ecological, cultural and visual criteria (MEEUS 1995). The resulted typology provides the necessary basis for identifying and analyzing landscapes (PHILLIPS 1995).

The necessary factors for a description and analysis of the landscape are numerous and variable (ecological, biological, socio-economic, cultural etc.). Therefore, it is often very difficult to integrate all of them in an analysis since this is strongly influenced by the available scientific, technical, financial etc. means. For this reason the appropriate factors for a landscape analysis depend on the study objectives (BUSTIAN & SCHREIBER 1994).

There are however, some basic components of the landscape on which information is required for an analysis. The most important of them include abiotic components, such as geology, geomorphology, soil and climate; biotic components e.g. vegetation, flora and fauna; and the human land uses and their changes, for instance farming, livestock, forestry, settlements, infrastructure. Finally, there are also some cultural factors e.g. archaeological, historical, traditional features, aesthetics etc., which are occasionally integrated in a landscape analysis (LUCAS 1992, BUSTIAN & SCHREIBER 1994, PHILLIPS 1995 & 2002). In the analysis the various landscape components are identified and described.

In the evaluation process the various elements (or other characteristics) of the landscape are weighted against specific criteria, which are considered important for the aims of the evaluation. So, the various landscape elements attain a particular value that is ecologically, socially, economically etc. more comprehensive and can be thus applied in the planning process. The aims of the evaluation direct also the choice of the evaluation method (LUCAS 1992, BUSTIAN & SCHREIBER 1994, PLACHTER 1995).

1.5 Related ecological studies in Greece

The identification of the main forms of agroforestry systems in Greece (SCHULTZ et al. 1987) provides the first basis for an effective typology and identification of the Greek traditional cultural landscapes.

Research on threatened landscapes of West Crete was carried out with the aim to study their contemporary landscape changes and to propose strategies for their conservation and restoration (GROVE et al. 1993, NAVEH 1993, RACKHAM & MOODY 1996). In this frame the traditional land uses, their changes and influences on the landscape and the local economy were also detected (PAPANASTASIS 1993, ISPIKOUDIS et al. 1993, LYRINTZIS et al. 1998, ISPIKOUDIS et al. 1999).

Research on traditional agroforestry systems in Greece, e.g. the traditional mixed farming, agropastoralism and mixed agroforestry systems, deals (among others) with the investigation of the ecological value of the traditional land use systems and the identification of their influences to the local economy and their development potential

(PAPANASTASIS 1996, ZIOGANAS et al. 1998, GALANOPOULOU-SENDOUCA & KONTSIOTOU 1999).

Recent theoretical approaches attempt to develop adequate conceptual models and methodological framework for the analysis, evaluation and planning of the contemporary landscape by the incorporation of cultural (TERKENLI 2001, 2005), or aesthetic criteria (ELEFTHERIADIS 2002), the application of the remote sensing technology and GIS (KOUTSIAS 2001) and the development of the necessary inventory systems (GATZOJANNIS 1996, GALATSIDAS 2001).

1.6 Introduction to the study area, objectives and structure of the study

The present study investigates the traditional cultural landscape in the area of Vikos-Aoos National Park, NW Greece (Fig. 1.1). The interest for the study raised during the elaboration of the management plan of the National Park, to which the author has also contributed (KASIOUMIS & GATZOJANNIS 1996).

Vikos-Aoos National park was established in 1973 and is extended on an area of 12.600 ha at Tymfi Mountain (North Pindos). The landscape at the hilly and mountainous zone of the National Park was shaped by traditional agro-silvo-pastoral land uses, practiced there for centuries. The cultural landscape constitutes a mosaic of various ecosystems including small terraced fields with tree hedges, fallow grasslands and rocky sites, grazed open shrublands and woodlands, along with various forests and forests fragments (Photo 1.1 in Photo annex).

The traditional cultural landscape within the area of Vikos community (Photo 1.2) was considered representative for the area of the National Park and was chosen for the study. The area is of great aesthetic value due to the impressive geomorphology. It is also characterized by an outstanding traditional architecture and is famous in Greece not only for its rich history and local culture, but also as the place, where the famous practical doctors, known as “Viko-giatroi” (the doctors of Vikos in Greek), were collecting their medicinal herbs in the past.

The area appears nowadays heavily depopulated, due to the strong emigration that took place after the World War II. The gradual abandonment of the traditional rural economy and the land use system has affected the cultural landscape. Vegetation succession and invasion of woody species has been accelerated in the area, affecting thus the mosaic-like structure of the landscape, which has started to lose its open (not forest) landscape elements (KASIOUMIS & GATZOJANNIS 1996).

Since the changes in the land use system are associated with changes in the cultural landscape, the habitats and their fauna and flora, questions about the conservation management of the traditional cultural landscape in the area of Vikos-Aoos National Park have been raised.

In this frame the objectives and the structure of the present study are as follows:

1. Description and analysis of the cultural landscape and the traditional land use system (chapter 2).

This includes the identification and description of the various components and elements of the cultural landscape, the analysis of their functions and contemporary changes in relation to the local land use system.

2. Ecological evaluation of the cultural landscape for assessing its nature conservation value (chapters 3 & 4).

The evaluation is based on the vegetation and flora of the landscape and its elements. For this reason a vegetation inventory of the main landscape elements is initially carried out. The analysis of the inventory data follows and leads to the identification and description of the vegetation types that consist the landscape.

At a further step, specific nature conservation criteria important in nature conservation, i.e. plant species diversity and rarity, naturalness and restorability are chosen. For each vegetation type the criteria are either quantified (diversity, rarity) by the application of specific indices, or qualitatively defined (naturalness, restorability) on the basis of specific ecosystem characteristics.

The ecological evaluation that follows is carried out at two stages. At the first stage the vegetation types are evaluated for each criterion separately, which results in aggregating them in groups of different value of the specific criterion. At the second stage an overall evaluation based on the four criteria together is conducted in order to classify the vegetation types in groups of similar ecological characteristics.

3. Formulation of alternative management scenarios and recommendations for the conservation of the cultural landscape (Chapter 5).

Based on the results of the landscape evaluation that provides the necessary ecological basis, two alternative management schemes (scenarios) are formulated and their effects on the traditional cultural landscape are examined. The 1^{st} scenario corresponds to the strict protection status of the National Park (core). The 2^{nd} scenario takes into account the ecological value of the cultural landscape. The possible influences of both scenarios on the landscape are discussed and finally specific management recommendations are presented for the conservation of the traditional cultural landscape.

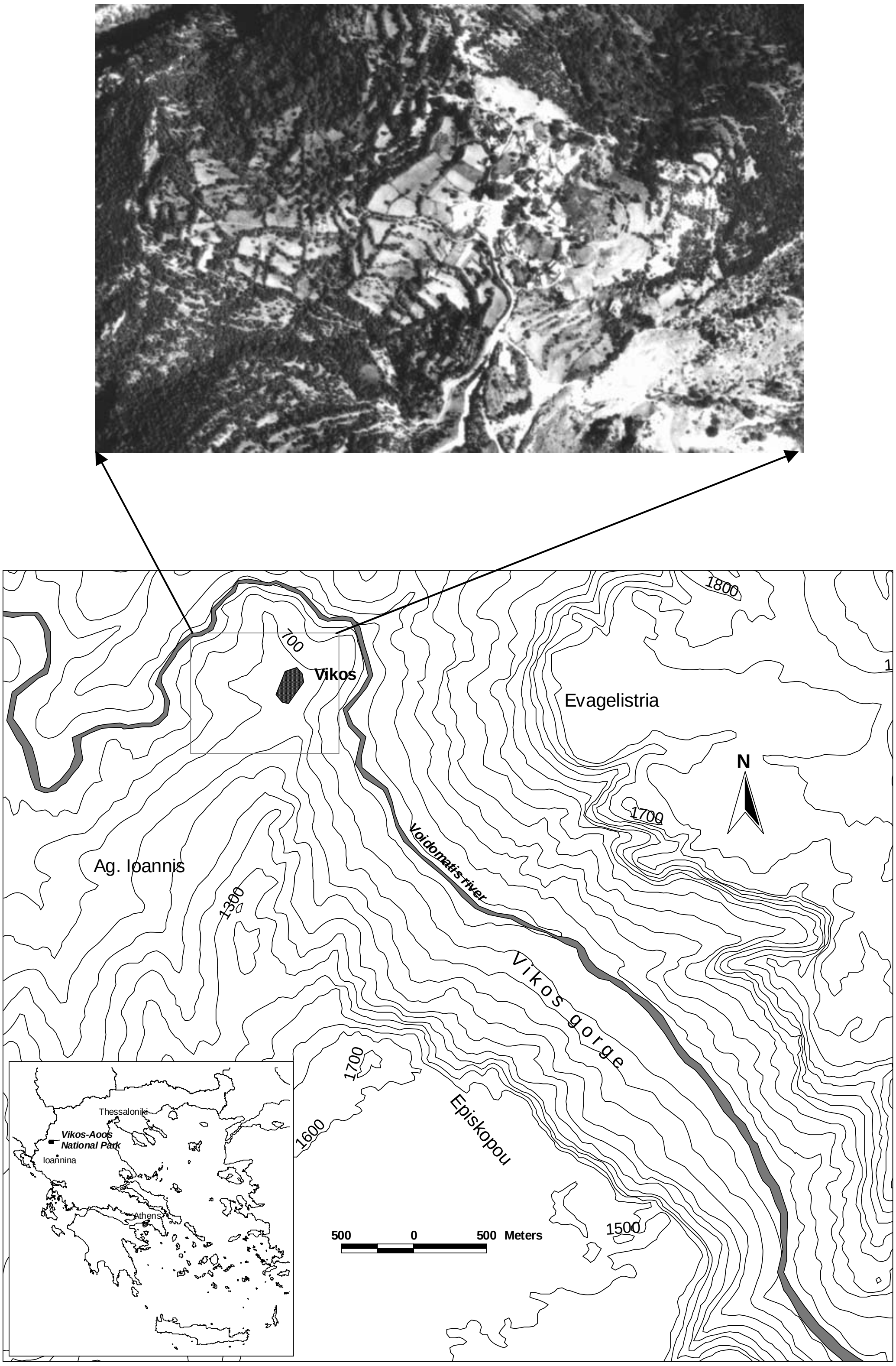

Fig. 1.1. Study area

2 The traditional cultural landscape of Vikos area

2.1 Components of the cultural landscape

2.1.1 Geomorphology

The landscape of the study area is depicted by the presence of Vikos gorge (Photo 2.1), which is a deep ravine in the southern slopes of Mount Tymfi. The gorge has a length of about 20 km, an altitude that ranges from 450 m to 1.600 m and a width from 400 m to some meters at its narrowest part near the village of Monodendri.

The main part of the gorge is extended between the villages of Vikos and Monodendri (Photo 2.2), where it has a depth of about 1.000 m, a funnel-like shape and a NNW-SSE direction. The landscape presents a diverse relief and is characterized by abrupt altitudinal changes. Steep slopes and precipitous rock cliffs dominate at the middle and higher zones respectively. Numerous gullies dissect both sides of the gorge and the movement of water detaching various rocky materials creates extended screes. The valley is narrow and is characterized by the presence of Voidomatis River, which has a seasonal flow to its major part, being permanent only at the lowest part of the gorge.

2.1.2 Geology

The area belongs to the Inner Ionian zone and is dominated by hard limestone of various geological age (KATSIKATSOS 1992). The subalpine zone and the upper slopes of the gorge at a depth of about 400 m consist of the relatively young Eocene limestone (Fig.2.1). Limestone of the same geological era constitutes the slopes around Vicos village as well. Downwards to the gorge the previous layers are succeeded by a 200 m stratum of limestone of the Senon era, while the middle and lower slopes at a depth of about 700 m are consisted of Jurassic and Cretaceous limestone. Finally, at the deepest layers and up to an altitude of 500 (700) m, grey Jurassic dolomite dominates (PERRIER et al. 1970).

A special feature of the limestone, resulting from its chemical weathering to water, is its carstic nature. Limestone dissolves easily as the water percolates through its pores, so that an extended underground drainage system is developed with caves and channels that enlarge with the time when their roofs collapse producing rocky exposures and perpendicular slopes in the form of Vikos gorge. For the same reason the water is scarce in such a landscape, and only when an impenetrable stratum is met, the water appears on the earth surface (PAPAMICHOS 1985).

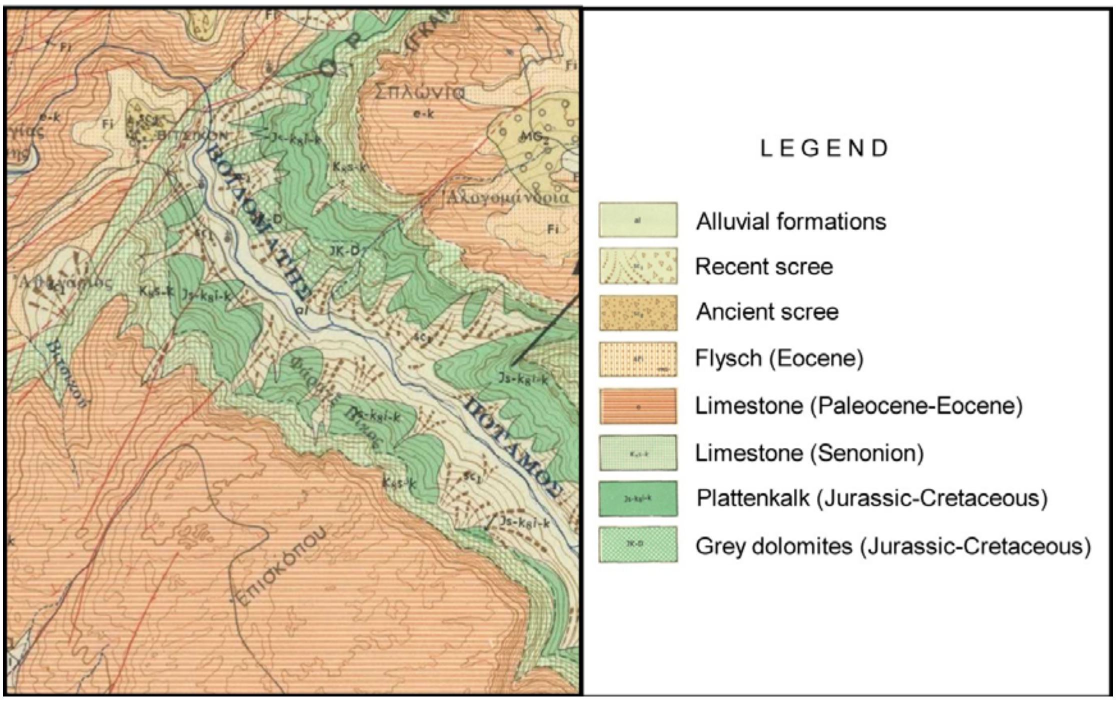

Fig. 2.1 Geological map (*Source: IGME 1970*)

The flysch, a sedimentary formation of alternating sequences of sandstones, shales, marls and clays (PAPAMICHOS 1985) is of limited extend in the study area. It is found near the village of Vikos, in an area where terraces were established there in the past to provide the necessary land for agriculture. Flysch covers an extensive area western of the National Park. Finally, a narrow interrupted strip of alluvial land is located along Voidomatis River. The land was also cultivated in the past due to the water availability. Nowadays it is abandoned because of the remoteness from the village.

2.1.3 Soil

Parent rock along with topography, local climate, vegetation and land use are the main factors determining the soil characteristics of an area (PAPAMICHOS 1985). In the study case, the soil developed upon limestone is neutral to slightly alkalic (pH measured in H_2O: 7.3) and in some cases slightly acidic (pH: 6.6) (Table 1 in Annex). At steep sites of the upper slopes or at ridges that are usually covered by low open shrublands or sparse woodlands and used for livestock grazing, the soil is shallow and occasionally limited between the rocky fissures. In such cases, the soil appears red or reddish-brown resembling the Mediterranean red soils (Terra rossa; ALEXANDRIS & DAFIS 1989). At the middle and lower slopes, under a forest canopy, the soils are relatively deep (>60cm), dark brown in color and humose, resembling a rendzina type (with A-C horizons), or a brown forest soil (with A-B-C horizons) (ALEXANDRIS & DAFIS 1989). The soil texture is generally sandy(-clayey)-loamy.

In areas dominated by hard limestones, a common practice in the past to establish the villages near the flysch, which provided the necessary land for agriculture (HALSTEAD 1987). Terraces were constructed there to extend the agricultural land at the inclined sites. However, the soil derived from flysch is fragile in its use, especially in an inclined terrain. The small water permeability of this soil type due to the high content of fine grain (clay and / or silt), makes the soil periodically dry or wet and results to frequent landslides and intense erosion (PAPAMICHOS 1985). The soil upon the terraces is deep, light brown in color, neutral to slightly acidic, of sandy-(clayey) loamy texture and of A_p-C profile.

2.1.4 Climate

The study area is located at the western flanks of Pindos, an area of high precipitation compared to Eastern Greece. The climate is Mediterranean transitional to the continental (SOULIS 1994). The Mediterranean character is associated with the annual distribution of precipitation, being high during the winter months and having a drought period of 2 or 3 months in summer (Fig.2.2). The continental climatic element is attributed to the high amplitude* of annual temperature that exceeds 40 °C.

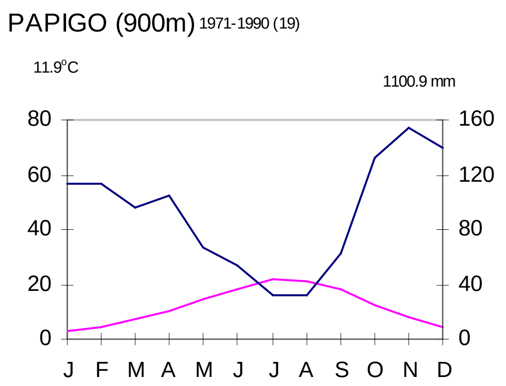

Fig. 2.2 Meteorological diagram

Information about the climate of the study area was derived from the meteorological station of Papigo, which is sited within the National Park at 900 m altitude, not far from the study area. For the

* difference between the mean maximum and the mean minimum annual temperature.

period 1971-1990 the mean annual temperature and the mean annual precipitation were 11,9^{o} C and 1.100,9 mm respectively. Extreme winter temperature (<0^{o} C) are usual in the area and the late frost danger is generally present (SOULIS 1994). In relation to the Mediterranean bioclimatic divisions the area belongs to the humid zone with cold winter (MAUROMATIS 1980).

Local climate

The local climate is considered important for the vegetation of an area and is mainly determined by the relief. The landscape in the study area is characterized by the presence of Vikos gorge and is therefore very diverse due to the abrupt altitudinal changes. The NNW-SSE direction of the gorge and its narrow funnel-like shape affect the local climate in such a way that it appears humider and cooler in relation to an open area. The direct exposure to the sun is limited throughout the year and especially in winter. This favors the vegetation, firstly by decreasing the late frost danger (except from the valley bottoms) and secondly by mitigating the summer dryness. The mid-slopes are the warmer zone of the gorge, in comparison to the upper part, which is influenced by the climatic conditions of the ridge (stronger wind velocity, lower temperature because of higher elevation and higher evaporation) and the valley, where temperature inversion occurs (ARBEITSKREIS FÜR STANDORTSKARTIERUNG 1996).

2.1.5 Vegetation

Deciduous mixed broadleaved woodlands and forests are extended in a large part of the area of Vikos community between 500 m and 1000m altitude (GANIATSAS 1971, GEORGIADIS et al. 1996, HANLIDOU & KOKKINI 1997) (Fig. 2.3). These are composed primarily of *Carpinus orientalis, Ostrya carpinifolia, Quercus pubescens and Q. coccifera,* and are rich in other tree and shrub species, with the most common being *Acer monspessulanum, Fraxinus ornus, Acer obtusatum, Quercus cerris, Cornus mas* and *Corylus avellana.* These vegetation types belong to the zone of the sub-mediterranean deciduous broadleaved forest (*Quercetea pubescentis*) (Photo 2.3). This forest zone is represented at the lower altitudes by the mixed broadleaved forests (*Ostryo-carpinion*) and at the higher altitudes by the mixed oaks forests (*Quercion confertae*) (DAFIS & JAHN1975, GEORGIADIS et al. 1996).

At highly inclined, unstable, air-humid sites of Vikos gorge up to about 1000 m the forest is enriched with species such as *Aesculus hippocastanum, Tilia cordata, T.*

tomentosa, T. platyphyllos, Corylus colurna, Carpinus betulus and Acer pseudoplatanus (Photo 2.4). *Fagus sylvatica* lacks from the area, probably due to the unfavorable (unstable) site conditions. At the upper, precipitous slopes of the gorge (between 1000 m and 1600m) the forest is consisted mainly of Abies borisii-regis (Photo 2.5).

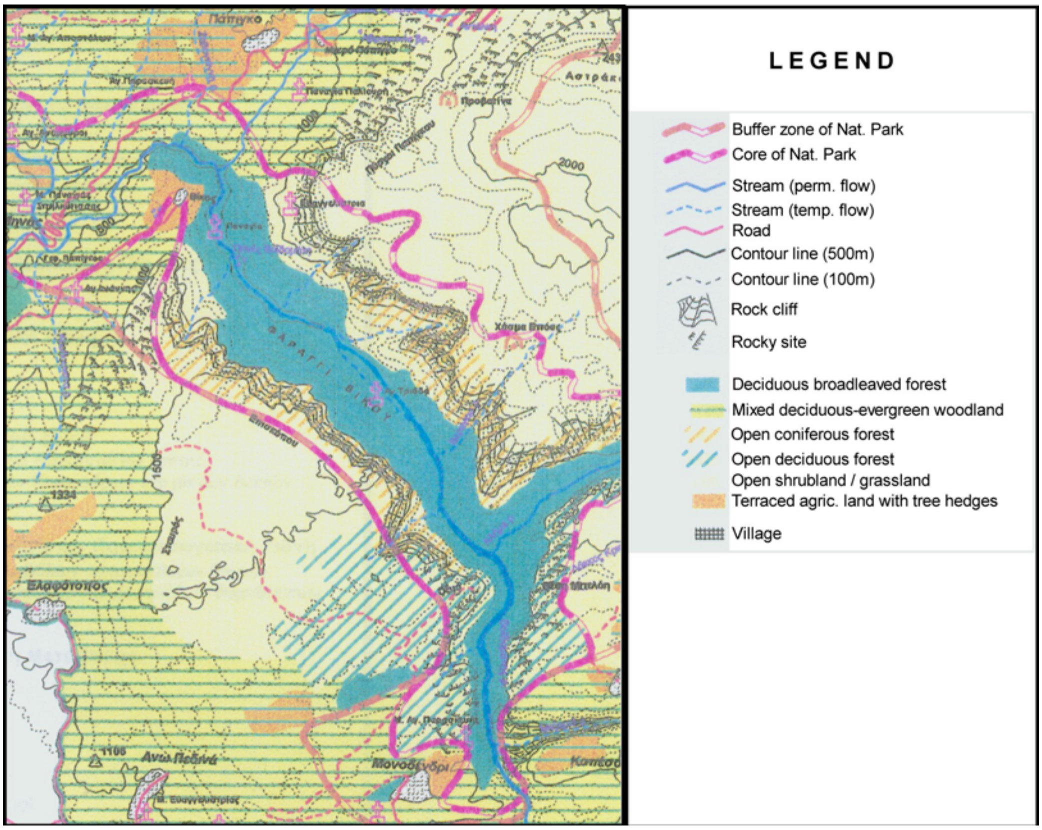

Fig. 2.3 Vegetation map (*Source: Kasioumis & Gatzojannis 1996*)

Strips of the Mediterranean evergreen broadleaved forest (*Quercetea ilicis*) with *Quercus ilex and Phyllirea latifolia* cover rocky exposures at the lower slopes (Photo 2.6). These are spatially limited and represent extra-zonal elements of the *Quercetea ilicis* forest zone, which appear at the lower altitudes of the study area (HORVAT et al. 1974, ZAFEIRATOS 1995, GEORGIADIS et al. 1996).

Semi-evergreen shrublands dominated by *Quercus coccifera, Phillyrea latifolia* and *Carpinus orientalis* cover extended areas at the lower zone of the area and the adjacent land up to about 700 m altitude (Photo 2.7). These vegetation types are attributed to extensive anthropo-zoogenous pressure associated with logging, livestock grazing and fire that prevailed there in the past (ZAFEIRATOS 1995, GEORGIADIS et al. 1996).

Intensively grazed sites are often covered by low, semi-open evergreen shrublands (Photo 2.8) in the form of garigue or phryganic vegetation types, and are dominated by *Juniperus oxycedrus*, *Quercus coccifera* or *Phlomis fruticosa* (GEORGIADIS et al. 1996, HANLIDOU & KOKKINI 1997).

The extended uplands above 1500 m, usually of moderate to low inclination or even level are covered by secondary grasslands (Photo 2.9) attributed to the transhumant pastoralism practiced there for centuries (WILLIS 1992). These vegetation types are dominated by perennial grasses (*Festuca sp., Stipa sp., Sesleria* sp. etc.) and low or cushion-shaped shrubs (*Juniperus sp., Daphne oleoides, Rosa sp., Prunus* sp. etc.) (GEORGIADIS et al. 1996).

Azonal riparian vegetation, in the form of a narrow gallery forest stretches along the sides of Voidomatis stream, and is consisted of *Platanus orientalis* often with *Salix elaeagnos* at the understory (Photo 2.10), or also with Alnus glutinosa (ZAFEIRATOS 1995, GEORGIADIS et al. 1996, HANLIDOU & KOKKINI 1997).

Secondary grasslands (forest or woodland openings) of previously cultivated fields (Photo 2.11) at the lower and middle slopes are rich in *Fabaceae* species, e.g. *Trifolium nigrescens, T. xanthinum, T. physodes, T. repens, T. campestre, Medicago minima, M. lupulina, M. arabica, Lotus corniculatus*; they include many other species such as *Plantago lanceolata, Bromus hordaceous, Poa bulbosa, Crepis rubra, C. neglecta, Scorzonera laciniata,* and also some orchids, e.g. *Anacamptis pyramidalis, Ophrys scolopax ssp. cornuta, O. mammosa, Orchis morio ssp. picta* (GANIATSAS 1971, STRID & TAN 2000).

Tall herb fringes of woodlands adjacent to the previous grasslands or footpaths include species such as *Campanula spatulata ssp. spruneriana, Geranium lucidum, Hypericum perforatum, Hypericum rumeliacum, Malabaila aurea, Melissa officinalis, Melitis melissophyllum, Orlaya daucorlaya, Prunella laciniata, Tordylium apulum, Vicia grandiflora* (GANIATSAS 1971, STRID & TAN 2000).

Xerophytic vegetation of rocky sites within the grazed shrublands (Photo 2.12) or adjacent to stone paths is consisted of species such as *Alyssum alyssoides, Asphodeline liburnica, Carex halleriana, Convolvulus elegantissimus, Festuca jeanpertii, Helianthemum nummularium, Leontodon crispus, Ruta graveolens, Salvia* *officinalis*, *Sedum acre, Silene graeca*, *Valerianella coronata* (GANIATSAS 1971, STRID & TAN 2000).

Chasmophytic vegetation (Photo 2.13) growing in crevices of ledges of limestone rocks is characterized by the presence of *Athamanta macedonica, Centaurea pawlowskii, Ceterach officinarum, Ramonda serbica, Micromeria juliana, Hypericum apollonis, Crepis dioscoridis, Pterocephalus perennis* (GANIATSAS 1971, STRID & TAN 2000).

Finally, several synanthropic vegetation types have been phytosociologically described for Vikos village (BERGMEIER 1990a). Here are included a chasmophytic vegetation type with *Campanula versicolor*, which grows on fissures of weathered traditional stone fences and on nearby limestone boulders; a veil plant community with *Clematis vitalba* covering the stone fences; a nitrophilous fringe vegetation type of moderately disturbed sites with *Sambucus ebulus* and *Urtica dioica*; a perennial nitrophilous ruderal community of *Leonurus cardiaca – Ballota nigra ssp. toetida* with *Marrubium peregrinum* on semi-shaded sites; and finally a perennial thermophilous ruderal community of *Marrubium peregrinum – Plumbago europaea*, covering sunny sites at the edges of paths, stone walls or tree hedges.

2.1.6 Flora

GANIATSAS (1971) reported the presence of 219 vascular plant taxa in the area of Vikos gorge including 67 medicinal ones (GANIATSAS 1974). Recent studies on the flora of Vikos-Aoos National Park approximate it to 873 vascular plant taxa for the whole area of the National Park including more than 250 medicinal, aromatic or poisonous taxa (GEORGIADIS et al. 1996). Finally, for the whole area of Mount Tymfi 1750 plant taxa have been reported (AUTHIER 1997). An important element of the mountainous flora of Tymfi, apart from the high number of plant species (richness), is the high degree of endemism in Balkan (23%) and Greek species (5,8%) (STRID & TAN 2000).

Information about the medicinal plants of the Vikos-Aoos National Park and their use, are provided in GANIATSAS (1974), MALAMAS & MARSELOS (1992), along with information on other taxa that could potentially be used as medicinal (VOKOU et al. 1993) and also on aromatics plants (HANLIDOU et al. 1998). Most of these medicinal /

aromatic plants are widely spread species met also in other areas in Greece (VOKOU et al. 1993) and often they are ruderal species (HANLIDOU et al. 1998).

Studies on the non-vascular flora recorded the presence of about 150 moss species in the area of Vikos including one newly described taxon (LÜTH 2002 & 2003).

2.1.7 Fauna and associated habitats

According to KATSADORAKIS (1996) the area of Vikos-Aoos National Park and Tymfi Mount hosts one of the most complete spectrum of animal species, typical of the Greek mountains and is considered among the 5-6 areas in Greece with the richest fauna characteristic for mountain and forest ecosystems.

The fauna of the area is not well documented and the information includes mainly species lists of specific animal groups (Fig.2.4). Data on the avifauna is relatively abundant, while the invertebrates are the least studied group (KATSADORAKIS 1996, WORKING GROUP 1999).

A total of 121 bird species has been observed in the area of Vikos-Aoos National Park; 26 of them are considered of conservation priority (Directive 79/409). The area hosts 15 raptor species and populations of bird species with limited distribution in Greece, e.g. *Bonasa bonasia, Aegolius funereus, Turdus torquatus, Parus montanus* and *Tichodroma muraria*. The bird communities of the subalpine and forest ecosystems are considered of the most complete and richest ones in Greece (KATSADORAKIS 1996).

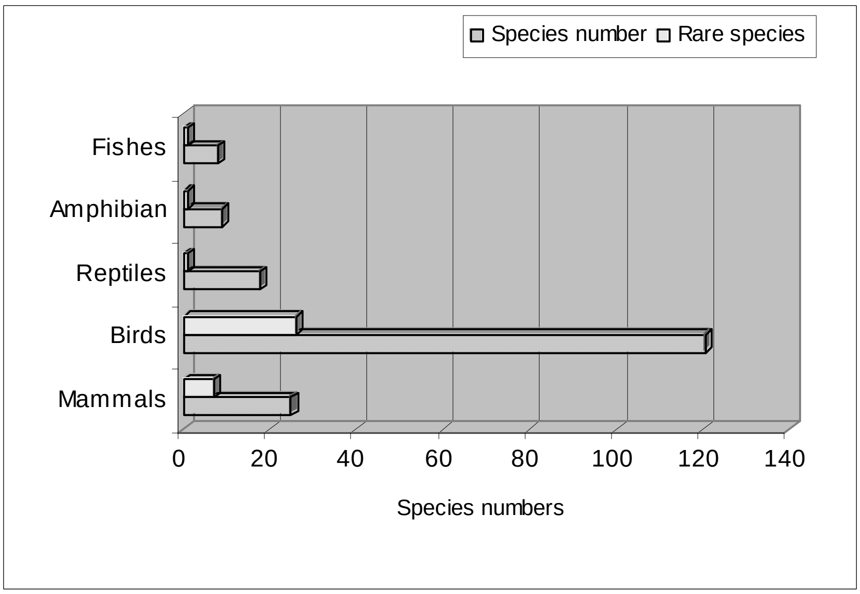

Fig. 2.4 Vertebrate animals (total vs. rare species number) in the area of Vikos-Aoos National Park (*Source: Katsadorakis 1996*).

In the study area the following main habitat types have been identified (PANAGIOTOPOULOU 1994, KATSADORAKIS 1996, PAPAIOANNOU 1999, TSIAKIRIS 1999):

1) Sub-mediterranean forests and woodlands

Here are included the various deciduous broadleaved forests and woodlands and the pseudomacchie woodlands up to an altitude of about 1500 m. The avifauna of these forest habitats is similar to that of the temperate European forests and includes typical forest species such as *Accipiter nisus, A. gentilis, Pernis apivorus, Carduelis chloris, Columba oenas, Emberiza cia, E. cirlus, Fringilla coelebs, Garrulus glandarius, Parus caeruleus, P. major, Sitta europea, Sylvia cantillans, S. atricapilla, Monticola solitarius, Alectoris graeca, Erithacus rubecula, Turdus merula, Lanius collurio, Dendrocopus medius, D. major*.

Among the large mammals, *Ursus arctos* (bear), *Canis lupus* (wolf) and *Sus scrofa* (wild boar) use the area of Vikos the whole year around. *Rupicapra rupicapra* (chamois) appears at the higher altitudes and far from human activities at the area of “Megas Lakos”, a large secondary ravine of Vikos gorge. *Capreolus capreolus* (roe deer), *Lutra lutra* (otter), *Felis silvestris* (wild cat) and *Lynx lynx* (lynx) exist also in the area of Tymfi Mount, although the last two are quite rare.

Concerning the invertebrate species, the forests due to their structural complexity and the co-existence of various small biotopes i.e. streams, ponds, forest openings, rocky sites, dead trees, old pollards, coppices etc., support a very diverse fauna, especially at the various ecotones, including often very specialized species (KIRBY 1988, ARBEITSKREIS FORSTLICHE LANDESPFLEGE 1993). However, information on these species groups is lacking for the study area.

2) Mosaic of agricultural land with tree hedges and various woodlots, in combination with semi-open shrublands and rocky sites of the lower and middle slopes near human settlements.

The mosaic landscape with the diverse structure, the numerous flowering plants and the diverse site conditions provide feeding and / or nesting sites to a large number of animal species. The combination of open and forested sites favors a rich invertebrate fauna. For instance, many insects like butterflies, grasshoppers, beetles and spiders, or snails live there, which along with the many plants, shrubs and trees have a vital role in the nutrition and breeding of many reptiles, small birds and small mammals, which in their turn attract larger mammals and raptors.

Mediterranean semi-open habitats, such as the various low shrublands and garigues have a rich and abundant reptile fauna, with typical species including the globally threatened *Testudo hermanni* and other priority species according to the Habitat Directive e.g. *Testudo marginata, Lacerta trilineata, Podacris muralis, Vipera ammodytes, Coluber najadum* (ROCAMORA 1997), all reported also for the study area (KATSADORAKIS 1996, PAPAIOANNOU 1999).

The agricultural land with the cultivated and fallow fields, the tree hedges with the various fruit trees and the gardens are important feeding and nesting sites for many small birds such as *Sylvia communis, Emberiza cia, E. cirlus, Carduelis chloris, C. carduelis, Sylvia communis, Luscinia megarhynchos, Lanius collurio, Parus caeruleus, Passer domesticus, Hirundo rustica*. Small mammals, e.g. *Lepus capensis, Erinaceous europaeus, Mustela* vinalis, *Martes foina* and rodents are abundant in the agricultural land. The high density of pray attracts larger predators, e.g. wild boar, wolf, bear, *Vulpes vulpes* (fox) and raptors nesting or feeding there. For instance, many raptors search their food within the agricultural land and the open shrublands and nest at nearby old trees or rocky sites, e.g. *Aquila heliaca, Ciraetus gallicus, Falco tinnunculus, Apus apus, A. melba, Sitta neumayer, Strix aluco, Otus scops, Athene noctua, Bubo bubo,* or they nest at higher slopes, e.g. *Aquila chrysaetos, Gyps fulvus, Neophron percnopterus.* Also many typical forest birds nest at old trees of the tree hedges and the forest fragments of the habitat mosaic, such as *Troglodytes troglodytes, Erithacus rubecula, Turdus merula, Lanius collurio, Dendrocopus medius, D. major*.

3) Uplands with subalpine grasslands and rock cliffs.

This habitat is found above 1500 m altitude and as it concerns the avifauna, it hosts two bird communities. The first community includes bird species, which nest and feed at the subalpine area, e.g. *Pyrrhocorax graculus, P. pyrrrocorax, Monticola saxatilis, Eremophila alpestris, Phoenicuros ochruros, Montifringilla nivalis, Prunella collaris, Apus melba, Sitta neumayer, Ptyonoprogne rupestris.* The second community includes bird species, which nest at the cliffs and the treeline of the uplands, but they search for food in a wider zone and they often reach down to the lower slopes and the plain of Konitsa. Here are included characteristic Mediterranean birds, e.g. *Aquila chrysaetos, Gyps fulvus, Neophron percnopterus, Falco peregrinus, F. tinnunculus, Hirundo daurica*. These birds require a mixture of woodlands, shrublands and rocky habitats within their foraging area, which are usually related to traditional non-intensive grazing, forestry and agricultural practices (KATSADORAKIS 1996, ROCAMORA 1997). This applies rather for all priority bird species of Mount Tymfi, which need mainly forest and / or rocky habitats for their breeding and nesting, but for their feeding the mosaic cultural landscape is of major importance (TSIAKIRIS 1999).

2.1.8 The traditional land-use system: Agro-silvo-pastoralism

The mixed farming system (traditional peasant economy) and the pastoralism were the main forms of traditional mountain economy in Pindos. The first one characterized the economy of the local permanent mountain villages. The second one - the specialized animal-breeding - was practiced in the form of transhumance, involving animal movement between the lowland of Epirus or Thessaly in the cold months of the year, and the uplands of Pindos in summer (HALSTEAD 1996).

The mixed farming system in the form of agro-silvo-pastoralism has shaped the landscape around permanent villages in the lower zone (up to ca.1.200 m altitude) of Pindos and it has prevailed in the area of Zagori since the 16th century. It was practiced in the form of traditional agricultural, forest and pastoral activities taking place at the same time on different spatial units, or alternating each other during the year at the same area (MCNEILL 1992, HALSTEAD 1996).

The main components of the agro-silvo-pastoral system were the cultivated land, the community woodlands and the livestock (Fig.2.5). The land-use system utilized the natural resources of the community by providing land for cultivation, fodder for the livestock, and food, energy and almost all necessities for the everyday needs of the inhabitants (subsistence production). The establishment of terraces and tree hedges provided protection against soil erosion and wind, while the whole system was adjusted to the local conditions (e.g. water economy and soil properties) (LAZARIDIS 1980). The system involved land-use practices, such as cultivation on terraces, establishment of hedgerows and scattered multipurpose woodlots, animal-raising, pollarding of trees and grass-cutting for fodder and forest exploitation in the form of selective cutting, coppicing and woodland grazing.

2.2 Historical evolution of the landscape

Extended glacial conditions prevailed at the uplands of Mount Tymfi during the Late Quaternary period ca. 28.000 years before present (BP). Sedimentary and lithological investigation in Vikos basin revealed that the inner of the alluvial units is consisted of limestone-derived material, carried into the river from the higher elevations by glacial action about 30.000 years BP. The subsequent (middle) unit is product of the deglaciation and the extended run-off from the uplands about 20.000 years BP, while the outer unit is attributed to anthropogenous actions associated with pastoralism, which assumed to have caused extended deforestation and soil erosion about 1.000 years BP (LEWIN et al. 1991).

The first evidence of human presence in the area of Vikos catchment is dated between 17.000 and 10.000 years BP (BAILEY et al.1990). During this period favorable climatic conditions prevailed and permitted the use of the gorge on a seasonal base for the ibex (*Capra ibex*) and chamois (*Rupicapra rupicapra*) hunting. During this time the human impact on the environment was negligible.

At the same period a distinct altitudinal forest zonation existed in Mount Tymfi (WILLIS 1992). The montane forest was dense and rich in tree species and it was established probably from nearby montane refugia. Tree species of the genera *Quercus, Pinus, Abies, Carpinus/Ostrya, Corylus, Ulmus, Salix, Tilia, Phillyrea, Pistacia, Fagus, Fraxinus* and *Acer* composed the forest, with fluctuations in their proportion at various periods analogue to the climatic variations. The montane forest persisted till the Bronze Age (ca. 4.000 BP). Since then the establishment of pastoralism in the form of transhumance at the uplands of Tymfi led to the destruction of the forest, the lowering of the treeline and the development of subalpine grasslands similar to the present day situation. Due to extended soil depletion and increased anthropogenic intervention, the forest vegetation never re-expanded to the uplands (BOTTEMA 1974, WILLIS 1992, GERASIMIDIS & ATHANASIADIS 1995).

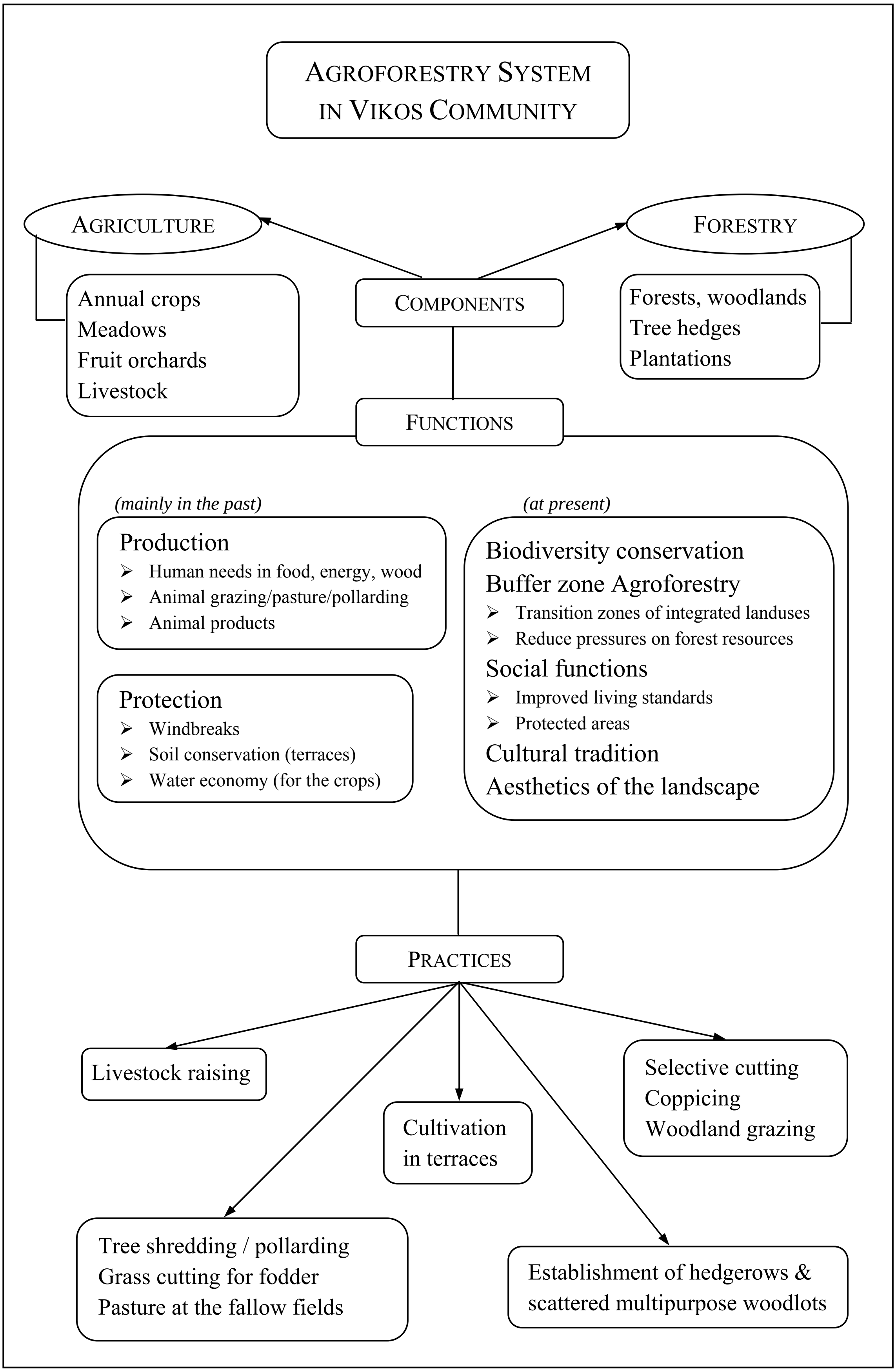

Fig.2.5 Agro-silvo-pastoralism is the traditional land use system in the study area.

During the late glacial period (ca. 20.000 to 12.000 years BP) the lowland was covered by open oak woodlands dominated by herbaceous taxa (WILLIS 1992). The establishment and expansion of agricultural cultivation at ca. 4.500 BP led to the reduction of the oak woodland and the formation of a vegetation type similar to the present day, dominated by herbaceous taxa and sclerophyllous shrubs, e.g. *Quercus coccifera* and *Paliurus spina-christi*. Since the Bronze Age the human depiction on the landscape in the area of Tymfi, as with other areas in Greece, has become strong (BOTTEMA 1974, GERASIMIDIS & ATHANASIADIS 1995).

Archaeological and historical findings trace the continuous human presence in the area of Vikos basin and Mount Tymfi during the Ancient Greek, Roman, Byzantine and Ottoman period (MAKRIS 1996). Throughout most of the historical time the mountainous population was sparse and the land provided mainly for pastoralism (in the form of transhumance) and firewood for the local needs (MCNEILL 1992).

The situation changed during the Ottoman period (17th century). At that time the area of Zagori[*], having acquired the privilege of autonomy from the Ottomans (mainly due to the mountainous and inaccessible land), had started to attract people from the lowland of Epirus (Western Greece), due to the pressure of the Ottoman occupation and the recurrent spreads of infectious diseases (plague). During this time terraces were opened up on the hills enabling the expansion of agriculture up to an altitude of ca. 1.200 m (MCNEILL 1992, HALSTEAD 1996).

The low productivity of the land though could not support the increased population for long. The people took advantage of the rise of the trade market during the Era of Ali Pasha (18th century) and many of them emigrated to the Balkans and overseas. The lack of the necessary labor for the maintenance and cultivation of the terraces initiated the gradual abandonment of the fields. At that time the increased trade with Corfu, which reached a zenith in the 19th century, promoted large scale deforestation. During this time the area of Pindos supplied Corfu with thousands of sheep and goats each year, along with timber and firewood, which was further traded to the other world (MCNEILL 1992). This process favored land use intensification and the depletion of forest resources. The forests, which were cut for timber and firewood,

[*]Zagori or Zagorochoria is an area with 46 mountainous villages near Mount Tymfi, where also Vikos village belongs to.

were successively grazed promoting thus soil erosion and (pseudo-) macchie and garigue vegetation types.

The trade between (Ottoman) Epirus and Corfu stopped in the end of 19th century, when Britain ceded Corfu to Greece. The political disorder and the wars that followed, along with the increased population kept the pressure on the land. These factors and the marginal land productivity encouraged further immigration and land abandonment, a process that was completed after the World War II and left the mountain villages heavily depopulated, the terraces to collapse and to be colonized by woody species and pastoralism as the main land use.

In conclusion, the present cultural landscape of Mount Tymfi and Zagori area is considered to have emerged in the period between 1800 and 1950 following similar historical evolutionary process to the other mountains of Pindos and the Mediterranean world (MCNEILL 1992).

2.3 Elements of the traditional cultural landscape

The long human presence and activities in the area have created a mosaic landscape (Fig. 2.6) of small terraced fields with tree hedges, grasslands, semi-open shrublands and woodlands, forests and forest fragments, which along with the human settlements and the rest infrastructure consist the elements of the traditional landscape.

Table 2.1 The elements of the traditional cultural landscape
➢ village and infrastructure
➢ terraced fields with tree hedges
➢ grasslands, shrublands and woodlands
➢ forest fragments and forests.

2.3.1 Village and infrastructure

Vikos belongs to the geographical area of Zagori, which is a complex of 46 mountainous villages in the area of Tymfi. Zagori flourished economically in the late Ottoman period (17-19th cent.) and is characterized by an outstanding traditional architecture dating to that era. Nowadays the area is heavily depopulated due to the strong immigration that followed the 2nd World War and the end of the Civil War (1947). The marginal land productivity along with the socio-economic changes of the mid 20th century led to the gradual abandonment of the traditional economy (KASIOUMIS & GATZOJANNIS 1996).

Vikos is a small village, where traditional agro-silvo-pastoral activities are still practiced, although decreased in comparison to the past. The establishment of the village is not exactly known. Like most Zagorochoria Vikos village has a nucleus-like form, with the houses situated around the central square, where the church is also placed. The old infrastructure within and around the village are made of the local limestone rock. The houses used to be one or two stored and apart of the main building where the family lived, they incorporated also secondary rooms for the livestock (NTIA & STAMATOPOULOU 1983). Nowadays the livestock remains in stables outside of the village. All new houses are built in agreement to the local architecture and are usually attached to irrigated gardens abundant in fruit trees and enclosed by stone walls.

Rocky pathways connect the houses with the centre of the village, the meeting place of the local community. Other old constructions include threshing floors, springs, watering ditches and small storehouses in the fields, all made of local limestone rock (Photo 2.14). A network of these rocky pathways (“kalderimia”) was expanded on the whole area of Zagori, abetted in the steep slopes by constructions called «skales» (scales, stairs) or by bridges, wherever a stream had to be crossed. This infrastructure was constructed during the period that Zagori flourished economically (17-19th cent.) (NTIA & STAMATOPOULOU 1983).

2.3.2 Terraced fields with tree hedges

Due to the mountainous and intense relief the adequate land for cultivation was limited. For this reason terraces were opened up parallel to the contour lines by ploughing on several layers on the slopes near the village (Photo 2.15). Their margins were stabilized by walls made of the stones, which had been removed from the soil during the ploughing. The stone walls were let to be colonized by shrub and forest vegetation and partly were planted with fruit and fodder trees. Long distances had to be covered and much labor was needed for the cultivation of the fields that were spread from the hills next to Voidomatis River up to an altitude of ca. 1000 m.

In the agricultural land cereals (mainly wheat, barley, oat and rye) and legumes (lentil, pea, vetch) were cultivated alternatively from year to year. After 3 or 4 years of consecutive cultivation the fields remained fallow for one year, to let the soil recover. During this time the land was grazed by the livestock. The seeding was done in autumn at the fields of the lower altitude. On the contrary, the fields on higher elevation were seeded in early spring. Before cultivation the fields were manured. The manure was brought to the fields from the stable. For a short period vineyards have been also established, but their cultivation did not last long due to diseases.

The tree hedges and the forest fragments of the steep sites dispersed among the agricultural land were of major importance for the local economy. Although their main role was to stabilize the terraces and protect the soil against erosion and the cultivations from strong winds, they provided also leaf fodder for the livestock, timber, firewood and various wood products for the inhabitants, along with fruits and nuts necessary for their nutrition (Photo 2.15). In proximity to the village the tree hedges abound in fruit trees, e.g. *Prunus avium*, *P. mahaleb*, *P. cocomilia*, *Malus sylvestris*, *Ficus carica*, *Morus alba*, *M. nigra*, *Pyrus communis, Juglans regia*.

In an area dominated by limestone the water is scarce and wherever it appeared, it was collected. A watering system of stony reservoirs accompanied by small channels and furrows were dug up in the terrain and provided for the irrigation of small gardens established closed to the villages (Photo 2.16). In spring the gardens were manured, and beans, potatoes, onions and other vegetables were cultivated. The production was destined to self-consumption.

The maintenance of the terraces and the watering system was a hard work, requiring a lot of labor. On the other side, the marginal productivity of the land could hardly provide for the whole year nutrition of the inhabitants. For these reasons the cultivation of the fields and the gardens has been gradually abandoned since 1950. Nowadays the stone fences break down making the terrace borders susceptible to erosion. Part of the land has been invaded by woody vegetation. In advanced forest succession only the presence of the stone fences gives evidence of the previous agricultural use. Most of the terraced land is not cultivated nowadays and is either grazed or used as meadow for hay production.

2.3.3 Meadows and grasslands

The summer drought of the Mediterranean climate does not favor meadows (HORVAT et al. 1979). This fact along with the limited land for cultivation are the reasons for the lack of meadows in the study area in the past. Usually the boarders of the fields were mown for feeding the young livestock in spring.

Meadows have been established relatively recently (after 1950) on the terraces, as an alternative to the agricultural cultivation. From early spring the farmers let the grass grow in the terraces and they mow it at the end of May (Photo 2.17). The rest of the year the land is grazed. The hay production is low and it only partially covers the feeding needs of the livestock. Nowadays a small fraction of the terraced land adjacent to the village is still mowed. Most of the former cultivated land serves as pasture or remains fallow.

2.3.4 Shrublands and woodlands

In the traditional peasant economy pastoralism was supplementary to the agricultural and forestry activities, and aimed to cover the annual needs of the inhabitants in dairy products (milk, butter, cheese, meat). The livestock of each family was usually 1 or 2 cows and 5 to 20 small animals (sheep and/or goats), along with 1 or 2 animals (donkeys, horses) for the field work. A communal shepherd was usually hired to lead the herd of the small animals to the communal pasture during the day.

The lower and middle slopes in vicinity to the village provided the daily pasture of the community livestock from autumn till spring, and made possible the daily return of the livestock back to the village (Photo 2.18). The high grazing pressure led however to the degradation of forests and their gradual substitution by open woodlands and low shrublands (mainly garigue and phrygana), with the last one in intensively grazed sites usually near the village.

During the summer when the grassy biomass around the village was dry, the livestock was moved upwards to the community woodlands of the higher slopes, where fresh fodder could be found. With time the forest canopy was opened up and the tree layer became sparse, with abundant woody and herbaceous undergrowth, which provided the necessary food. Due to the distance from the village, the animals remained at these slopes the whole summer.

Special care was taken to keep the livestock away from the agricultural land, not only for protecting the crops, but also the stone terraces, which were destroyed easily by the animals. Only for short the animals were let graze on the fields of their owner after the cropping of the yield or during the fallow phase.

Nowadays only a few families are occupied with pastoralism. There is no community shepherd anymore and the animals are either accompanied to the field by their owner, or are left alone to graze since most of the agricultural land is abandoned.

After the designation of the National Park in 1973, part of the community grazing land was incorporated in the core of the National Park. However the livestock is occasionally found to graze there, raising thus conflicts with the Forest Service.

Nowadays two herds of about 300 small animals (mainly goats) graze the community shrublands. The abandoned terraces provide pasture (Photo 2.19) to a small number (20-30) of sheep during the year (Table 2 in Annex).

2.3.5 Forests and forest fragments

Traditional forest management systems all over the world combine activities that exploit forest resources, in order to provide for the human living (NAIR 1993). In the study area the main functions of the forests in the past were the supply of firewood, timber, wood for constructions (rods, poles, logs etc.) and forest pasture (Fig.2.5).

Forest management was practiced in an irregular form of coppice forest with standards. The forest stand was cut in a short rotation of about 10 to 20 years to provide the necessary firewood for the yearly needs. Only a few scattered trees were let to grow for several rotation periods. These trees were kept for their timber and they were usually replaced by seedlings. The low forest management favored resprouting species such as *Ostrya carpinifolia*, *Carpinus orientalis* and *Quercus coccifera,* which expand quickly after coppicing (BLASI et al. 2001). *Ostrya carpinifolia* and *Carpinus orientalis* are both abundant at northern sites, with the first species preferring higher altitudinal zone. *Quercus coccifera* dominates at southern slopes and at shallow / rocky sites up to about 700 m altitude.

Apart from supplying wood, the forests served also as wood pasture. In winter the woodlands of *Quercus coccifera* provided for the daily pasture of the animals, lowering thus the demand for hay or leafy fodder. In summer the forests of *Carpinus orientalis* and *Ostrya carpinifolia* in the gorge provided the necessary pasture. Both the undergrowth and the low tree layer offered essential food for the livestock at a period, when the nearby open land was completely dry.

In the cold days of winter, when the snow covered the nearby shrublands, the livestock was kept in the stables and fed with tree branches, hay and straw. The pruning of the tree branches and the use of leaves and twigs as fodder to the livestock is an old praxis in Pindos and the Balkans in general, spread wherever the meadows or the evergreen scrub were lacking (HORVAT et al. 1979, HALSTEAD 1998). The leafy fodder was taken mainly from the oaks (*Quercus pubescens, Q. cerris, Q. frainetto*), and secondarily from other broadleaved tree species (*Carpinus orientalis*, Fraxinus ornus, *Ostrya carpinifolia*). The branches were cut from the stem of the tree in September, every 2 or 3 years. In the area of Pindos the side branches of the trees were usually cut (shredding), creating thus a cylindrical crown form (Photo 2.20). Occasionally the whole top of the tree was cut (pollarding). The branches were then dried and stored to feed the livestock during the winter. The need for leafy fodder promoted the dominance of oaks in the tree hedges and the forest fragments in proximity to the village (HALSTEAD 1998).

During the last decades, the traditional forest praxis was gradually abandoned. The aged population cannot provide the required labor. Activities such as firewood collection and timber production inside the communal land are regulated nowadays by the Forest Service, and forest pasture officially is forbidden. The needs for firewood, timber and fodder are covered by the local market. Only small-scale tree shredding or pollarding for animal feeding is occasionally practiced by some elderly people on private land, while on communal land it is also prohibited by the Forest Law. The legal status of the National Park bans any of these activities inside the core area.

2.4 Policy framework in nature conservation and sustainable development

The main driving factors determining the future of nature conservation and rural development in Vikos-Aoos National Park are the marginal land productivity, which does not favor large scale productive activities, and the ecotouristic potential associated with the high ecological, cultural and aesthetic value of the area (KASIOUMIS & GATZOJANNIS 1996, PAPAGEORGIOU & BROTHERTON 1999).

The traditional land-use system does not function any more. Nevertheless, small-scale traditional activities such as cultivation of the terraces without or with limited use of mineral fertilizers and chemicals, meadows, tree pollarding and mainly pastoralism are still practiced. The future of these activities depends largely on the general European and national policies dealing with the conservation, management and development of mountainous and protected areas, and the policies of related sectors e.g. agriculture, livestock, forestry, tourism, industry (IUCN 1994, EUROPEAN COMMISSION 1998, NCECD 2002, MARAGOU 2004).

The area of Vikos-Aoos national park is touristically attractive and has high ecotouristic potential. Ecotourism is seen the last years as an alternative to the economic decline of the heavily depopulated local communities and as a means against further immigration (PAPAGEORGIOU & BROTHERTON 1999). Within this frame small scale interventions in the villages and the infrastructure of the National Park have been carried out for improving the tourism facilities and providing jobs and additional income to the inhabitants. The local private tourism industry has been favored by national and European funds and provides nowadays modest accommodation and high quality tourism services with respect to the local tradition and culture (KASIOUMIS & GATZOJANNIS 1996).

At the same time at national level the requested implementation of the Habitat Directive and the responsibilities resulting from the national commitment to the Convention on Biodiversity, along with the pragmatic need for an efficient implementation of a National system of protected areas (KASIOUMIS et al. 1998), have recently led to significant changes in the policy concerning the protected areas.

Specifically, the two main EU Directives about the environment (Birds directive 79/409 and Habitats Directive 92/42) have been incorporated in the Greek Legislation. A new law (Law 2742/99 “on the physical planning and sustainable development”) concerning the management of protected areas and the implementation of Natura 2000 network in Greece has come into force, and 25 new management boards have been established in existing and new protected areas (Law 3044/2002).

Among the new protected areas is the National Park of North Pindos, which incorporated both Vikos-Aoos National Park and Pindos National Park (YPEXODE 2002, MARAGOU 2003) and the area between them. The necessary legislative regulations concerning the organization and finance of the new management board are expected to be enacted soon, in order the new management scheme to become functionable (YPEXODE 2005).

On the other side Greece conforming to the new reform of the Common Agricultural Policy (EUROPEAN COMMISSION 2003), promotes a series of measures aiming both at the integration of environmental concerns into the related policy sectors such as Agriculture, Livestock Husbandry, Forestry and Fisheries, and at the development of agricultural practices preserving the environment and the countryside (MINISTRY OF AGRICULTURE 2004a). With these objectives minimum environmental standards (compulsory cross-compliance) are to be applied by the farmers as a condition for the full payment of the subsidies starting in 2006, which will be decoupled by the type and the size of production. Furthermore, agri-environmental measures support (in a form of compensatory payments) environmental friendly farming techniques that go beyond the usual good farming practice (MINISTRY OF AGRICULTURE 2003) and favor activities related to the extensification of farming and livestock husbandry, the organic agriculture and pastoralism, the preservation of the rural landscape and traditional features such as hedgerows, terraces, isolated trees and woods and the conservation of ecologically sensitive and high value habitats and their associated fauna and flora (MINISTRY OF AGRICULTURE 2004b).

3 Material and Methods

In the previous chapter the local cultural landscape in the area of Vikos-Aoos National Park was identified and its various components and elements were described along with the traditional land use system. This chapter presents the methodology applied for the ecological evaluation of the cultural landscape. The evaluation was based on the vegetation and flora of the landscape elements. For this reason the inventory, analysis and description of the vegetation was carried out prior to the landscape evaluation, which was further realized by applying specific nature conservation criteria.

3.1 Inventory of the vegetation

Physiognomic stratification of the vegetation provided the basis for its inventory. Four formations were identified corresponding to the landscape elements: forests (including woodlands), shrublands, grasslands and rocky sites. The plot sizes were chosen according to the minimum area concept (GLAVAC 1996).The plot size was set to 100 m^2 for the forests and shrublands, 20 m^2 for the grasslands and 10 m^2 for the rocky sites (Table 3.1).

Table 3.1 Plot characteristics

Vegetation formation	Plot size (m^2)	Plot dimensions	Number of plots
Forest/woodland	100	8m x 12,5m*	179
Shrubland	100	8m x 12,5m	31
Grassland	20	4m x 5m	157
Rocky sites	10	2m x 5m	43
Total			410

To facilitate the comparison of vegetation data with different plot sizes, a nested plot design (KENT & COKER 1992, STOHLGREN et al. 1997) was adopted for the inventory (Fig.3.1). Specifically, inside each plot of 100 m^2 or 20 m^2, a subplot of 10 m^2 was set for inventory. Furthermore, for fifty (50) plots of the grassland vegetation the 20 m^2 plot was expanded to 100 m^2. In each case the 100 m^2 plot contained the 20 m^2 and the 10 m^2 plot. Also forty (40) plots of the forest type were expanded to the 200 m^2. This was decided for the forests of the gorge, where the extended forest cover and the

* The tree hedges, which were also included to the forest/woodland formation, were inventoried with a plot size of 100 m^2, but with no standard dimensions due to their linear structure.

homogeneous site conditions permitted the inventory of a larger plot size than that of 100 m^2.

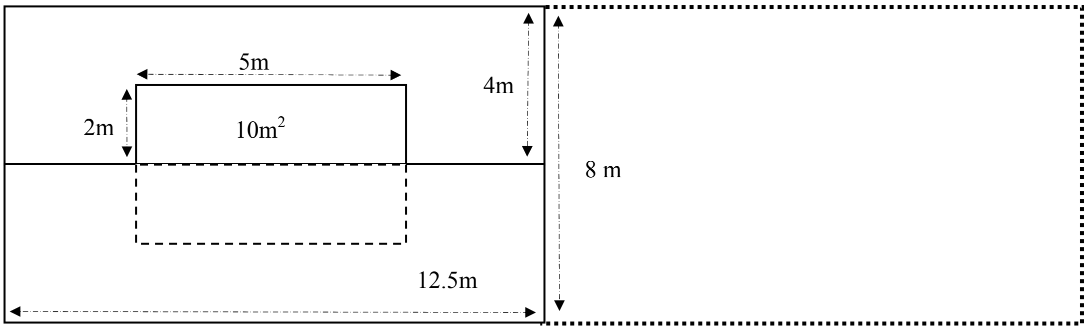

Fig.3.1 The nested plot design used for the vegetation inventory.

The inventory of the vegetation was conducted from May till July of the years 1999, 2000 and 2001. Each year the grasslands, rocky sites and shrublands (open vegetation) were inventoried between May and June. The forests and woodlands (woody vegetation) were sampled from the end of May till July. At the same time the

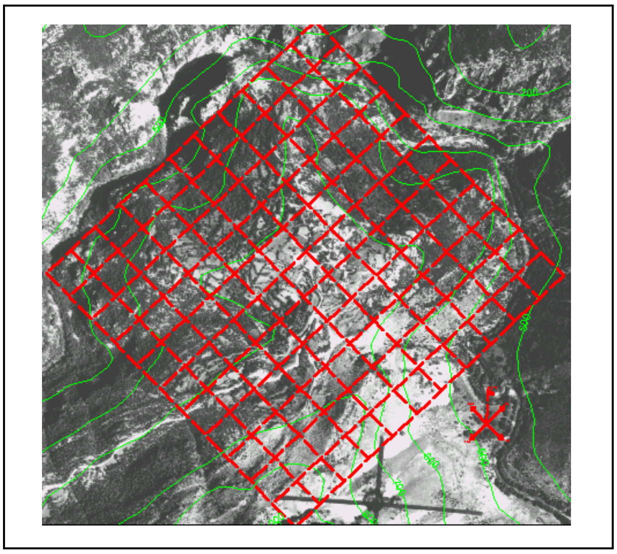

Fig.3.2 Systematic inventory (grid)

open vegetation was also inspected for late growing species.

Two extra visits at the study area, once early in spring and a second late in autumn of the year 2001, contributed to the identification of early and late growing species respectively, which have been registered at the plots, but remained unidentified due to missing floral parts. During these visits all new plant species encountered in the area were also registered.

A systematic inventory was applied initially by the use of a grid. The distance between the plots was set to 100 m, due to the alteration of the vegetation in relatively short distance (Fig.3.2). The 100 m distance between the plots allowed all vegetation formations to be inventoried, although with different plot numbers (KENT & COKER 1992). At the grid nodes falling at two vegetation formations the sampling plot was moved accordingly, so that only one formation was inventoried. A supplementary random sampling provided additional plots for vegetation types under-represented in the systematic sampling. The numbers of plots in the two designs are given in Table 3.2.

Table 3.2 Plots of the systematic and random inventory

Vegetation type	Number of plots		
	Systematic inventory	Random inventory	Total
Open vegetation	63	168	231
Woody vegetation	130	49	179
Total	193	217	410

The vegetation was inventoried at three layers (herbs, shrubs and trees) of fixed height. The herb layer included all herbaceous species and also all woody species found in a zone up to 1 m above ground. The shrub layer contained all woody species found between 1 and 5 m above ground. Woody species with a height of 5 m or more formed the tree layer. The plant species of the shrub and tree layer are marked with the letter “S” or “T” respectively at the vegetation table. At each plot and for each vegetation layer the presence of all vascular plant species was recorded and their abundance was visually estimated according to an adjusted BRAUN–BLANQUET scale (GLAVAC 1996) (Table 3.3).

Also, the total cover value of each vegetation layer and that of the soil, rocks and mosses were estimated. Site parameters, such as altitude, exposition, inclination, relief type and land use type (Table 3.4) were also registered at each sampling plot. Data of the geology were provided from the geological map of the study area (PERRIER et al. 1970). Soil samples were also collected from plots considered representative for each vegetation type and geological substrate.

Non-vascular plant species such as mosses and lichens were not inventoried. These species vary strongly in short distance depending on the micro-climatic and micro-site (humus quality, quantity of dead wood) conditions. Their inventory is also time consuming and requires expertness in the knowledge of the cryptogamous flora (WILMANNS 1998).

Table 3.3 BRAUN-BLANQUET cover-abundance scale and respective transformed mean cover values

BRAUN - BLANQUET scale	Abundance / cover range*	mean cover value (%)
r	1-3 individuals & cover <1%	0.01
+	4-10 individuals & cover <1%	0.1
1	11-50 individuals & cover 1-3%	2
2m	>50 individuals & cover 3-5%	4
2a	any number of individuals, cover 5-15%	10
2b	any number of individuals, cover 15-25%	20
3	any number of individuals, cover 25-50%	37.5
4	any number of individuals, cover 50-75%	62.5
5	any number of individuals, cover 75-100%	87.5

* adjusted from GLAVAC (1996)

PLANT SPECIES IDENTIFICATION

Specimens of the plant species were collected and identified based on Flora Europaea (TUTIN et al. 1964-1980), Mountainous Flora of Greece Vol.1 (STRID 1986) & Vol.2 (STRID & TAN 1991) and Flora Hellenica Vol.1 (STRID & TAN 1997).

The plant life form spectrum was assigned according to the major divisions of the RAUNKIAER'S system in phanerophytes, chamaephytes, hemi-cryptophytes, geophytes, and therophytes (MUELLER-DOMBOIS & ELLENBERG 1974, ATHANASIADIS 1984). The necessary information on the life forms was based on DROSSOS & ATHANASIADIS (1989), ATHANASIADIS & DROSSOS 1990, BÖHLING (1995) and OBERDORFER (2001), and the above mentioned literature of the Greek Flora.

Table 3.4 Land-use types	
Land-use type	Main characteristics
Meadow	Grassland mown once per year and grazed afterwards
Forested field	Terraced land with successional woody vegetation
Old garden	Fallow land recently abandoned (< 10 years)
Pasture	Grassland grazed by sheep
Wood pasture	Shrubland and open forest grazed by goats
Shredding /Pollarding	Cutting the young tree branches for fodder
Coppice forest	Vegetatively regenerated woodland, cut in short rotation (15-20y) for firewood, occasionally grazed
Middle forest	Forest with coppiced undergrowth and standards

3.2 Analysis of the vegetation data

Objective of the vegetation analysis was to identify and describe the plant communities forming the vegetation of the various landscape elements. The analysis followed the procedure described in WILDI (1989), and was done with the use of Mulva 5 software (WILDI & ORLOCI 1996).

The analysis includes a series of procedures to handle the vegetation data (data transformation and species dataset reduction), detect outlier plots, classify plots and species and identify differentiating species, associations between plots and species groups and potential ecological gradients (Table 3.5).

The particular methods applied in the study are presented in the following sub-chapters. For certain methods, results are presented in this part as well, because they help on a better clarification of the methods.

3.2.1 Handling of the vegetation data

At first the cover-abundance data of the plant species were transformed to the mean cover value of the respective class of the BRAUN-BLANQUET (Br.-Bl.) Scale (Table 3.5). Due to the fact that the first two levels (r, +) of the Br.-Bl. scale represent species abundance and only roughly cover data, the respective mean cover values were set in approximation to the specific cover range (VAN DER MAAREL 1979, KOCH & GRABHERR 1998). The very low cover value of these two levels (0.01% and 0.1% respectively) can hardly influence their relations to the higher cover values of the other levels.

The replacement of the Br.-Bl. codes with the mean cover values is considered a type of data transformation that is often referred to as code replacement (VAN DER MAAREL 1979, WILDI & ORLOCI 1996). A species cover value represents the species weight or the species importance value in the vegetation and the diversity analysis (KREBS 1989, KENT & COKER 1992).

The vegetation data included 410 plots with a total of 700 different plant taxa (including species and subspecies). However, species occurring in more than one vegetation layer entered the analysis several times as „different“ species, resulting in a total of 815 species-variables. Species found in 3 or fewer plots ("rare" species[1]) were removed from the numerical analysis, thus resulting in a total of 617 species. Despite this information loss, the exclusion of the "rare" species is considered not to affect seriously the analysis, since more than 3 plots were used for the determination of the plant communities (WILDI 1989).

3.2.2 Detection of outlier plots

The aim of the outlier analysis was to identify and exclude from the analysis plots with low resemblance to the others. Prior to the outlier analysis, each individual species cover value was transformed by taking its square root. This form of transformation downweights the high cover values and underpins the low ones, reducing the influence of the differences in the cover values of the species.

The outlier analysis was based on the nearest-neighbour method. By using the VAN DER MAAREL coefficient as a similarity measure, the resemblance value between the plots was calculated and the nearest neighbour to each plot was identified. In general, the lower level, below which the similarity value of two plots is considered critical, is not fixed (WILDI 1989). Although the experience on the application of VAN DER MAAREL coefficient sets a critical level of similarity at 0.3 or 0.4, the inspection of the histogram of the nearest-neighbour resemblance values is considered more appropriate for the identification of outlier plots (WILDI & ORLOCI 1996) and it was applied in the present analysis.

3.2.3 Classification of plots and species

The numerical classification as an explorative method aims at the identification of pattern and order in the data and leads to data reduction and hypothesis generation (KENT & COKER 1992). In the present study a hierarchical agglomerative classification was applied with the objective:

- to identify groups of plots with similar floristic composition, which will represent the plant communities of the data, and

[1] The term "rare species" is used in this chapter in the sense of "infrequent in this data set", and applies only for the vegetation analysis and it has a different meaning from the same term applied later as a criterion in the ecological evaluation.

- to aggregate the plant species into groups of similar distribution patterns, which will be used for the definition and description of the plant communities.

The hierarchical agglomerative classification proceeds from the individual items (samples or species) and progressively combines them into groups, in terms of their similarity, until all items fall in one group.

The classification was done by applying the specific data transformations, resemblance measures and clustering algorithm proposed by WILDI (1989).

Critical to a hierarchical agglomerative classification is the number of groups to be chosen, so they adequately explain the pattern of the data. For the objective selection of an optimal number of groups, analytic criteria have been developed, but none of them can be considered as standard (AFIFI & CLARK 1990). As a general rule, sudden jumps in distances between groups at successive agglomeration steps provide a good indication of a fair separation of groups, but the investigator should have in mind the objectives of the analysis as well (BACKHAUS et al. 2000).

WILDI (1989) approximates the number of the items groups as a function of the square root of the items number. This rule results in 20 plot groups and 25 species groups for the present study. Decision on the appropriate number of groups was made taking into account the above numbers, studying the respective dendrograms and considering the ecological interpretation of the plots and species groups as well.

The examination of the respective dendrograms with respect to the separation distances among successive agglomeration steps and the consideration of the ecological interpretation of the derived groups led to the discrimination of 24 plot groups, which defined the plant communities or sub-communities of the study area (as it will be seen later), and 36 species groups, which were used to describe the plant communities.

3.2.4 Selection of differentiating and diagnostic species

JANCEY's (1979) ranking algorithm is an analytical tool to rank species on their ability to discriminate between a priori known groups of plots. The algorithm considers plot groups as levels of an analysis of variance and calculates the within and between groups sums of squares for each species. The variance ratios of between over within sums of squares have an F distribution with the appropriate degrees of freedom and their values can be tested for significance at a *p* probability level. Species with significant ratios have high discriminatory power, while those with non-significant ratios are considered to have no discriminatory power.

The decision on the probability *p* level is critical, since it determines the size and composition of the species subset that would be used for plot groups differentiation. JANCEY (1979) states that very small values can derive meaningful differentiations only with well structured data sets, while in cases with virtually absent structure even a *p* value of 0.10 can not lead to a satisfactory number of differentiating species.

The 24 groups of plots derived from the previous analysis (classification of plots) were used as the a priori groups for the application of JANCEY's algorithm. A probability level of p=0.01 was considered small enough to derive a sufficient number of differentiating species. This resulted in a critical F-value of 2.4 (with 23 degrees of freedom (DF) for the nominator and 384 DF for the denominator[*]). All species with an F-value greater than 2.4 are not randomly distributed, they have statistically significant discrimination power and therefore they can be used to differentiate plot groups.

From the 617 plant species, 450 species were found to have an F-value > 2.4 and consisted the <u>differentiating species</u> of the plots groups, which were further used for the description of the plant communities. These species remained in the structured part of the Vegetation Table (Annex II). The rest 163 species were considered without significant discrimination power and consisted the accompany species of the plant communities in the Vegetation Table, encoded as "species group 999".

The application of JANCEY's algorithm led to a reduction of the plant species number. The further steps of the analysis were carried out on the data set of the 408 plots and the 450 differentiating species.

Furthermore, an even smaller number of species than the differentiating ones were identified, i.e. the diagnostic taxa, which are taxa highly associated with a specific plant community. <u>Diagnostic taxa</u> to a community were considered those with constancy in the community greater than 30% and more than twice the constancy of the specific taxon in other communities (BERGMEIER 2002). The constancy of a taxon in a specific community (plot group) was expressed in percentage and was defined as

[*] DF_1= (number of plot groups) – 1, DF_2 = (number of plots) – (number of plot groups)

the number of plots with the certain taxon divided by the total number of plots of the specific community.

3.2.5 Identifying the association between plot groups and species groups

To identify the association between plot groups and species groups, a so called concentration analysis (WILDI 1989) can be used. It is based on the species presence data and it includes a Chi-square (X^2) test. The degree of the association between plots and species groups is evaluated by the difference between the observed relative abundance of a species group in a plot group against the expected one. The greater the difference, the more associated the species group to a specific plot group is. The species group with the highest association to a specific plot group is considered the diagnostic species group for this plot group.

3.2.6 Structuring the vegetation table

According to WILDI (1989), the ordered vegetation table (with the dense blocks along the diagonal) can be attained with an ordination analysis (correspondence analysis, CA) of the matrix of the differences between observed and expected values resulted from the previous concentration analysis. Thus, the coordinates of the plot- and species groups are obtained. By ordering the plots and species groups along the first axis of the CA, which represents the main floristic gradient, the diagonal structure of the vegetation table can be acquired. Thereafter, the plots and species can be also rearranged along the 1st axis of the correspondence analysis within the groups.

In the present study, the mathematical solution of WILDI (1989) was rearranged by modifying the Vegetation Table (Annex II): (1) The diagonal structure of the vegetation table was attained by rearranging the plot- and species groups manually, but the group compositions were maintained. The species groups with high discrimination power were moved manually to the top section of the table, while the not discriminating accompany species (“species group 999”) were moved to the lower part of the table, with the species in decreasing constancy. (2) Also the species within each species group were rearranged, with the tree and shrub species set before the herbs, and the more constant species prior to the less constant ones.

The sequence of the plant communities (plots groups) in the Vegetation Table (Annex II) and Constancy Table (Annex III) (starts from those representing the near-natural and less affected by the human activities vegetation types of the study area (forest vegetation) and proceeds to the anthropo-zoogenous and the synanthropous ones (open vegetation), following a transition under increased human influence.

3.2.7 Naming of the plot and species groups

The naming of the plant communities was based on characteristic species in the sense of BRAUN-BLANQUET and follows in general Article 10 of the Code of Phytosociological Nomenclature (WEBER et al. 2000). The species groups were named after the species with the highest discrimination power within each group (WILDI 1989). Plot groups with no diagnostic species consisted sub-division of the closest community type and were characterized as community form (BERGMEIER 2002).

3.2.8 Syntaxonomy

The classification of the plant communities to the syntaxonomical system of the Greek vegetation was facilitated by DIMOPOULOS & GEORGIADIS (1995) and PAPASTERGIADOU et al. (1997) for the Greek vegetation, MUCINA (1997) for the European - Mediterranean one, and HORVAT et al. (1974) for the Balkan vegetation. Due to the lack of complete knowledge of the Greek vegetation and especially of the non-forest types, the plant communities were ranked synsystematically up to the Alliance level. An effort was made to correspond the plant communities derived from the present work to specific associations of the literature.

3.2.9 Identification of ecological gradients

Ecological gradients can be detected by two major analyses: the direct (or environmental) gradient analysis and the indirect gradient analysis. The first one demands measurements of environmental factors combined with the floristic data, while the second one can reveal ecological gradients on the basis of only floristic data (KENT & COKER 1992).

Since in the present study the environmental data were not explicitly referred to the floristic data of the plots, an indirect ordination was applied to detect the underlying ecological gradients (KENT & COKER 1992, JONGMAN et al. 1995). The two main techniques of indirect gradient analysis, i.e. Principal Component Analysis (PCA) and Correspondence Analysis (CA) have been tested and performed with CANOCO version 4 software (TER BRAAK & ŠMILAUER 1998).

In the various alternative ordination options tested the first ordination axis presented a length of more than 3 standard deviations, a fact that directed to the application of Correspondence Analysis (TER BRAAK 1988 in SAYER 2000). The data demonstrated in addition an "arch" effect in the ordination diagram (KENT & COKER 1992), suggesting the Detrended version of CA (DCA) as the proper ordination method (JONGMAN et al. 1995, TER BRAAK & ŠMILAUER 1998).

DCA proved to be the best performing model in terms of meaningful interpretation of the results as well. Detrending by segments on the log transformation of species data and no downweighting of rare species were the applied settings (TER BRAAK & ŠMILAUER 1998). The log transformation was applied to downweight the dominant species and to obtain the statistically important normal distribution of the species data (JONGMAN et al. 1995).

DCA was applied to the data set of the structured part of the vegetation table, which included 408 plots and 450 species. This was decided for practical reasons, since the specific version of Canoco could not carry out the analysis with more than 500 species.

Rank correlation based on SPEARMAN'S non-parametric coefficient (BÜHL 2001) was used afterwards, to relate the ordination axes to existing environmental, structural and ecological data. This facilitated to the ecological interpretation of the ordination axes.

Finally, both plot- and species ordination diagrams were visually examined to identify the environmental gradients of the dataset and detect other structures, which could not be explained from the recorded environmental data. This contributed additionally to the illustration of ecological characteristics of the plant communities.

Table 3.5 Stages of the vegetation analysis		
Aim / Stage	Method / Measure	Applied criterion / process
Data transformation	Code replacement	BR-BL.codes replaced by mean cover values Initial dataset: 410 plots with 815 species variables
Species dataset reduction	Removing species present in ≤ 3 plots	617 species variables proceeded to the analysis
Outlier plot elimination	Scalar transformation resemblance measure Nearest neighbor algorithm	square root of absolute value VAN DER MAAREL similarity measure 2 outlier plots, 408 plots remained
Classification of the plots	Scalar transformation vector transformation resemblance measure for plots clustering algorithm	square root of absolute value releve vector to unit length covariance minimum variance
Classification of the species	Scalar transformation vector transformation resemblance meas. for species clustering algorithm	log(x+64) attribute vector to unit length chord distance minimum variance
Selection of differentiating species	JANCEY'S ranking (analysis of variance)	450 species are not randomly distributed (F-value >2.4, P=0.01, Df1=23, Df2=384)
Identifying the association between plot groups and species groups	Concentration analysis (X^2 test)	Defining the diagnostic species group of each plot group.
Structuring the vegetation table	Manual ordering of plots-and species groups Rearrange plots and species within groups	Location of the discriminating species groups at the upper part of the table.
Identification of ecological gradients	Detrended Correspondence Analysis (DCA) Rank correlation between ordination axis and ecological data.	Data: 408 plots, 450 species Detrending by segments, log transformation of species SPEARMAN'S coefficient

3.3 Ecological evaluation of the cultural landscape

In nature conservation there is a variety of methods dealing with the ecological evaluation of an area or biotic community. All methods extrapolate the intrinsic value of the area / biotic community from a number of quantitative and/or qualitative observations, which describe and quantify specific ecological and/or biological criteria. Some evaluation methods integrate ecological with cultural and educational criteria, while others use certain taxonomic groups (indicator approach) for their assessment. In each case the choice of the appropriate method and criteria depends on the objectives, the character and the extent of the study area, the habitat types and the observer's interests as well (SPELLERBERG 1992, KIRBY 1994).

An ecological evaluation scheme provides from the one side for the comparison among areas or habitats, with the aim to the establish priorities in nature conservation. From the other side, it can be used for comparison among land uses and practices influencing the habitats or ecosystems, in order to identify those that serve better the aims of nature conservation and pinpoint those that impede them, so that to avoid, buffer, or even compensate such negative human influences (COBHAM & ROWE 1994, KIRBY 1994).

SPELLERBERG (1992) identifies the following points as important for the operational framework of an ecological evaluation: the definition of the objective of the evaluation and the choice of the criteria which should be quantifiable rather than relying on subjective assessments; the evaluation scheme should be repeatable and based on biological principles and sound statistics, so that to ensure the ecological validity; the methods, results and analysis should be explained and be well understood; the costs in time and money should be set against the depth and integrity of the ecological methods.

In the present study the ecological evaluation was based on vascular plants and the vegetation of the study area. Plants, in comparison to other taxonomic groups (especially animals), are easy to locate and record, along with their seasonal changes, while vegetation structure and composition, along with its plant species richness, diversity and rarity, are relatively easy to quantify and for this reason they are widely used in ecological evaluation methods (VAN DER PLOEG 1994).

Since there is not a universally applied nature conservation evaluation method, there are also no specific criteria used in all cases (KIRBY 1994, USHER 1994). In the list of MARGULES & USHER (1981 in USHER 1994) with the most popular criteria in nature conservation biodiversity, naturalness, rarity and endangerment (of habitats and / or species) are the most often used in the ecological evaluation schemes (KIRBY 1994, USHER 1994). There are, however, a series of other important criteria i.e. the extent, fragility, representativeness, typicalness, the cultural, historical, aesthetic, or educational value etc. (SPELLERBERG 1992, USHER 1994).

There is also a great variability in the ways that these criteria are incorporated in the evaluation procedure and this has to do with the choice of the necessary variables and their inventory and assessment scheme. Up to a point, the determination of the variables and the methods used for their assessment relies upon subjective decisions. However, the evaluation scheme can be set on an objective basis by applying a standardized methodology and quantifiable criteria. The value of various sites/ habitats can be compared through specific indices only if these refer to the same data type, collected with the same sampling method. Especially when the indices are based on species and communities also the identification procedure should be the same for comparison among sites. With no such standardization, there can be no justification for any comparison (SPELLERBERG 1992).

PROBLEMS RELATED TO CONSERVATION EVALUATION SCHEMES

Evaluation of conservation status should never be accepted as absolutely right and it should be subjected to revision. For instance, the evaluation may be based on incomplete knowledge of the species or communities, or the ecological requirements of a species under threat were not fully documented or understood (PLACHTER 1991).

Also, the ecological role of some criteria should not be overemphasized. For instance, although high species richness is related to high conservation value (as it is the case with some old, diverse, unperturbed ecosystems), some early successional stages and certain ecosystems of extreme sites are typically species poor, but the few plant species might be rare or highly specialized (PLACHTER 1991, BASTIAN & SCHREIBER 1994).

To evaluate and then prioritize (rank) communities on the basis of specific ecological criteria encourages making choices and is useful in decision making. However, each community or species has its own intrinsic value and the need to be conserved should be judged independently of the need to conserve all the other communities / species (PLACHTER 1991, SPELLERBERG 1992).

Common to many evaluations and assessments is the practice of adding (or multiplying) score classes from ordinal values, in order to aggregate them in a single index, which represents the value of an area or community. This is a mathematically invalid procedure, while the act of representing a range of measurements or observations by a single index is considered arbitrary and subjective, and ecologically not always explicable. In any case an index should not be regarded simply as a number, but it should be accompanied with a range of values that it can have: The potential range of values that a specific index can take, should be mentioned together with the values the index took in a specific case (SPELLERBERG 1992, BASTIAN & SCHREIBER 1994).

The reliability of the index is also of importance. An index is reliable if it produces the same value, when several people independently evaluate the same area. For instance, plant species richness depends on reliable identification, on the thoroughness of the inventory and on the season of the year. To ensure a reliable calculation of the index all previous factors should be kept "constant" in independent evaluations. Also small differences in the evaluation results should not be over drown, because this could be attributed to variability in the season, year of inventory, or location of the inventory plot (inclined vs. even sites), or inventory intensity (PLACHTER 1991, SPELLERBERG 1992).

The more complicated the indices used in the evaluation scheme are, the more difficult it is to interpret the meaning of differences in evaluation results among areas. A difference on the basis of plant species numbers, or on numbers of rare or endangered taxa, is easy to be interpreted and incorporated in the evaluation, compared to a difference in an additive value of all indices, for instance when points are given for each plant species or rare taxa etc. (SPELLERBERG 1992, BASTIAN & SCHREIBER 1994).

In conclusion, there is no simple index for the calculation or estimation of the conservation value of an area, community or ecosystem. The nature conservation value is an expression of the human esteem and although specialists could generally agree on the basis of an evaluation, they would probably disagree on the weight of the various evaluation criteria. For this reason there is no universally valid index (MARGULES 1994). Ecosystems are complex systems and in order to evaluate them efficiently a broad spectrum of parameters is needed instead of an aggregation index based on a few indicators / criteria (KIRBY 1994).

THE APPLIED EVALUATION SCHEME

Objective of the ecological evaluation in the present study was to assess the conservation value of the traditional cultural landscape based on the plant communities consisting its landscape elements. The evaluation took advantage of the criteria most commonly used in nature conservation, e.g. plant species diversity, species rarity, naturalness and restorability. Based on these criteria specific characteristics / attributes of the plant communities, important in nature conservation, were assessed.

The plant species diversity and rarity were quantified with indices based on the vascular plant species composition of the communities. For each criterion the plant communities were grouped in three clusters representing high, middle and low value of the specific criterion. The criteria of naturalness and restorability, on the contrary, were qualitatively evaluated on the basis of specific ecosystem characteristics. Based on the literature, the communities were classified into groups of similar ecological value for the specific criterion (high, middle and low value).

Finally, an overall evaluation of the plant communities based on the four criteria simultaneously was done. The communities were aggregated in groups of similar ecological characteristics regarding their diversity, naturalness, rarity and restorability through a cluster analysis. WARD algorithm and square Euclidean distance were the applied settings. The specific ecological characteristics of each community group have been identified and described, along with the land uses and management practices related to them, providing thus for their future conservation management.

Detailed definition of each criterion, its importance in nature conservation and the method applied to assess it and evaluate the plant communities are presented in the following chapters.

CRITERIA OF THE ECOLOGICAL EVALUATION

3.3.1 Diversity

Biodiversity or biological diversity is a wide concept that comprises the diversity of life in all its forms. This includes all genes, species and ecosystems and also the ecological processes of which they are part (UNCED 1992, GASTON 1996, KAENNEL 1998). Due to the lack of a unique measure that quantifies overall biodiversity, the research on biodiversity is usually concentrated on specific organisation levels (genes, species, ecosystem, landscape), diversity components (compositional, structural, functional), spatial scales (local, regional, global) or taxonomic units (NOSS 1990, HEYWOOD 1995, GASTON 1996). Nowadays the assessment of biodiversity on hierarchically high organization levels and especially on the landscape level is considered a prerequisite for the improved planning and sustainable management of the natural resources (NOSS 1983, NAVEH 1994).

A variety of terms exists for the characterization of the various aspects of biodiversity often leading to confusion, since the same term can mean different things to different people. For this reason the a priori definition of the diversity aspect going to be studied is necessary (SPELLERBERG 1996, GASTON 1996).

The present study deals with vascular plant species diversity. Species diversity can refer to a specific community or habitat (alpha diversity), the changes in diversity between communities/habitats (beta diversity), or the communities/habitats consisting a landscape (gamma diversity or landscape diversity) (WHITTAKER 1977, NOSS 1990, MAGURRAN 1995).

Species diversity is an important criterion in nature conservation. The high species diversity of a community/ecosystem indicates high complexity of organization, which is often associated with high stability, although this may not be always the case. For instance, there are species poor, but ecologically stable ecosystems, i.e. some types of beech forests, or boreal coniferous forests, heathlands, moors, etc. (BASTIAN & SCHREIBER 1994). On the other side, high diversity can be the result of the human influence, as it is the case with some managed forest types (REIF et al. 2001). For this reason the absolute species number does not mean much for the quality of an ecosystem and it should be seen in relation to the specific ecosystem type, the specific development stage, the intensity of the human influence, the site conditions, etc. (PLACHTER 1991, BASTIAN & SCHREIBER 1994). Considerations should be given to which species an ecosystem or area contains and their level of endangerment. Also, the typical species and structural diversity for a specific ecosystem type are regarded essential, and should be conserved and enhanced in relation to other ecosystem characteristics e.g. naturalness, rarity, endangerment (REIF et al. 2001). For these reasons maximizing biodiversity or protecting areas with high biodiversity need not be always of the highest priority for conservation action (GASTON 1996).

The species diversity can be determined either as species richness, when it refers only to the species number of an area, or as function of both the species numbers and their relative abundance. In this case the species abundance can be estimated as number of individuals, cover or biomass of each species (KREBS 1989, USHER 1994, MAGURRAN 1995). From the numerous indices applicable for estimating diversity, four widely used were chosen for the study case, due to the simplicity in their computation, and in order to facilitate the comparison with the existing literature, i.e. the Species number, Shannon Diversity, Simpson Diversity and Evenness (KREBS 1989, KENK & COKER 1992, MAGURRAN 1995).

In the present study the quantification of the diversity was based on the vascular plant species. The four indices have been calculated at three observation scales: the sampling plot, the plant community and the whole study area (landscape). The way of computation at each scale will be described after the presentation of the indices and the problematic concerning their application.

SPECIES NUMBER (S)

Species number (S) is the number of species of a specific taxonomic group (vascular plants in the study case) found in an area of specific size (MAGURRAN 1995, LANDE 1996). It is the simplest form of a diversity index and is also known as Species richness. The more the plant species of a plant community, the higher its richness and the more valuable the community is usually considered, although this may not be always the case.

SHANNON DIVERSITY INDEX and SIMPSON'S DOMINANCE INDEX

Shannon Diversity Index and Simpson Dominance Index are well known indices used for the estimation of diversity. They take into account the relative abundance of the plant species, which can be expressed as function of its cover, number of individuals, biomass or productivity. Both indices combine richness and equitability in abundance into a single index and express how equally abundant the species of the community are. The value of the indices raise with the species number and species equitability in abundance. High indices values indicate high diversity (KREBS 1989, KENT & COKER 1992, MAGURRAN 1995).

The computation of Shannon Diversity H was based on the formula

$$H = -\sum_{i=1}^{S} pi * \ln pi \ , \ pi = \tfrac{ni}{N}$$

where S = the species number, pi = the relative abundance of the i´th species expressed as a proportion of its relative cover (ni) to the total cover (N) of the community and it ranges between 0,0 and 1,0. The way (pi) is estimated for the plot, community and landscape level will be explained at the next section.

The Shannon index is a measure of the probability of a species to be found in a community (PLACHTER 1991). The species diversity H has the lowest value 0, when the community is consisted from only one species. A high H value can be attributed to high species number or equitable species distribution.

For the computation of Simpson diversity D the following formula, known also as Gini index , was used:

$$D = 1 - \sum_{n=i}^{S} pi^2$$

with all symbols defined as above.

Simpson diversity in the form of Gini index theoretically expresses the probability that two randomly chosen individuals from a given community are different species (MAGURRAN 1995, LANDE 1996). The index D theoretically ranges between 1,0 and 0,0, with the lower value in monocultures as with Shannon index.

EVENNESS

Evenness (or equitability) is an index that provides information about the species distribution. This index shows if the high diversity of a plant community is owned to many species with different abundances or to less species with a more homogeneous distribution. In its computation beside the relative abundance of the species, also their distribution is taken into account. Evenness is the quotient of the Shannon index H to the maximum value that the index H can have, with the same species number and with equal species abundance, expressing thus, how equally abundant the species are. High evenness results when the species are equal or almost equal in abundance and this is equated with high diversity (MAGURRAN 1995).

The computation of Evenness is based on the formula:

$$E = \frac{H}{H \max} * 100 = \frac{\sum_{ni=1}^{S} pi * \ln pi}{\ln S} * 100$$

where H max : the maximum Shannon diversity and S, (ni) and (pi) as before (KENT & COKER 1992, MAGURRAN 1995).

PROBLEMS RELATED TO THE USE OF DIVERSITY INDICES AND THEIR COMPARISON AMONG COMMUNITIES/ECOSYSTEMS

By using the above diversity indices two or more plant communities are compared for their species richness and diversity. All indices and especially the species richness depend strongly on the intensity of the inventory, which is related both to the number of the inventoried plots and the total inventoried area. For this reason it is important the inventory to have capture the whole species spectrum of the community, or at least to represent it closely. Although this practically can never be achieved (PLACHTER 1991), it is possible to check the species saturation of a community graphically, for instance through the species - area curve. In this curve the increment in species number is plotted against the increasing inventoried area. When the curve approaches the parallel to the area axis, then it is considered that at this point (saturation point), which corresponds to a specific size of the inventoried area, the estimated species number is close to the actual one. This saturation point depends strongly on the community type and the inventory (e.g. method, plot number, plot size, time). For this reason, the comparison of diversity among communities can be safe only when their species saturation has been achieved (controlled through the species - area curve), and the previously mentioned factors influencing inventory have been kept the same for all communities (PLACHTER 1991, MAGURRAN 1995).

The use of the diversity indices presupposes additionally the homogeneity of the inventoried habitat/community, which in nature may hardly occur. Due to the fact that some of the ecosystems, communities or habitats with high conservation value are species poor or exhibit low diversity, the diversity comparison should be confined among communities with comparable structure and extent (PLACHTER 1991, BASTIAN & SCHREIBER 1994).

A week point in the comparison of the diversity indices among communities is that all species are treated equally without considering their ecological or trophical position, or their function in the ecosystem. For instance, a community can be species rich or highly diverse, but to have a few or none endangered or rare species, while a species poor or of low diversity community can have much more of such species. For this, diversity should be seen in relation to other nature conservation criteria.

Although the Shannon and Simpson indices are non-parametric i.e. their use is not based on any assumption about the distribution of the population (LANDE 1996), these can not express the dynamic of an ecosystem since they represent statical models. Also the maximal value of a diversity index referred to vascular plants usually appears in the early succession stages instead of the late or climax ones (PLACHTER 1991).

A weakness in the estimation of the diversity in the present study is related to the fact that the various indices took into account only the spring and summer component of the vegetation. Although the basic floristic component of the vegetation is represented in the data set, however a rather small part corresponding to the early spring and late autumn floristic component lucks from the data, due to practical reasons.

Another weak point in the computation of diversity is associated with the application of semi-quantitative scales for the estimation of plant species cover value, such as the

BRAUN-BLANQUET scale that was applied in the study. In such cases the estimated cover values correspond to a mere approximation of the real species cover and the same applies also for the estimated diversity (MAGURRAN 1995). Also the fixed cover classes result in more homogeneous species abundances than when these are measured, augmenting thus the estimated diversity.

In conclusion, although the use of the diversity indices is widespread in nature conservation, the diversity value of an ecosystem, as it results from the above indices, should not be overemphasized, but instead, it should be relativized and judged in comparison to other criteria e.g. naturalness, rarity, endangerment (PLACHTER 1991, SPELLERBERG 1992, REIF et al. 2001).

QUANTIFICATION OF THE DIVERSITY OF THE PLANT COMMUNITIES AND THE LANDSCAPE

The plant species diversity has been estimated at three observation scales (levels) i.e. each sampling plot, each plant community and the whole study area (landscape). A specific type of diversity corresponds to each scale level (Fig.3.3), i.e. the plot diversity, the community diversity and the landscape diversity (WAGNER et al. 2000). The estimation of the diversity at the plot and the community level facilitated the comparison of diversity among the plant communities.

Plot diversity

The plot diversity refers to the plot level and it was estimated from the species found in a releve (sampling plot). An estimate of the species richness at the plot level is the number of species found in a plot, while the calculation of the three diversity indices (Shannon, Simpson and Evenness) is based on the relative abundance (pi) of each species (i). In particular, the BRAUN-BLANQUET codes of the plants at each plot were replaced with the mean cover value of the respective cover / abundance class (VAN DER MAAREL 1979, HAEUPLER 1982). The cover values (ni) of all plant species (i) were summed up to the total plant cover of the plot (N). The quotient of the cover value of each species to the total cover of the plot gave the relative abundance of the species (pi =ni/N) at this plot (KENT & COKER 1992). Having calculated the relative abundance (pi), the diversity indices were then computed for each plot by applying the respective formulas.

A mean plot diversity was also calculated for each plant community (average of the plot diversity of its relevés). This was done in order to enable the comparison of the diversity indices among the communities at the plot level.

Community diversity

For a plant community the relative abundance of each species was computed as it follows. The mean cover values of the plant species found in the plots of the community were summed up to give the total cover. The quotient of the mean cover value of a species to the total cover of the community gave the relative abundance of the species within the community. By applying then the respective formulas, the diversity of each plant community was estimated (community diversity).

Following LANDE (1996) and WAGNER et al. (2000) the community diversity was expressed as function (sum) of the mean plot diversity and the between plots diversity of the community (Fig.3.3). The between plots diversity is the component of community diversity, which is related to the changes in diversity between the plots. It was computed by subtracting the mean plot diversity from the community diversity and functions as a linkage between plot and community diversity (LANDE 1996, WAGNER et al. 2000).

The mean community diversity was also computed for the study area (landscape) as the average of all communities diversity.

Landscape diversity

The landscape is considered the higher observation scale in the study. The diversity referred to this scale represents the landscape diversity and its estimation was based on the species of all relevés. At the landscape scale the mean cover values of all plant species were summed up to give the total cover of the landscape and the relative abundance of each species was expressed as proportion of the species mean cover to the total cover of the landscape. Based on these cover values the diversity indices were computed to quantify the landscape diversity of the study area.

Similarly to the community diversity, the landscape diversity was expressed as the sum of the mean community diversity and the between communities diversity (Fig.3.3).

The between communities diversity refers to the changes in diversity among the various communities of the landscape and it was computed from the subtraction of the mean community diversity from the landscape diversity. The between communities diversity links community and landscape diversity and corresponds to WHITTAKER'S (1977) beta-diversity.

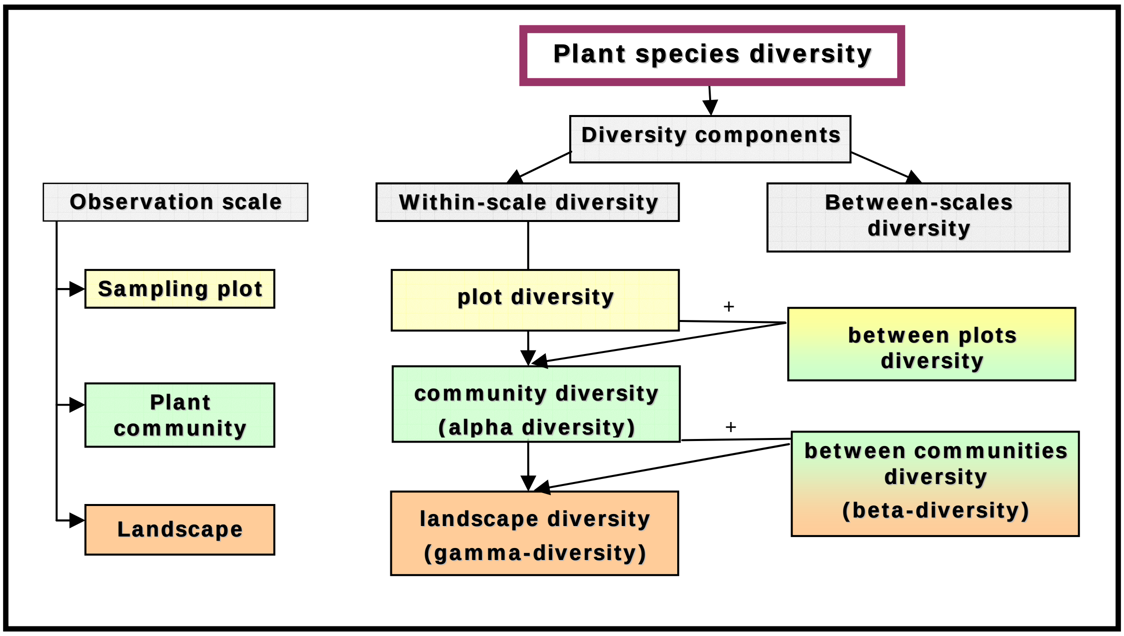

Fig.3.3: Diversity components. Plant species diversity can be quantified at different scales, i.e. plot, plant community and the landscape. At each scale within and between diversity components are identified and linked additively to form the diversity of the next hierarchically higher scale.

The relation among the diversity components of the three observation scales is illustrated in Fig.3.3. At each observation scale the within and between scale diversity components are additively linked to form the diversity of the next higher level. The landscape diversity is the sum of the diversity of lower hierarchical levels, which in our case are the plant communities and the sampling plots. The correspondence of the various diversity components to WHITTAKER's (1977) alpha, beta & gamma diversity is also shown in this figure.

COMPARISON OF THE DIVERSITY INDICES AMONG THE PLANT COMMUNITIES

An important point in a comparative analysis of the diversity sets the sampling plot size and sampling intensity. Due to the fact that diversity increases with increasing area, both sampling plot size and inventory should be the same when comparing the diversity among various vegetation types. For this reason the indices applied for comparing the diversity among the plant communities were estimated from the data of 10 m^2 and 100 m^2 plot sizes.

At first, the diversity indices of nine plant communities, each one represented with 10 plots (of both 10 m^2 and 100 m^2) were compared. For communities with more plots, 10 of them were selected at random. In this way the comparison of diversity indices among the nine communities referred to the same inventoried area (both as plot number and plot size).

Non-parametric statistical tests were employed to test for differences of the plot diversity among the communities, since the various indices (Richness, Shannon diversity, Gini index) are non-parametric (LANDE 1996). In particular, the KRUSKAL-WALLIS test was used to determine statistically significant differences among the nine communities and MANN-WHITNEY test was performed in pairwise comparisons of the communities (SOKAL & ROHLF 1995, BÜHL 2001).

The community diversity was also calculated for the nine selected communities, in order to have a measure of comparison at the observation scale of community.

In a further step, the diversity pattern of all plant communities, irrespectively of the inventoried area (plots number), was also investigated. All diversity indices of the plant communities, estimated at the plot level (both the 10 m^2 and 100 m^2 plot) were the variables of the hierarchical classification which aggregated the communities in groups with similar diversity pattern.

The hierarchical classification was applied by the use of WARD algorithm as clustering module, Squared Euclidean distance as dissimilarity measure and z-score standardization of the variables. Squared Euclidean distance was preferred, due to the more homogeneous clusters it produced. Z-standardization is a simple transformation that brings variables with different magnitude of values into the same range, avoiding thus oversized influence of the large values on the classification (BÜHL 2001).

The different sampling intensity (not equal plot number) of the various plant communities consists however a weak point in the classification, which could not be overcome since it was necessary all plant communities to be included in the evaluation scheme.

3.3.2 Naturalness

The criterion of naturalness is considered one of the most important criteria in nature conservation and at the same time one of the most difficult to quantify (PLACHTER 1991, SPELLERBERG 1992, USHER 1994). Although the term recalls to natural ecosystems, the criterion is also applied for ecosystems influenced by the human. In such cases the naturalness of a biotope or a landscape element is evaluated by the degree of the human influence upon it ("hemeroby"). The less influenced, the more natural, and ecologically the more valuable an ecosystem is, the more protection it usually deserves (MARGULES 1994, USHER 1994). This is considered so, not only because of its fauna and flora, but mainly because of the ecological processes that are preserved in intact ecosystems, i.e. the soil, water and nutrient cycle.

The commonly applied reference value for the assessment of naturalness is the "potential natural vegetation (pnV)". This is the vegetation that would develop under the current environmental and site conditions if man no longer intervened and vegetation had time to develop up to its final stage (GRABHERR et al.1998, REIF et al. 2001). For this reason the pnV should be defined for each site and then compared to the present vegetation. Depending on its closeness or similarity to the pnV the specific biotope or landscape element is classified for its naturalness or hemeroby. The hemeroby as an inverse term to naturalness is used also as a measure for the specification of the human influence upon ecosystems (BASTIAN & SCHREIBER 1994, PLACHTER 1991).

Several qualitative scales have been developed for describing the naturalness / hemeroby of a plant community (BLUME & SUKOPP 1976, DIERSCHKE 1984, ELLENBERG 1996, GRABHERR et al.1998, KOCH & GRABHERR 1998, DIMOPOULOS et al. 2000). In those scales the various naturalness and/ or hemeroby levels are not strictly demarcated, but they define successive stages of a continuum. The criteria for ranking the naturalness of the vegetation are based on structural and floristic changes in comparison to the potential natural vegetation and the human impact on both the biotic and abiotic factors (BASTIAN & SCHREIBER 1994, GRABHERR et al. 1998).

With increasing human influence the vegetation can be differentiated from natural to semi-natural, moderately altered, altered or artificial (SEIBERT 1980, DIERSCHKE 1984, ELLENBERG 1996). With reference to hemeroby the vegetation is characterized as ahemerobe (without influence), oligo-hemerobe, meso-hemerobe, eu-hemerobe, poly-hemerobe (artificial) and meta-hemerobe (with no vegetation at all) (BLUME & SYKOPP 1976, GRABHERR et al. 1998, KOWARIK 1999).

With increasing human influence the changes in the structure and species composition of the vegetation are stronger in relation to the pnV. Normally with decreasing naturalness of the vegetation, the organization level, life span and the stability of the ecosystem also decrease (BASTIAN & SCHREIBER 1994).

Due to the scarcity of natural ecosystems and the limited extent of semi-natural ones at European level, the criterion of naturalness is of importance and should be integrated in ecosystem management and especially in forests (REIF et al. 2001). This is justified by the usually high stability of the natural forests, especially in extreme incidents.

Since nowadays the natural ecosystems in Europe including Greece as well (DAFIS et al. 1996) are very limited, the application of the criterion of naturalness on the landscape level should be set on a relative basis. Consequently, semi-natural and extensively managed ecosystems are positively valuated, while intensively managed ecosystems are negatively graded (e.g., WITSCHEL 1980). Based on this, a cultural landscape and its ecosystems influenced by small scale extensive interventions are ranked higher than an intensively managed, monotonous landscape.

The pnV, the reference point for the assessment of naturalness, is a rather theoretic concept, which can differ between specialists. Therefore, for a certain site various forest types could be constructed as nearly natural, depending on the adopted theoretical concept, which can differentiate for instance in the succession time and the type of climax community (REIF et al. 2001). For this reason indigenous, pioneer woodlands or seral forest communities can be also near-natural. On the other side, old historical forests at extreme sites, or relicts of traditional cultural landscapes should be more appropriately evaluated by emphasizing more strongly other criteria instead of naturalness, in order to be conserved.

Prior to the evaluation, the potential natural vegetation of the moderate, extreme and azonal sites of the study area was defined based on the results of the vegetation analysis. The various vegetation types were then compared to the respective pnV type and classified for their naturalness on the basis of their closeness or distance to it. The human influence associated with factors such as the land use type, the intensity and frequency of the disturbance, was also taken into account based on the respective classification schemes of the literature (BLUME & SYKOPP 1976, WITSCHEL 1980, GRABHERR et al. 1998, DIMOPOULOS et al. 2000).

The naturalness scale, which was used in the present study, followed the reduced naturalness classes of the classification scheme in GRABHERR et al. (1998) after an adjustment to the study conditions. Specifically, the plant communities were classified into three naturalness classes, i.e. semi-natural, moderately altered and altered, which were assigned with high, moderate and low naturalness value respectively.

This evaluation scheme is qualitative and can be considered subjective, since it could lead to different results if applied by different people (SPELLERBERG 1992). The quantification of the respective criterion requires though extended research and plenty of data quantifying many different biological and ecological parameters of a plant community (GRABHERR et al. 1998), which were not available in the present case.

The criterion of naturalness directs the management of the vegetation types. The less natural a plant community or biotope is the more active management effort it requires. While for natural / ahemerob communities a passive protection might be sufficient, altered / euhemerob communities usually need specific management practices in order to be conserved (WITSCHEL 1980, PLACHTER 1991).

3.3.3 Rarity and Endangerment

Rarity is often a natural property of many species and communities associated with seldom and especial niches, ecological adaptations or survival strategies (REIF et al. 2001). For example, rare site conditions such as the raised bogs with hygrophilous woodlands were always rare and still are. Large mammals e.g. Ursus arctos, Lynx lynx, or raptors e.g. Gypaetus barbatus, Aquila chrysaetus, which require large territories for their survival, will always be considered rare in relation to their spatial density. Also many widely distributed species become rare in the boarders of their geographical distribution, when they withdraw from extrazonal sites and are thus separated from their main population. Also, an exotic species is rare when it starts to invade an area; however its rarity can not be an argument for preserving the species.

The criterion of rarity is of high importance in nature conservation especially when it refers to rare species or communities that are threatened. For instance, many species and communities have become rare and are threatened with extinction due to human interventions associated with changes in land uses e.g. intensification, which alter the site conditions and affect (fragmentate, decrease) the species populations and communities (USHER 1994). Stochastic events, such as extreme climatic conditions can easily affect fragmented or limited local populations / communities and decrease them below their minimal viable extent. Especially stenoecous species, such as those associated with old growth forests and other rare habitats are susceptible to changes in their site conditions.

Due to their limited population and / or extent and the associated few chances for survival, rare species and communities are vulnerable in any danger threatening their existence. For this reason, although such species and communities may not be endangered, it is essential to protect their biotopes from any activities that can damage them (BASTIAN & SCHREIBER 1994, REIF et al.2001).

Information on rare and endangered species and communities and the activities threatening their existence is provided in Red Lists or Red Data Books, which consist an important tool for identifying the conservation value of ecosystems, landscapes or protected areas and provide a solid basis for the argumentation in nature protection (PLACHTER 1991, BASTIAN & SCHREIBER 1994). Nevertheless, the use of the Red Lists is also related to shortcomings e.g. fault assessments, incomplete representation of all biotic components, insufficient historical or contemporary data. From the other side, their application implies that a species should be rare or endangered to deserve protection, or overlooks extended ecosystems / biotopes of ubiquitous species that may be important in diversity and nature conservation.

The criteria of rarity and endangerment are widely applied in nature conservation evaluation in the form of numbers of rare and threatened species or communities present in a specific habitat, landscape, protected area, etc. This is justified for practical reasons (time and cost saving), although it is considered to underestimate the complexity of an ecosystem and is thus scientifically problematic (BASTIAN & SCHREIBER 1994).

The incomplete knowledge of the Greek vegetation can not provide the scientific basis for assessing the rarity of the plant communities (DIMOPOULOS et al. 2000). At the European level, information on the importance for nature conservation of various vegetation types is provided by the Habitat Directive (Council Directive 92/43). The Annex I of the Directive lists the habitats of Community interest and conservation priority at the European level. Several of these habitats are encountered also in the study area (Table 3.6).

Most of the habitats of the study area, according to Annex I of the Directive 92/43 are of conservation interest at the European level. However the above classification does not represent adequately the conservation priorities at the national level (DAFIS et al. 1996). For this reason the evaluation of the studied plant communities with respect to the criterion of rarity was based simply on the presence of rare plant species in each plant community.

Table 3.6 Habitats of interest and priority at the European level found at the study area
Sclerophyllous scrub with Juniperus oxycedrus
Phrygana
Chasmophytic vegetation of calcareous rocky slopes
Riparian plane forests
Ravine forests
Karstic calcareous grassland (*Alysso-Sedion albi*)*
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*)*
Pseudo-steppe with grasses and annuals (*Thero-Brachypodietea*)*
* priority habitats according the Directive 92/43

The evaluation took advantage of the National List of the important plant taxa in Greece (DAFIS et al. 1996), which was compiled in the frame of the implementation of Habitat Directive in Greece. Based on this list four categories of rare plant taxa were identified: “Greek endemics”, “Threatened taxa”, “Wide endemics” and “Total rare plant species”.

Endemics are the plant species, which have evolved in isolation, or are relict species from the last ice ages and are nowadays found only in restricted localities (POLULIN & WALTER 1985). The Greek endemics are restricted to Greece. The wide endemics are either Balkan endemics, or Balkan hypo-endemics (i.e. plant taxa of the Balkans, Italy and/ or Turkey), or other native taxa with sparse populations in Greece (KOKKINI et al. 1996). Threatened taxa are those considered endangered according to the Greek Legislation (Presidential Decree 67/1981), the European Red List (ECE 1991), the WCMC Databank (WCMC 1993) and the CITES and Bern Conventions.

Total rare plant species is the number of all species belonging to one of the three previous categories of rare taxa, which can vary from their summation, since some taxa belong to more than one category.

None of the encountered plant species belongs to the Red Data Book of the Greek Plants (PHITOS et al. 1995), or the Annex II of the Habitat Directive of the Priority Plant species on the European level. For this reason in our case the Greek endemics represent the most important floristic element, due to their restriction in the Greek territory.

The numbers of Greek endemics, Threatened taxa, Wide endemics and Total rare plant species were identified for each plant community in order to quantify the criterion of rarity. With variables the four types of rare plant species the communities were further classified into three groups representing different levels of rarity (high, medium and low). The same classification scheme as with the criterion of diversity was applied (WARD method, Squared Euclidean distance, z-standardization).

Two more aspects of rarity have been also examined. The first refers to the spatial distribution of a rare species. A rare species could be found only in a few plots, having thus small distribution, or in more plots, having a broader distribution. The number of plots, therefore, in which a species is found, is a measure of its spatial distribution.

In each rarity group (high, medium, low) the spatial distribution of a rare taxon was expressed as the average plot number the taxon was found in the communities of the group.

The sum of the average plot number of the species for each of the four rare taxa category (Greek endemics, Threatened taxa, Wide endemics, Total rare taxa) within a rarity group gave the distribution of the respective rare species category to the specific rarity group. For instance, the sum of the average plot number of all Greek endemics found in a rarity group gave the distribution of Greek endemics in the specific group. By the same way the distribution of Threatened taxa, Wide endemics and Total rare taxa within a rarity group were estimated.

The second aspect of rarity deals with the fidelity (association) of a rare species to specific communities or rarity groups. A rare species could be found only in plots of a certain community (or rarity group) – a fact that implies high fidelity of the species to the community (or rarity group), or it could be found in plots of various communities, implying a lower species fidelity.

The fidelity of a rare taxon to a plant community was expressed as percentage of the plots of the community containing the taxon to the total plots the taxon was found. Fidelity was estimated only for the species found in more than 2 plots. A high fidelity (>50%) of a rare taxon to a plant community directs the management of the specific community in order to preserve the species.

Finally and similarly to the criterion of diversity, the nine communities represented by the same inventory intensity were compared for their rare species numbers at the community level.

3.3.4 Restorability

The necessary time for the restoration of an ecosystem after a disturbance i.e. land use, is of great importance in nature conservation and consists an important criterion in many ecological evaluations. The restoration of an ecosystem after its destruction or disturbance is a successional process and includes both the restoration of the initial site conditions and the re-appearance of the typical for the site plant and animal communities (REIF et al. 2001).

In nature there are ecosystems that are adapted to frequent disturbances e.g. pioneer grasslands, shrublands, or woodlands on alluvial riverine sites. Such ecosystems can be restored in relatively short time that can range from a few years for the grasslands to some decades for the woodlands. On the other side, there are ecosystems with very long succession, e.g. virgin or old growth forests, moors, natural ponds, associated with special site conditions that require hundreds of years to be developed. These ecosystems can not be practically restored in case of destruction and for this reason they should be excluded from any use (PLACHTER 1991, BASTIAN & SCHREIBER 1994, MERTZ 2000, REIF et al. 2001).

The restoration time of an ecosystem is often associated with its sensitivity against disturbances and can direct its management. For instance, while very long restoration time indicates that the ecosystem should be protected from any use, there are ecosystems, such as some managed forms of forests, shrublands and grasslands, which can be restored on a relatively short basis either through succession, or extensive management, or by replacing them with similar ecosystems, e.g. plantations (MERTZ 2000).

Due to the fact that the restorability of the various ecosystems is not exactly known, it is a common praxis to define it in approximation to their regeneration / succession time. For this reason also the scales applied for this criterion in nature conservation are subjectively determined on a rough basis and often vary among specialists. However, the longer the succession of an ecosystem is, the more time is required for its restoration after a destruction, the higher its value in nature conservation and the more protection it deserves (PLACHTER 1991, BASTIAN & SCHREIBER 1994, DIMOPOULOS et al. 2000, MERTZ 2000).

The plant communities of the study area were evaluated for the criterion of restorability with a scale taking into account their succession time based on the respective scheme presented in PLACHTER (1991) and adjusted to the study conditions. Specifically, the plant communities were classified into three restorability classes, which corresponded to short (< 20 years), medium (20-50 years) and relatively long (>50 years) succession / restoration time. The three classes were assigned with low, medium and high value for the criterion of restorability respectively.

The evaluation scheme assessed the restorability value of the plant communities through a rough approximation of the time the communities need to attain the typical species composition and structure. The classification took into account the land use type (forest, pasture, mowing, abandonment), the frequency of the disturbance (daily, periodical, occasional) and the approximate age of the vegetation. In general, this evaluation process is qualitative and can be considered subjective since the exact restoration time of the plant communities remains unknown.

OVERALL NATURE CONSERVATION EVALUATION

The results of the separate evaluations of the plant communities for each of the four nature conservation criteria have been used in a synthesis to derive an overall ecological evaluation. The synthesis was achieved through a classification of the communities on the basis of their similarity with respect to their diversity, naturalness, rarity and restorability. Before the classification, the high, medium and low value of the four criteria was replaced with the numbers 3, 2 and 1 respectively. The Ward algorithm and squared Euclidean distance were the settings of the classification.

The classification aimed at aggregating the communities in groups characterized by similar pattern for the four nature conservation criteria, which were further investigated means a Principal Components Analysis (PCA) that was applied to the community set. The ecological characteristics of the identified community groups were further illustrated through the respective ordination plot and set the necessary ecological basis for the conservation management of the cultural landscape.

To facilitate the explanation of the community groups, after the classification the rank scale (1, 2 & 3) of the four criteria was reverted to the initial nominal scale, i.e. of low, medium and high value respectively.

Finally, the same classification procedure was applied twice more, each time by giving weight to a specific criterion (naturalness or diversity), which was considered of special gravity in the cases of two alternative management scenarios about the study area. According to the first scenario the management aimed at enhancing the naturalness of the area, thus special weight was given to the criterion of naturalness, which was multiplied by three (3) for all communities, while the other criteria remained as they were. The second scenario aimed at supporting the plant species diversity of the area and thus special weight was given to this criterion, which was tripled, while the other criteria kept their initial value. The z-standardization of the variables was applied in both cases, in order to prevent the oversized influence of the weighted criteria (BÜHL 2001).

4 Results

4.1 Vegetation of the traditional cultural landscape

4.1.1 Flora

A total of 700 plant taxa (species and subspecies) were identified in the 410 plots. Their major taxonomical divisions are presented in Table 4.1. The plant taxa belong to 83 families with the most numerous seen in Fig.4.1.

Table 4.1 Taxonomic divisions of the plant species

Taxonomic divisions	Families	Taxa
Dicotyledonae	66	585
Monocotyledonae	9	103
Total *Angiospermae*	**75**	**688**
Gymnospermae	3	4
TOTAL *SPERMATOPHYTA*	***78***	***692***
PTERIDOPHYTA	*5*	*8*
TOTAL PLANT TAXA	**83**	**700**

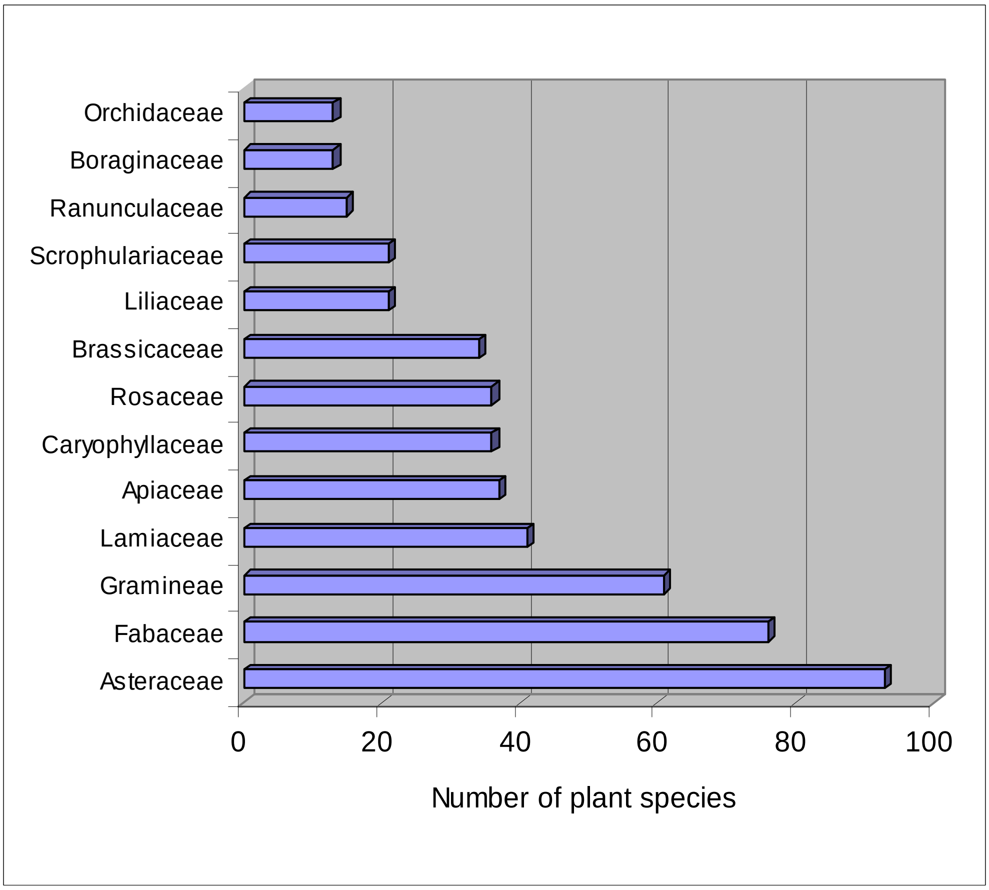

Fig.4.1 The most numerous families of the inventoried plant species

In terms of species life forms, the hemicryptophytes and therophytes dominate in the flora of the study area (with 32% and 29% respectively). However, the phanerophytes dominate in the vegetation cover (47%), followed by the therophytes and the hemicryptophytes (with 25% and 22% respectively). The chamaephytes and geophytes are represented with small numbers and cover values (Fig.4.2). The significant hemicryptophytic component of the vegetation is in agreement with the submediterranean climatic character of the area and demonstrates an intermediate position of the study area between the Mediterranean and temperate ecosystems (THEODOROPOULOS 1991, FREY & LÖSH 1998).

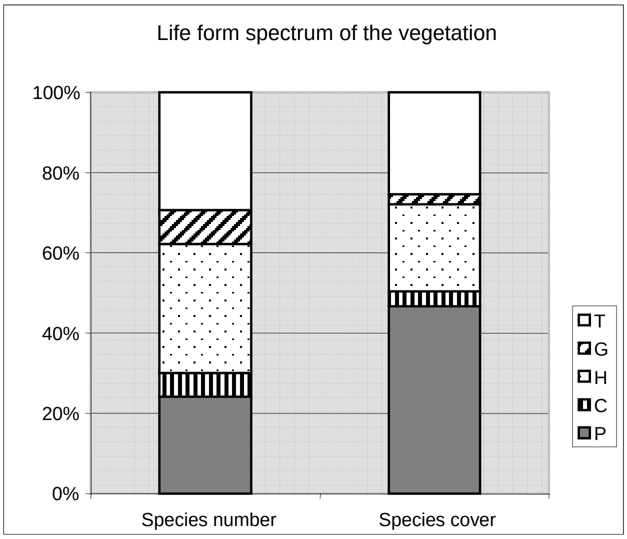

Fig.4.2 Life form spectrum of the vegetation
T: Therophytes, G: Geophytes, H: Hemicryptophytes,
C: Chamaephytes, P: Phanerophytes.

4.1.2 Plant communities

OUTLIER PLOTS

The examination of the histogram of the nearest-neighbour values revealed that the similarity values among the plots had a continuous function (WILDI & ORLOCI 1996), with only two plots being relatively isolated from the others (Table 2 in Annex). These were the plots with the numbers 206 (rocky site) and 381 (forest), which presented extremely low similarity values to their nearest neighbour (0,061 and 0,199 respectively). This indicated that both plots had only a few common species with the others. Thus they were considered outliers and excluded from the further analysis, which was carried out with 408 plots.

The plot 206 (Table 3 in Annex) belongs to the chasmophytic vegetation of the rocky exposures and is floristically related to the *Asperula chlorantha-Centaurea pawlowskii* community described later in this chapter. The small resemblance value to the plots of this community is attributed to the small species number (9 species) and the low vegetation cover (<5%).

The plot 381 (Table 4 in Annex) represented the Mediterranean *Quercus ilex* forest. It was the only plot of this forest type that was possible to be inventoried, due to the steepness of the site where it grows. For completing the presentation, this vegetation type is described later in the present chapter.

The vegetation of the study area incorporates forest and open vegetation types (Fig.4.3). The forest vegetation includes the forests, woodlands, treehedges, forest fringes and the chasmophytic vegetation. The open vegetation consists of the low shrublands and the grasslands. The plant communities identified for the study area, along with their diagnostic species group(s) are presented in Table 4.2. The complete and code names of the plant communities are seen in Table 5 in Annex.

FOREST VEGETATION

Platanus orientalis riparian forest

In the valley of Vikos gorge *Platanus orientalis* constitutes an azonal gallery forest along the banks of Voidomatis stream (Photo 2.10). Besides oriental plane that dominates both in the tree and shrub layer, also *Salix eleagnos, Viola riviniana, Calamintha nepeta* and *Prunella vulgaris* are diagnostic species of the community (plot group 15 in Annex II & III).

The riparian forest of *Platanus orientalis* is often in contact with other forest types and for this reason, forest species of the *Ostrya carpinifolia* (species group 25 in Annex II & III) and the *Hedera helix* species group (23) are abundant. *Carpinus orientalis* participates often in the tree and shrub layer, and *Acer monspessulanum, Brachypodium sylvaticum, Hedera helix, Selinum silaifolium, Cornus mas, Fraxinus ornus* are present with high constancy at the herb floor. The presence of species from the *Athamanta macedonica* species group (9), such as *Asperula chlorantha* and *Athamanta macedonica*, is related to the rocky habitat.

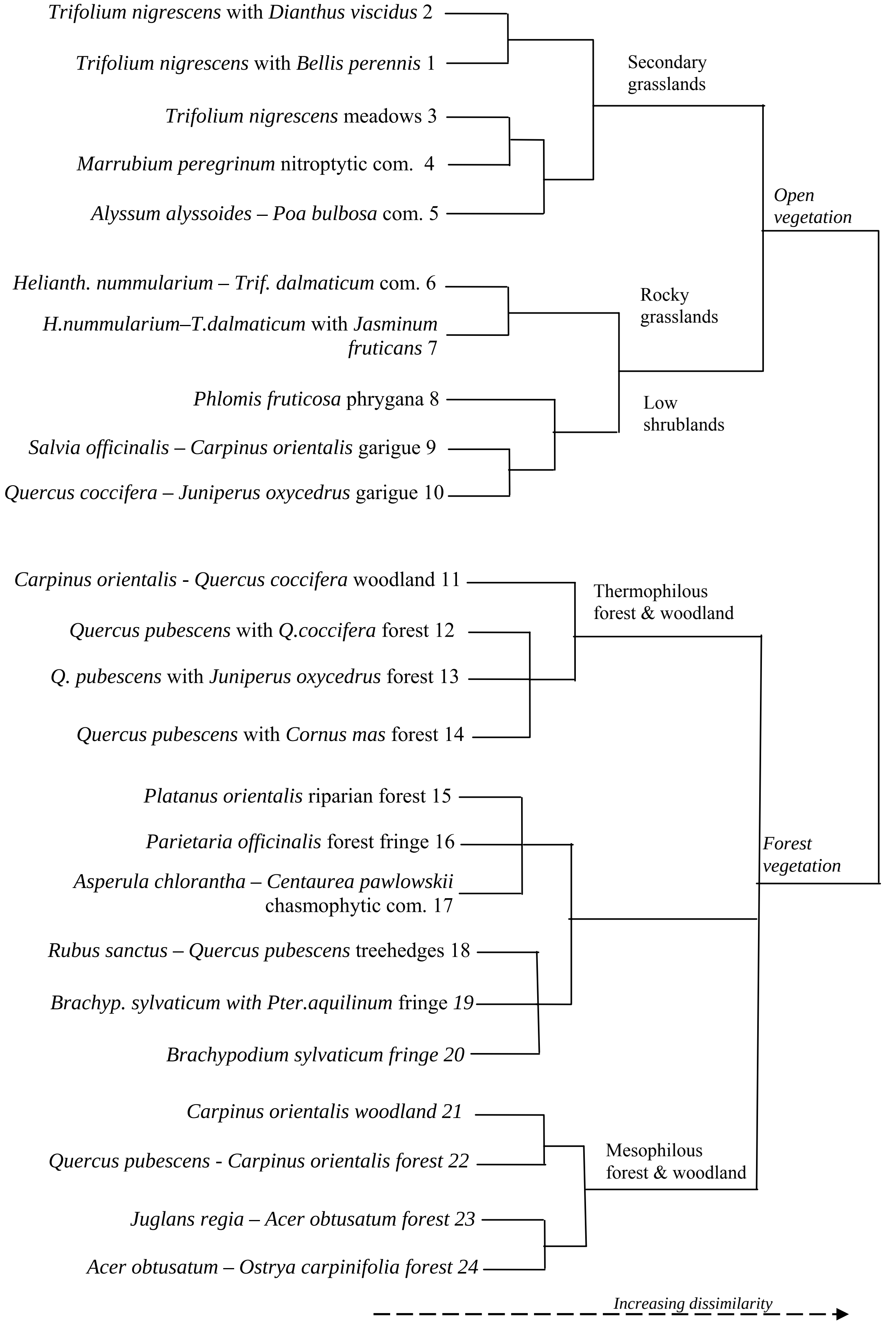

Fig.4.3 Synoptic dendrogram of the plant communities. Each community is represented by a number of plots in the original dendrogram that resulted after the hierarchical classification and the application of Mulva 5 software (WILDI 1989, 1992).

Table 4.2 Plant communities and diagnostic species groups

Veg/tion category	Vegetation type	Plant community name (number)	Diagnostic plant species group (number)
Forest veg/tion	Riparian forest	Platanus orientalis forest (15)	Platanus orientalis (28)
	Mesophilous forests, woodlands & forest fringes	Juglans regia – Acer obtusatum (23)	Juglans regia (32)
		Acer obtusatum – Ostrya carpinifolia (24)	Acer obtusatum (24) Ostrya carpinifolia (25) Umbilicus erectus (26)
		Carpinus orientalis woodland (21)	-
		Quercus pubescens – Carpinus orientalis (22)	Hedera helix (23) Lathyrus laxiflorus (16)
		Parietaria officinalis forest fringe (16)	Parietaria officinalis (31)
	Thermophilous forests, tree hedges, woodlands & forest fringes	Rubus ulmifolius ssp. sanctus – Quercus pubescens community (18)	Rosa canina (27)
		Quercus pubescens with Q.coccifera typical community form (12)	Quercus pubescens (22)
		Q.pubescens with Juniperus oxycedrus community form (13)	Daucus carota (21)
		Quercus pubescens with Cornus mas community form (14)	Corylus avellana (29) Pteridium aquilinum (30)
		Carpinus orientalis – Q.coccifera (11)	Pistacia terebinthus (15)
		Brachypodium sylvaticum typical community (20)	-
		Brachypodium sylvaticum with Pteridium aquilinum community form (19)	-
	Chasmophytic vegetation	Asperula chlorantha – Centaurea pawlowskii (17)	Athamanta macedonica (9) Centaurea pawlowski (10)
Open veg/tion	Low shrublands	Quercus coccifera – Juniperus oxycedrus garigue (10)	Erysimum cephalonicum (8) Galium aparine (19)
		Salvia officinalis – Carpinus orientalis garrigue (9)	Helianth.nummularium (6) Acinos suaveolens (7) Lonicera etrusca (14)
		Phlomis fruticosa phrygana (8)	Picris pauciflora (11) Malabaila aurea (12)
	Rocky grasslands	Helianthemum nummularium – Trifolium dalmaticum with Jasminum fruticans community form (7)	Jasminum fruticans (17) Minuartia mediterranea (18)
		H.nummularium-T.dalmaticum typical community (6)	Aegilops neglecta (13)
	Meadows & other grasslands	Alyssum alyssoides – Poa bulbosa community (5)	-
		Trifolium nigrescens typical community (3)	Chondrilla juncea (3)
		T.nigrescens with Dianthus viscidus community form (2)	Medicago minima (5) Dianthus viscidus (20)
		T.nigrescens with Bellis perennis community form (1)	Lotus corniculatus (4)
	Nitrophilous grassland	Marrubium peregrinum community (4)	Hordeum murinum (2) Sambucus ebulus (1)

Both species have the optimum of their distribution in the study area in the chasmophytic vegetation of the rocky exposures.

The *Platanus orientalis* forest grows at the part of the stream that is characterised with continuous water flow for at least 8-10 months during the year, although with great fluctuations in the quantity and velocity of the water. It has the form of a gallery forest, 4 to 6 m wide, and consists usually of one or two rows of plane trees along the riverbanks. It is found at the lowest altitudinal zone between 450 and 590 m. The forest canopy is loose and has a height between 9 and 12 m. The shrub and herb layers are usually sparse, due to the fluctuating water level, the rocky substrate and the limited fine soil content (KARPATI & KARPATI 1961).

The lack of constant surface flow during the year is probably the main reason of the gradual cessation of the riparian forest after the main springs (Panagia and Poros) of the stream. Further upwards the stream, at the part without water flow for most of the year, the riparian vegetation is represented by a sparse woodland of *Salix eleagnos*. The riparian forest is well developed at the lower part of the gorge (outside of the study area), where the river has permanent flow throughout the year and *Platanus orientalis* forms extended high stands.

The riverine forests of *Platanus orientalis* are a characteristic element of the Southern Balkan. They colonise poorly stabilised alluvial deposits of rivers, torrents, spring basins and the bottom of steep, shady gorges (KARPATI & KARPATI 1961), as in the study case. The *Platanus orientalis* forest is a habitat type of community interest according to the Directive 92/43/EEC (PAPASTERGIADOU et al. 1997).

Platanus orientalis has a wide ecological amplitude. Various communities have been described (KARPATI & KARPATI 1961, HORVAT et al. 1974, BERGMEIER 1990, DIMOPOULOS 1993, ATHANASIADIS et al.1996, REIF & LÖBLICH-ILLE 1999), reflecting regional and ecological variation in the composition of the undergrowth.

The *Platanus orientalis* forest is syntaxonomically incorporated to the *Platanion orientalis* alliance (KARPATI & KARPATI 1961) of the *Populetalia albae* (HORVAT et al. 1974, BERGMEIER 1990). Physiognomically and ecologically the community approaches the typical ravine forest of *Platanetum orientalis balcanicum* (KARPATI & KARPATI 1961), although no other characteristic species apart from *P. orientalis* was found in the study area.

MESOPHILOUS FORESTS AND WOODLANDS

As mesophilous forests and woodlands are characterized those influenced by the high air-humidity and cool climate that prevail at sites of the narrow parts of the gorge. They have been subdivided into two community groups, each one with two plant communities:

- the *Acer obtusatum* community group, which incorporated the forests of the middle and upper slopes, and
- the *Carpinus orientalis* community group, which included the woodlands and forests of lower altitudes.

Acer obtusatum community group

The *Acer obtusatum* community group (plot groups 23 & 24 in Annex II & III) contains the forests of Vikos gorge extended in an altitudinal zone between 580 and 960 m, on north-northeastern, usually steep slopes, found often on scree. Wherever the soil is not covered with scree, it appears relatively deep, although rocks and boulders are abundant in general. Due to the unstable and rocky site conditions the forest canopy appears loose and often with poor shrub and herb layers.

The community group is characterized by the high constancy of *Acer obtusatum* at the tree layer. *Umbilicus erectus, Mercurialis perennis* and *Lamiastrum galeobdolon* are diagnostic species of the community group. Species of the submediterranean deciduous forest *Quercetea (Quercetalia) pubescentis* and specifically of the *Ostryo-Carpinion* zone prevail in the community group, with the most abundant apart from *Acer obtusatum*, being also *Ostrya carpinifolia, Carpinus orientalis, Dryopteris pallida* (GAMISANS 1979). Other species of the *Quercetalia pubescentis* order often present are *Fraxinus ornus, Cornus mas, Hedera helix, Melittis melissophyllum, Galium laconicum, Silene italica* (GAMISANS 1979, BERGMEIER 1990).

The forests are abundant in mesophilous species associated with the cool local climate of the gorge, such as *Lunaria annua, Ulmus glabra, Salvia glutinosa, Calamintha grandiflora, Campanula trachelium, Melica uniflora, Aesculus hippocastanum, Tilia cordata* and *T. platyphyllos*. These species along with the diagnostic ones represent the *Tilion-Acerion* floristic element of the community (HORVAT et al. 1974).

In the past the forests provided wood pasture in the late summer and autumn. Signs of old tree pollarding are still detectable. Nowadays, the forest stands in vicinity to the village are occassionaly grazed.

The following two communities of the Acer obtusatum community group were identified:

***Juglans regia – Acer obtusatum* forest**

The *Juglans regia – Acer obtusatum* forest (plot group number 23) is characterised by the dominancy of Acer obtusatum in the tree layer. *Juglans regia* and *Tilia cordata* are diagnostic of the community. Both species participate in the forest canopy along with *Fraxinus ornus* and *T. platyphyllos* (in companion species). *Cornus sanguinea, C. mas* and *Sambucus nigra* consist the shrub layer. The forest has a closed canopy and sparse shrub and herb layers. The high presence of *Juglans regia* should be rather attributed to human intervention especially at sites near Vikos village. Due to the dominance of *Acer obtusatum* and the significant floristic element of the *Ostryo-Carpinion*, the community was classified to this alliance (GAMISANS 1979).

***Acer obtusatum - Ostrya carpinifolia* forest**

The *Acer obtusatum - Ostrya carpinifolia* forest (plot group 24) is characterised by the dominance of *Ostrya carpinifolia* in the tree layer (Photo 4.1). Other diagnostic species of the community are *Ulmus glabra, Acer platanoides, Aesculus hippocastanum* and *Viola reichenbachiana*.

This forest type is rich in tree species, grows on limestone and dolomites, and approximates the "Karstwald" described by MARGRAF (1932) for northwestern Greece and southern Albania. Besides *Acer obtusatum*, also *Carpinus orientalis, Fraxinus ornus, Acer monspessulanum, Quercus cerris, Tilia platyphyllos, T. cordata* and *Aesculus hippocastanum* compose the forest canopy. This community represents the tallest forest type in the study area, with a height ranging between 12 and 15 m.

Due to its ecological and floristic characteristics and especially the abundance in the forest of species of the *Ostryo-Carpinion* zone and the thermophilous submediterranean forest *Quercetea (-etalia) pubescentis* in general, found mainly in the *Acer obtusatum* (23) and *Hedera helix* (22) species groups, the community was classified to the respective syntaxonomical scheme (VOLIOTIS 1985, POLDINI 1988, BERGMEIER 1990, PIGNATTI 1998, BERGMEIER et al. 2004).

Physiognomically and floristically close stands of *Ostrya carpinifolia* with *Acer obtusatum* and *Quercus* spp. (*Q. pubescens, Q. cerris*) are known from the sub-mediterranean zone of the Appennines (Central and Southern Italy) as *Scutellario-*

Ostryetum or *Melitti-Ostryetum* (PIGNATTI 1998) and they are considered a precedent (successional) stage of the *Quercus pubescens* forest.

In the study area, the dominance of species such as *Ostrya carpinifolia, Carpinus orientalis* and *Fraxinus ornus*, which grow and expand rapidly after coppicing, should be rather attributed to the long human presence and the irregular, low forest management (BLASI et al. 2001). This, along with the presence of *Quercus pubescens* at the herb layer lead to the conclusion that, the potential natural forest should rather be a type of deciduous broadleaved forest, with higher presence of oak species (mainly *Quercus pubescens* and *Q. cerris*), but also with high constancy of the previously refered forest species, due to the specific climatic and edaphic conditions (BERGMEIER et al. 2004).

Carpinus orientalis community group

The *Carpinus orientalis* community group (plot group 21 & 22) has the structure of a high shrubland to low forest with a height of 5 to 8 m. It is characterized by the dominance of *Carpinus orientalis* both in the tree and shrub layer, and is found on the lower and middle slopes of the study area, mainly on northern exposures. The forest canopy is relatively open with few tree individuals reaching a height more than 5 m. On the contrary the shrub layer is usually dense with a sparse herbaceous layer. The geological substrate is limestone and the dark brown loamy soil is rich in gravels and relatively deep (>60 cm).

Apart from *Carpinus orientalis,* also *Acer monspessulanum, Fraxinus ornus, Quercus pubescens, Q. cerris, Q. coccifera* and *Cornus mas* are the main woody species. At the herb layer *Hedera helix, Viola odorata, Helleborus cyclophyllus, Geum urbanum, Dryopteris villarii ssp. pallida, Melica uniflora, Aremonia agrimonioides, Potentilla micrantha* are present with high constancy.

Two communities have been identified:

Carpinus orientalis woodland

This vegetation type (plot group 21) has the form of a dense, coppiced woodland, which rarely exceeds 5-6 m in height. *Carpinus orientalis* dominates both the tree and the shrub layer (Photo 4.2). *Acer monspessulanum, Fraxinus ornus, Quercus cerris* and *Q. pubescens* participate in the tree canopy. On the ground layer species of the *Hedera helix* group are abundant. *Polypodium vulgare* and *Ajuga reptans* are diagnostic species of the community.

The community is found mainly at the lower and middle altitudinal zone (up to 650m) of the forested part of the gorge. Fragments are also found at the lower part of the gorge near the village, on shady, relatively moist sites nearby the stream.

Similar communities in Greece (OBERDORFER 1947, DAFIS & JAHN 1975, ZOLLER et al. 1977) and the Balkans in general (HORVAT 1958, HORVAT et al. 1974, POLDINI 1988, BLASI et al. 2001) were syntaxonomically incorporated to the *Ostryo-Carpinion* orientalis Horvat 1959.

In the study case, due to the dominance of *Carpinus orientalis* in the shrub layer and the presence of *Acer monspessulanum, Quercus cerris* and *Fraxinus ornus* in the tree layer, along with *Melittis melissophyllum ssp. albida, Teucrium chamaedrys, Asparagus acutifolius* and *Ruscus aculeatus* in the herb layer, the community can be classified as *Carpinetum orientalis* Horvat 1958 of the *Ostryo-Carpinion* alliance (HORVAT 1958, OBERDORFER 1947). This forest type was managed as coppice forest for firewood production and summer pasture and is considered a degradation stage of the deciduous oak forest (DAFIS & JAHN 1975, BLASI et al. 2001).

***Quercus pubescens - Carpinus orientalis* forest**

The community (plot group 22) is floristically similar to the previous one. *Carpinus orientalis* dominates both the tree and shrub layer. However, the forest stand is higher than the previous one, with a better developed tree layer. *Quercus pubescens* participates with high constancy and cover value in the tree layer. Tree species, such as *Fraxinus ornus, Acer monspessulanum, A. obtusatum, Quercus cerris* are also abundant.

Apart from the structure, the community is differentiated from the previous one also floristically through the higher constancy of many species of the Quercus pubescens species group, such as *Juniperus oxycedrus, Clematis flammula, Colutea arborescens, Luzula forsteri, Lonicera etrusca, Tamus communis*.

The *Quercus pubescens – Carpinus orientalis* community has the structure of a middle forest with a coppiced shrub layer and a higher forest crone, which appears to be relative open and light, favouring thus the development of a rich shrub and herb layer. It should be considered as an advanced successional stage of the previous community. The forest is found on predominantly northern exposures of the middle slopes of the gorge near Vikos village. The soil is loamy, with high content of rocky material.

The forest is floristically and structurally similar to the *Quercus pubescens* - *Carpinus orientalis* community described by OBERDORFER (1947). The dominance of *Carpinus orientalis* and *Quercus pubescens* in the tree layer, the presence of character species of the community, e.g. *Colutea arborescens, Coronilla emeroides, Helleborus cyclophyllus, Cardamine graeca, Aremonia agrimonioides* (all of the *Ostryo – Carpinion* alliance) and other *Quercetea pubescentis* species, e.g. *Cornus mas, Lithospermum purpuro-caeruleum, Potentilla micrantha* (OBERDORFER 1947) support the incorporation of the study community to the above syntaxonomical scheme.

THERMOPHILOUS FOREST FRAGMENTS AND WOODLANDS

Thermophilous forest vegetation types grow at the relatively warm sites of the study area, such as the low and middle slopes of the open part of the gorge and the ridge of Vikos village. Thermophilous oak species, such as *Quercus pubescens, Q. cerris, Q. ilex* and *Q. coccifera* are abundant in these vegetation types, along with other thermophilous species from the *Quercus pubescens* species group. The forest vegetation types included here are the *Quercus pubescens* community group (with two communities), the *Carpinus orientalis* - *Quercus coccifera* woodland and the *Q. ilex* forest fragments.

Quercus pubescens community group

The *Quercus pubescens* community group (plot groups 18, 12, 13, 14) is characterized by the high constancy of *Quercus pubescens* in the tree layer. The forests of this community group grow upon flysh and are dispersed into or adjacent to the former acticultural land. The forest has a height between 6 and 12 m and a loose canopy that allows the establishment of rich shrub and herb flora.

The high presence of *Quercus pubescens* in the area is attributed to the human influence, since the species provided leaf fodder to the livestock in the past (HALSTEAD 1998). However, *Q. pubescens* should be considered in any case a significant component of the potential natural forest (KASIOUMIS & GATZOJANNIS 1996).

The following two communities with different degree of human influence were identified:

- *Rubus ulmifolius ssp. sanctus – Quercus pubescens* tree hedges and
- *Quercus pubescens* forest fragments with three community forms
  - a) Typical form with *Quercus coccifera*
  - b) Community form with *Cornus mas*
  - c) Community form with *Juniperus oxycedrus*

***Rubus ulmifolius ssp.sanctus – Quercus pubescens* tree hedges**

This community (group 18) consists the tree hedges of the terraced agricultural land in vicinity to the village. It has the structure of a narrow (2-3 m) woody corridor along the boarders of the fields and supports the terraces and the dry-stone walls (Photo 2.15). The tree canopy is sparse and low (5-8 m) and rarely exceeds 10 m. Along with the forest tree taxa, e.g. *Quercus pubescens, Acer mospessulanum, Acer obtusatum*, *Cercis siliquastrum,* the tree hedges are also abundant in fruit tree species, such as *Prunus mahaleb, P. avium, P. cocomilia, Cydonia oblonga* and *Ficus carica*, all being diagnostic for the community. The shrub layer is dense and abundant in thorny shrubs, e.g. *Rosa canina*, *Rubus ulmifolius ssp. sanctus, Prunus spinosa*, and climbers, e.g. *Clematis vitalba, C. flammula* (also all diagnostic species), *Lonicera etrusca* and *Hedera helix*.

The field hedges have been created after the forest clearing, from the rest of the stems and the roots of the forest species that have been removed and set aside at the edge of the fields. The largest stones, which have been removed from the field and located along the edges, created a stone fence to support the field and protect its soil from erosion especially at inclined sites (HORVAT et al. 1974).

The tree hedges, which are usually abundant in photophilous woody and thorny species resistant to animal grazing, represent secondary formations of the zonal forest and are syntaxonomically classified to the *Rhamno-Prunetea spinosae* class and the *Prunetalia* spinosae order (HORVAT et al.1974, DIMOPOULOS & GEORGIADIS 1995, MUCINA 1997). Two alliances have been described in Greece for similar plant communities, the *Pruno-Rubion ulmifolii* alliance in Kephallonia (BOLOS et al. 1996) and the *Berberido-Prunion cocomiliae* in Kato Olympos (BERGMEIER 1990). The abundance of character species of the second alliance in the tree hedges of the Vikos region, such as *Rosa canina, Prunus cocomilia, Lonicera etrusca, Pyrus amygdaliformis, Clematis vitalba, Phillyrea latifolia*, *Euonymus europaeus* support the classification of the *Rubus ulmifolius ssp. sanctus – Quercus pubescens* community to the *Berberido-Prunion cocomiliae* Bergmeier1990.

***Quercus pubescens* forest fragments**

These forest fragments (groups 12, 13, 14) are characterised by the dominance of *Quercus pubescens* in the tree layer. *Fraxinus ornus, Acer mospessulanum, A. obtusatum, Quercus cerris* participate in the forest canopy, which is loose and permits the development of a rich undergrowth (Photo 4.3). *Quercus coccifera, Carpinus orientalis, Phillyrea latifolia, Juniperus oxycedrus, Colutea arborescens* are the main shrubs. *Dactylis glomerata, Campanula spatulata spp. spruneriana, Galium monasterium, Luzula forsteri*, *Lithospermum purpurocaeruleum, Tamus communis* are some constant herbs.

The forest fragments of *Quercus pubescens* grow mainly on flysh, in-between or adjacent to the former agricultural land, at the low and middle slopes near Vikos village. The *Quercus pubescens* community is floristically related to the *Carpinus orientalis – Quercus pubescens community*, which grows mainly on limestone.

Floristically and structurally close communities of *Quercus pubescens* have been described in Athos (*Quercetum pubescentis*; ZOLLER et al. 1977, THEODOROPOULOS et al. 1998), Kato Olympos (BERGMEIER 1990), Kyllini (*Quercetum frainetto-brachyphyllae*; DIMOPOULOS 1993) and Thessaly (THEODOROPOULOS 1996). Syntaxonomically, the *Quercus pubescens* forests are classified to the *Quercion frainetto* and the *Quercetalia (-etea) pubescentis* (HORVAT et al. 1974, DAFIS 1975, BERGMEIER et al. 2004).

In the study area three community forms have been identified, which differ mainly in the shrub species dominating the stand undergrowth, i.e. the typical community form with *Quercus coccifera*, the community form with *Juniperus oxycedrus* and the community form with *Cornus mas*.

a) Typical community form with *Quercus coccifera*

This community form (group12) is characterised by the dominance of *Q. coccifera* in the shrub layer. It includes the forest fragments in proximity to the agricultural land, either in the form of narrow tree hedgerows (2-5 m wide) that support the field terraces, or as small woodlots of irregular shape scattered at the agricultural land.

This community form grows in an altitude between 620 and 790 m. The soil is neutral to slightly acidic, loamy and relatively deep (Table 1 in Annex).

Apart from the other functions (stabilisation of the terraces, protection against wind and soil erosion, wood prodution) these forest stands provided in the past the leafy fodder (leaves and twigs) for the livestock. The young branches of *Quercus pubescens* were cut every 2-3 years, stored to get dry and fed to the livestock in winter.

c) Community form with *Juniperus oxycedrus*

This community form (group 13) is characterised by the co-dominance of *Juniperus oxycedrus* and *Quercus coccifera* in the shrub and herb layers. The presence of *Pyrus amygdaliformis* and with less constancy of *Dorycnium herbaceum* in the shrub and herb layer respectively are diagnostic species of this community form.

This community form has an open structure, with rich shrub and herb layers; it grows at western exposures of an altitude between 700 and 960 m; consists remnants of the oak forest in the former agricultural land of Kastri area, outside of the National Park and is nowadays grazed by the community livestock. The high cover of *Juniperus oxycedrus* is attributed to the grazing pressure (HORVAT et al. 1974).

b) Community form with *Cornus mas*

This *Quercus pubescens* community form with *Cornus mas* (group 14) is differentiated by the dominance of *Cornus mas* in the shrub layer, the constancy of *Acer obtusatum* and *Quercus cerris* in the tree layer, and that of *Pteridium aquilinum* in the herb layer. The presence of *Corylus avellana* at the tree level is diagnostic for this community form. Mesophilous species of the *Acer obtusatum* and *Carpinus orientalis* species groups are abundant.

This form represents the tallest one of the *Quercus pubescens* community forms with an average height of more than 10m and a closed canopy. It occupies depressions and shady sites in vicinity to the village. The soil is slightly acidic (pH: 6,7), loamy and relatively deep.

***Carpinus orientalis - Quercus coccifera* woodland**

The slopes above limestone up to an altitude of about 800 m are covered by a closed mixed deciduous–evergreen shrubland (plot group 11), which physiognomically resembles to the “macchie” vegetation and is known as “pseudomacchie” (DAFIS 1975, BERGMEIER 1990). The main difference to the macchie is that in the pseudomacchie vegetation the deciduous woody species represent an important floristic component along with the evergreen species. In the present community *Quercus coccifera* is the dominant species, where *Carpinus orientalis, Phillyrea latifolia* and *Juniperus oxycedrus* are also present with high constancy. The presence of *Pistacia terebinthus* at the shrub layer is diagnostic for the community.

The community has the structure of a high (about 3-4 m) coppiced woodland (Photo 2.7) that has been grazed from autumn till spring. The presence of small openings (of small previously cultivated fields), in combination with the dispersed rocky outcrops increase the plant species richness of the community, which is abundant in annuals and other heliophilous species of the open vegetation types. The topsoil is clayey-loamy to sandy-loamy, reddish to light brown, with high skeleton content and usually shallow. In the study area the community covers predominantly western exposed sites.

Floristically the *Carpinus orientalis - Quercus coccifera* woodland is related to the *Quercus pubescens* forest, although it is differentiated physiognomically through the absence of a distinct tree layer. Rarely a few tree individuals of *Fraxinus ornus, Acer monspessulanum* and *Quercus pubescens* exceed the height of 4-5 m. These species participate with high constancy in the shrub layer. The herb layer is abundant in species of the sub-mediterranean decideous forest (*Quercetea pubescentis*), e.g. *Dactylis glomerata, Campanula spatulata, Colutea arborescens, Lithospermum purpurocaeruleum, Tamus communis*.

The xero-thermic site conditions associated with the rocky, calcaric substrate and the shallow soil favour also species of the mediterranean forest (*Quercetea ilicis*), e.g. *Ruscus aculeatus, Paliurus spina-christi, Asparagus acutifolius, Pistacia terebinthus, Clematis flammula*.

Syntaxonomically, the community is related to the *Coccifero-Carpinetum* of the *Ostryo-Carpinion*, *Quercetalia pubescentis* (OBERDORFER 1947, HORVAT 1958, DAFIS 1975, HORVAT et al. 1974) and is considered regression stage of a *Quercus pubescens* forest (DAFIS 1975, BERGMEIER 1990, POLDINI 1998).

Quercus ilex forest fragments

A characteristic mediterranean element of the vegetation in the study area is the presence of forest fragments with *Quercus ilex*, which grow on precipitous limestone rockcliffs at the lower and middle zone of Vikos gorge (450-900 m). *Phillyrea latifolia, Pistacia terebinthus, Fraxinus ornus, Acer monspessulanum* and *Carpinus orientalis* participate in the forest stand (Photo 2.6). Species of both *Quercetea ilicis* and *Quercetea pubescentis* orders are present (Table 5 in Annex).

The appearence of extra-zonal Mediterranean forest elements (*Quercetea ilicis*) in the area of the sub-Mediterranean forest *(Quercetea pubescentis*) is attributed to the xero-thermic site conditions and the induced water stress associated with the rocky substrate. The phenomenon is common at the borders of the two vegetation zones. *Quercus ilex* avoids the cold air masses of the valley of the gorge and is found on sunny exposures of the lower and middle slopes, where it is favoured by the sun radiation and the luck of competition of the deciduous oak species (HORVAT et al. 1974).

Due to the steep and inaccessible site conditions of the *Quercus ilex* forest fragments only one plot (plot number 381) was possible to be inventoried. This plot was detected as an outlier in the numerical analysis, because of its floristic dissimilarity to the other plots, and for this reason it is not presented in the Vegetation (Annex II) or Constancy table (Annex III).

Syntaxonomically the *Quercus ilex* forest fragments are close to the *Orno-Quercetum ilicis*, which is classified to the *Quercion ilicis* of the *Quercetea (-etalia) ilicis* (HORVAT et al. 1974, DAFIS 1975, RAUS 1979, BERGMEIER 1990, THEODOROPOULOS 1991).

OPEN VEGETATION

The low shrublands and grasslands of the study area formed the open vegetation. Structurally, these vegetation types are characterized by the presence of only one vegetation layer namely the herb layer. Only sporadically, in the case of the low shrublands, some shrubs exceed the height of 1,5 - 2 m.

LOW SHRUBLANDS

These correspond to the garigue and phrygana vegetation types, which are dwarf scrub formations dominated by low, cushion-shaped, spiny and / or grey-leaved, aromatic shrubs (STRID & TAN 1997). The following three plant communities were identified here:

- *Quercus coccifera - Juniperus oxycedrus* garigue
- *Salvia officinalis – Carpinus orientalis* garigue

- *Phlomis fruticosa* phrygana.

Quercus coccifera and *Juniperus oxycedrus* are the common shrub species, while *Juniperus foeditissima* and *Acinos suaveolens* are diagnostic species for these shrublands. The three communities cover an area that has been grazed all over the year for long (Photo 4.4).

Species of the *Acinos suaveolens* species group (7), e.g. *Paliurus spina-christi, Festuca jeanpertii, Origanum vulgare, Acinos suaveolens, Aethionema saxatile ssp. oreophilum, Leontodon crispus ssp. asper, Micromeria juliana, Campanula ramosissima* are common to the three communities (groups 10, 9 & 8). The shrublands are also rich in species of the *Helianthemum nummularium* (6) and the *Medicago minima* (5) species groups, which are abundant in the grasslands.

***Quercus coccifera - Juniperus oxycedrus* garigue**

The *Quercus coccifera-Juniperus oxycedrus* community (group 10) is characterized by the dominance of *Juniperus oxycedrus* both at the shrub and the herb layer. It is an evergreen short (< 2m) shrubland with small openings (Photo 4.5). The community grows at northern slopes not far from the village, in a wide altitudinal zone (560-910 m), on calcaric substrate that is abundant in rocky outcrops. The topsoil is loamy terra-rossa, neutral in pH (7.1), with high skeleton content and a depth that varies from locally deep to shallow.

Quercus coccifera and *Carpinus orientalis* are highly constant at the shrub and herb layer, and in lesser degree *Paliurus spina-christi*. The presence of species of *Hedera helix* and *Quercus pubescens* species groups (23 & 22 respectively) indicate the floristic relation of the shrubland to the forest vegetation. *Erysimum cephalonicum, Inula oculus-christi, Daphne oleoides, Centaurea zucchariniana, Rosa pulverulenta, Acinos alpinus ssp. majoranifolius, Sorbus umbellata, Achillea holosericea* are some diagnostic species of the community. The patchy structure of the shrub layer and the rocky substrate supports a rich herbaceous flora that includes many species of the nearby dry grasslands and meadows. *Asperula chlorantha, Satureja montana* and *Salvia officinalis*, all of the *Athamanta macedonica* species group (9), are related to the rocky substrate.

Syntaxonomically the community belongs to the *Rhamno-Prunetea spinosae* class and the *Prunetalia spinosae* order, due to the dominance of perennial woody species resistant to grazing, such as *Juniperus oxycedrus* and *Quercus coccifera*, which are considered character species of this order (MUCINA 1997). Such vegetation types represent seral pre-forest formations attributed to excessive grazing pressure (HORVAT et al. 1975, BERGMEIER 1990, THEODOROPOULOS 1991). The presence of species such as *Rosa canina, Prunus cocomilia, Lonicera etrusca, Prunus spinosa, Clematis vitalba* and *Phillyrea latifolia* support the classification of the community to the *Berberido-Prunion cocomiliae* (BERGMEIER 1990).

Salvia officinalis – Carpinus orientalis garigue

The *Salvia officinalis – Carpinus orientalis* community (group 9) is a dwarf (<1m) coppiced shrubland dominated by *Carpinus orientalis*. The community covers a limited area at the lower slopes of Vikos gorge near Poros spring (Photo 4.6). The site conditions are characterised by north-northestern exposure, medium inclination and light brown soil with high skeletic content and stones dispersed also on the ground. *Briza humilis, Centaurea affinis spp. pallidior, Paliurus spina-cristi, Minuartia mediterranea* and *Dasypyrum villosum* are diagnostic species of the community.

Phryganic species of the *Cisto-Micromerietea julianae* class (OBERDORFER 1954), e.g. *Micromeria juliana, Aethionema saxatile, Origanum vulgare, Acinos suaveolens, Teucrium polium, Phlomis fruticosa* (MUCINA 1997) have high constancy in the community, which is also rich in annual species of the *Thero-Brachypodietea* class (BRAUN-BLANQUET et al. 1952). These are mainly aggregated in the *Helianthemum nummularium* (6) and the *Medicago minima* (5) species groups. The abundance of species such as *Acer monspessulanum, Fraxinus ornus, Cornus mas, Helleborus cyclophyllus, Dryopteris pallida* demonstrates the relation of the community to the *Carpinus orientalis* forest.

Due to the previous structural and floristic characteristics the *Salvia officinalis – Carpinus orientalis* community is considered a regression stage of a *Carpinus orientalis* forests, attributed to the long-lasting excessive grazing and is syntaxonomically incorporated to the *Rhamno-Prunetea spinosae*, the *Prunetalia spinosae* and the *Berberido - Prunion cocomiliae* as the previous community.

Phlomis fruticosa phrygana

A phryganic vegetation type characterised by the presence of *Phlomis fruticosa* covers an extended area on southern and northern slopes of Vikos gorge in a wide altitudinal range.

In the study area the *Phlomis fruticosa* community (group 8) is extended predominantly on steep, rocky slopes above limestone, in an altitude between 540 and 900 m and a variety of exposures in proximity to Vikos community. The soil is usually shallow, red-brown and skeletic, often limited between the rocky fissures. The area has been intensively grazed by the community livestock since long and on a daily basis throughout the year.

The community has the structure of a short, evergreen shrubland, with *Phlomis fruticosa* being the dominant woody species (Photo 2.8). Thermophilous species of the *Cisto-Micromerietalia julianae* (OBERDORFER 1954, MUCINA 1997), such as *Helianthemum nummularium*, *Micromeria juliana, Campanula ramosissima, Euphorbia myrsinites, Acinos suaveolens, Teucrium polium* are abundant. Species of the *Malabaila aurea* species group, namely *Geranium rotundifolium, Fumaria officinalis, Scandix pecten – veneris* and with less constancy *Mercurialis annua, Echinops spinosissimus ssp.neumayeri* are diagnostic of the community. The presence of mitrophilous species e.g. *Galium aparine, Rhagadiolus stellatus, Geranium lucidum, Trifolium speciosum, T. aurantiacum* is related to the prolonged grazing pressure (HORVAT et al. 1974, BERGMEIER 1990). Annual species of the *Thero-Brachypodietea* class (BRAUN-BLANQUET et al. 1952) are numerous in the community favored by the xero-thermic site conditions.

The study community is floristically and ecologically close to the *Phlomis fruticosa - Biarum tenuifolium* community described in Epirus by OBERDORFER (1954), which was syntaxonomically classified to the *Micromerion julianae* alliance of the *Cisto-Micromerietalia*.

Phrygana of *Phlomis fruticosa* are common in Greece and cover extended areas in Thessaly (RAUS 1979) and Southern Greece (BARBERO & QUEZEL 1989, BERGMEIER 1995, PAPASTERGIADOU et al. 1997). This vegetation type is generally rich in plant species with numerous annuals and geophytes (POLUNIN & WALTER 1985, BERGMEIER 1995, STRID & TAN 1997). In the study area the phrygana of *Phlomis fruticosa* presented both high plant species richness and diversity (chapter 4.2).

CHASMOPHYTIC VEGETATION

***Asperula chlorantha - Centaurea pawlowskii* community**

The *Asperula chlorantha - Centaurea pawlowskii* community (group 17) is a chasmophytic vegetation of sparse plant cover (Photo 2.13), found on exposed limestone cliffs and other rocky outcrops of Vikos gorge, among other vegetation types usually at the middle and upper slopes.

Centaurea pawlowski, Hypericum rumeliacum ssp. apollinis, Silene cephallenia, Teucrium flavum ssp. hellenicum, Ramonda serbica, Crepis turcica, Euphorbia characias ssp.wuffenii and *S. fabarioides* are diagnostic species of the community.

Campanula versicolor, a character species of the *Campanulion versicoloris* alliance, is also present in the community*. This along with the presence of other character species of the *Asplenietea trichomanis,* e.g. *Asplenium trichomanes, Alyssoides utriculata, Athamanta macedonica, Ramonda serbica, Ceterach officinarum* (MUCINA 1997) supported the classification of the *Asperula chlorantha-Centaurea pawlowskii* community to the *Campanulion versicoloris* and the *Onosmetalia frutescentis* of the *Asplenietea trichomanis* (BERGMEIER 1990a, DIMOPOULOS et al. 1997).

In the numerical analysis the community was classified to the woody vegetation (Fig. 4.3). However, it was included to the open vegetation types, because of its structure. Its sequence after the *Phlomis fruticosa* community, is due to their ecological and floristic similiarities.

ROCKY GRASSLANDS

Small openings among the various woody formations at sites with shallow soil and high skeletal content are covered by sparse grasslands. Their occurance is attributed to the forest clearance for cultivation in the past. Nowadays they are largely maintained through livestock grazing from autumn till spring, while in summer they dry out.

***Helianthemum nummularium -Trifolium dalmaticum* grassland**

The community includes thermophilous grasslands (relevé groups 7 & 6) of low biomass that are extended on former cultivated fields of low productivity, which were early abandoned. Nowadays the land is grazed by a few sheep, while a large part is under forest succession.

The community is found on limestone, which weathers to clayey, red-brown soil, neutral in pH reaction, and is usually shallow and skeletic. The vegetation is sparse and is dominated by annual low grown herbs and grasses (Photo 2.12), such as *Poa bulbosa ssp.*

* The species is not seen in the vegetation table, although it was found in three plots of the community. The species was excluded from the vegetation analysis, along with the other “rare” species (see chapter 3.2.1)

pseudoconcinna, Trifolium dalmaticum, T. campestre, Medicago minima, Helianthemum nummularium, Teucrium polium and Alyssum repens. *Xeranthemum cylindraceum* and with lower constancy also *Petrorhagia saxifraga* are diagnostic species of the community. The community supports a rich flora including several *Orchidaceae,* e.g. *Anacamptis pyramidalis, Orchis morio, O. quantripunctata, O. tridentata, Ophrys scolopax ssp. cornuta*.

The presence of character species of the *Thero-Brachypodietea* (*-etalia*), such as *Trifolium dalmaticum, T. campestre, Medicago minima, Petrorhagia prolifera, Aira elegantissima,* along with the structural and ecological characteristics of the study community support the classification of the community to the respective class (BRAUN-BLANQUET et al. 1952, OBERDORFER 1954, HORVAT et al. 1974, MUCINA 1997). However, the alliance can not be specified due to the lack of sufficient information of similar vegetation types in Greece.

Two community forms have been identified namely the typical form and the *Jasminum fruticans* form.

a) Typical community form

The typical community form (group 6) occurs on small fallow fields with moderate fine soil content compared to the second community form. It was found between 600 and 740 m a.s.l. The herb layer is fairly dense (with a mean cover of 50 %) (Annex III). *Trifolium dalmaticum* has a high cover in this community form. *Psilurus incurvus* and *Onobrychis caput-galli* are diagnostic species of the community form.

b) *Jasminum fruticans* form

The *Jasminum fruticans* community form (group 7) covers small rocky openings among the pseudomacchie shrubland (Photo 4.8). The community has a sparse herb layer (mean cover of 39 %) and was met in an altitude between 500 and 920 m. *Lupinus albus ssp. graecus, Lilium candidum* and *Steptorhamphus tuberosus* have a moderately low (20-30%) diagnostic value for the community form.

NITROPHILOUS VEGETATION

Marrubium peregrinum community

The *Marrubium peregrinum* community (group 4) is a perennial thermophilous ruderal community, which occupies sunny sites above limestone, adjacent to the village, which are often fenced paddocks and host the livestock for a couple of hours daily. The topsoil is loamy with high skeletal content and often rich in manure.

Nitrophilous, browse or trampling resistant species dominate in the community, such as *Marrubium peregrinum, Rumex pulcher, Torilis nodosa, Carduus pycnocephalus, C. tmoleus, Mentha longifoli* and *Medicago arabica*. Diagnostic species of the community are *Hordeum murinum, Sisymbrium officinale, Sambucus ebulus* and *Potentilla reptans*.

The community is also rich in annual species of the *Thero-Brachypodietea*, which are included in the *Medicago minima* species group (5) and indicate the xerothermic site conditions of the community and its floristic relation to the other grasslands of the area, e.g. *Trifolium nigrescens, T. subterraneum, Anthemis arvensis* and *Geranium molle*.

Syntaxonomically, the *Marrubium peregrinum* community is associated with the *Marrubion peregrini* Slavnic 1951 (HORVAT et al. 1974), the *Onopordetalia* order and the *Artemisietea vulgaris* class (BERGMEIER 1990a, MUCINA 1997).

MEADOWS AND OTHER SECONDARY GRASSLANDS

These are secondary vegetation types dominated by annual and low-grown herbs and grasses, which are found on former cultivated land and nowadays provide for animal grazing. The *Medicago minima* species group (5) consists the floristic base of these grasslands, which are rich in clover species, e.g. *Trifolium nigrescens, T. subterraneaum, T. physodes, T. dalmaticum, T. striatum, T. campestre, T. arvense, T. stellatum ssp. xanthinum, T. cherleri*. The main grasses *are Poa bulbosa ssp. pseudoconcinna, Vulpia ciliate* and *V. myurus*.

Two plant communities have been identified, i.e. the *Alyssum alyssoides - Poa bulbosa* community and the *Trifolium nigrescens* community.

Alyssum alyssoides - Poa bulbosa grassland

The *Alyssum alyssoides-Poa bulbosa* community (group 5) is characterized by the dominance of *Poa bulbosa* and *Medicago minima* (Photo 4.8). *Trifolium dalmaticum* and

Medicago rigidula are highly constant in the community with moderate coverage. *Alyssum alyssoides* differentiates the community from the *Trifolium nigrescens* one.

The community is rich in annual species of the *Thero-Brachypodietea,* such as *Trifolium dalmaticum, T. campestre, T. stellatum, Vulpia ciliata, Medicago minima, Poa bulbosa, Tordylium apulum, Crepis neglecta, C. rubra* (BRAUN-BLANQUET et al. 1952, MUCINA 1997)

The community occupies trampled, rocky sites near the village, grazed by the animals of the community on their way to the daily pasture or during their return to the village. The topsoil is sandy-loamy, shallow and rich in stones. Structurally, the community is of low biomass, with the herb layer reaching a height of only a few centimetres, due to the heavy trampling and browsing effect. Probably for the same reason the various clover species are less constant than in the *Trifolium nigrescens* community. The presence of species of the *Chondrilla juncea* (3) and the *Hordeum murinum* (2) species groups indicate a moderately nitrophytic character of the community.

The *Alyssum alyssoides-Poa bulbosa* community is floristically and structurally close to the *Biaro–Poetum bulbosae* association, which was described also in Epirus and classified to the *Romulion alliance* of the *Thero-Brachypodietea* (OBERDORFER 1954). *Biarum tenuifolium* has been found also in the present community, but with low constancy (Veg. Tbl. in companion species). The luck of sufficient bibliographic information on this vegetation type in Greece cannot support the classification of the present community to the *Romulion* (OBERDORFER 1954) or the *Thero-Brachypodion* alliance (BRAUN-BLANQUET et al. 1952).

Trifolium nigrescens **community**

The *Trifolium nigrescens* community (groups 1, 2, 3) incorporates the secondary grasslands and meadows of the former agricultural terraces established upon flysh, which nowadays are grazed or used for hay production. The community is rich in clover species, with *Trifolium nigrescens* being highly constant. *Moenchia mantica* has a diagnostic value for the community.

Species of the *Medicago minima* species group, such as *Poa bulbosa ssp. pseudoconcinna, Vulpia myuros & ciliata, Plantago lanceolata, Veronica verna, Hypochoeris cretensis, Geranium molle, Sherardia arvensis, Trifolium stellatum ssp. xanthinum, Cichorium intybus, Sanguisorba minor ssp. muricata, Crepis neglecta,* *Parentucellia latifolia, Potentilla recta, Cerastium brachypetalum ssp. roeseri* consist the floristic basis of the community (Veg.Tab.).

The *Trifolium nigrescens* community is floristically related to the *Trifolietum nigrescento-subterranei* association (MICEVSKI 1957), of the *Trifolion resupinati* MICEVSKI 1957 alliance, the *Trifolio-Hordetalia* Horvatic 1963 and the *Molinio-Arrhenatheretea* Tüxen 37. The *Trifolietum nigrescento-subterranei* association has been described for Mediterranean mesophilous meadows in FYROM influenced by high water level (near rivers or at depressions), which differ from the xero-thermic site conditions of the *Trifolium nigrescens* community. The present community differentiates from MICEVSKI'S to the low constancy and cover value of the *Trifolium subterraneum* and the luck of most of the character species of the *Trifolietum nigrescento-subterranei* association and those of the other syntaxonomic units.

The ecological, structural and floristic characteristics of the *Trifolium nigrescens* community support its syntaxonomical classification to the *Thero-Brachypodietea* class (BRAUN-BLANQUET et al. 1952, MUCINA 1997). Due to the luck of sufficient information the alliance can not be specified.

Three community forms of the *Trifolium nigrescens* community have been identified:

- Typical form
- *Dianthus viscidus* form
- *Bellis perennis* form

a) Typical form

The typical form of *Trifolium nigrescens* community (group 3) represents the hay meadows of the study area and grows at the most productive part of the terraced land, abandoned from agricultural use ca. 30 years ago. It is extended on sunny sites on the hill around the village. The topsoil is sandy-loamy, deep, rich in organic matter and relative acidic to neutral (pH: 6.8). Structurally, the community has a dense (81 % coverage) and relatively high (30-40 cm) herb layer, although its yearly biomass can fluctuate strongly depending on the precipitation. The mowing is carried out once per year, usually between end of May and middle of June. The fields are grazed by a small herd of sheep throughtout the year, except for 2-3 months before the mowing.

The typical community form is the most thermophilous of the three forms, appears especially colourful during late spring and dries out quickly thereafter. *Trifolium nigrescens* seems to be favored by the mowing and reaches a high coverage especially in its blossom (Photo 4.9). *Chondrilla juncea, Tordylium apulum, Avena barbata, Crepis rubra, Scorzonera laciniata* differantiate this community form from the others.

b) *Dianthus viscidus* form

The *Dianthus viscidus* community form (group 2) covers abandoned fields of north-northwestern exposures, in an area which is grazed by a few sheep on a daily basis (Photo 4.10). Structurally the community is of lower biomass, with a thinner (mean coverage 71 %) and shorter herb layer (height: 10-15 cm), compared to the typical form.

The *Medicago minima* and the *Dianthus viscidus* species groups are diagnostic for this community form. *Trifolium nigrescens* is present with lower cover value and constancy in relation to the typical form. Forest and forest fringe species, such as *Quercus pubescens, Q. coccifera, Dactylis glomerata, Campanula spatulata ssp. spruneriana, Carex guestfalica* are abundant in this community form.

c) *Bellis perennis* form

The *Bellis perennis* community form (group 1) is extended on small shaded terraces, of northern or western exposure, adjacent to the forest (Photo 4.11). The grazing pressure is less due to the remoteness of the land.

The *Lotus corniculatus* species group differentiates the community form. Tall herb and grass species of thermophilous fringes (MUCINA 1997), such as *Clinopodium vulgare, Poa trivialis, Coronilla varia, Cruciata laevipes, Brachypodium sylvaticum, Dactylis glomerata, Campanula spaturata ssp. spruneriana, Hypericum spruneri* are constant to the community form.

The site conditions in combination to the moderate grazing pressure favor the invension of forest species, which are more abundant in the *Bellis perennis* community form than in the previous one. *Quercus pubescens, Q. coccifera, Juniperus oxycedrus* are already established as shrubs.

FOREST FRINGES

These are vegetation types dominated by tall perennial herbs and grasses and grow on abandoned terraces adjacent to the forests and woodlands.

In the hierarchical classification of the plot data, the fringe communities (groups 16, 19 & 20) were incorporated to the forest communities (Fig.4.3). However, due to their structure, they are described here along with the other grasslands.

Two forest fringe communities have been identified:

- *Brachypodium sylvaticum* fringe community and
- *Parietaria officinalis* fringe community.

Brachypodium sylvaticum forest fringe

The *Brachypodium sylvaticum* community (groups 20, 19) is a thermophilous forest fringe vegetation type that covers small terraces adjacent to the *Quercus pubescens* forest or the pseudomachie woodland. It was found at the ridge of Vikos village, at sites with northern or western exposure and an altitude between 575 and 745 m, often on flysh.

The community abounds in fringe species of the *Lotus corniculatus* species group and forest species of the *Hedera helix* and *Quercus pubescens* species groups. *Ranunculus neapolitanus, Cruciata laevipes, Clinopodium vulgare, Brachypodium sylvaticum, Viola odorata, Carex guestphalica*, *Quercus pubescens, Q. coccifera* are moderately to highly constant. The community is also rich in grassland species, especially of the *Medicago minima* species group.

The *Brachypodium sylvaticum* community is floristically, structurally and ecologically close to the *Calamintho-Brachypodietum sylvatici* and *the Agrimonio-Brachypodietum sylvatici* associations of the *Trifolion medii*, *Origanetalia* and *Trifolio-Geranietea* T. MÜLLER 61, which refer to fringe vegetation types that occupy openings of the *Carpinion* and *Quercion pubescenti-petreae* forests in Mediterranean areas in France (ROYER & RAMEAU 1979).

The presence in the *Brachypodium sylvaticum* community of character species of the *Trifolion medii* alliance, e.g. *Agrimonia eupatoria, Brachypodium sylvaticum, Veronica chamaedrys*, and of the *Origanetalia* order and *Trifolio-Geranietea* class e.g. *Calamintha clinopodium, Coronilla varia, Origanum vulgare, Vicia tenuifolia, Astragalus glycyphyllos* (the last two in companion species in Annex II & III) support the classification of the community to the respective syntaxonomical scheme (ROYER & RAMEAU 1979, MUCINA 1997).

Two forms of the *Brachypodium sylvaticum* forest fringe community were identified:

a) Typical form
b) *Pteridium aquilinum* form

a) Typical form
The *Brachypodium sylvaticum* typical community form (group 20) grows on fallow terraces, abandoned from cultivation for more than 50 years. They are not intensively grazed, due to the distance to the village and so they are subject to forest succession (Photo 4.12). The absence of *Pteridium aquilinum* differentiates the typical community form from the next one.

b) *Pteridium aquilinum* form
The *Pteridium aquilinum* form (group 19) of the *Brachypodium sylvaticum* fringe community covers small and shaded terraces that are almost overgrown by the *Quercus pubescens* forest. Tree, shrub and fringe species are abundant in the community (Photo 4.13). The *Pteridium aquilinum,* favored probably by the slightly acidic site conditions (pH: 6.7), consists dense stands and prevents thus the existance of many species of the typical community form.

This community form grows on a spatially limited area near the Vikos village, where only the presence of stone walls, which support the terraces, indicate the former agricultural land use. No evidence seems to exist about the last cultivation of these terraces, indicating thus a long abandonment, perhaps longer than 100 years and is probably related to the inclined site conditions.

***Parietaria officinalis* forest fringe**
The *Parietaria officinalis* community (group 16) is a mesophilous forest fringe vegetation type that covers small openings adjacent to the mesophilous *Juglans regia-Acer obtusatum* forest (Photo 4.14). The community was met at a spatially limited area, north of Vikos village and grows at northern, shady, small terraces in an altitude from 570 to 700 m, where the presence of springs enabled the establishment of small irrigated terraced gardens. The cultivation in most of these terraces has been relatively recently abandoned

(about 10-15 years ago). Nowadays the terraces are mowed for feeding the young animals. The shady and humid site conditions favour the invasion of woody species of the neighbouring tree hedges and forests on the abandoned terraces.

The *Parietaria officinalis* community is a perennial, tall herb nitrophilous community. *Parietaria officinalis*, along with *Urtica dioica, Tordylium maximum* and *Cuscuta europaea,* all diagnostic species of the community, form dense stands up to 1m high and relatively poor in plant species. *Myrroides nodosa, Lapsana communis, Galium aparine, Lamium garganicum ssp. laevigatum, Sambucus nigra* are constant species of the community related to the humid air and the good nitrogen supply of the soil (BRANDES & BRANDES 1981, BERGMEIER 1990a).

The *Parietaria officinalis* fringe community is also extended at the tree hedges of the adjacent terraces. These hedges have a sparse tree and shrub layer, where *Juglans regia* is the main tree species and *Cornus sanguinea* along with *Sambucus nigra* the usual shrubs. *Campanula trachelium, Calamintha grandiflora, Symphytum ottomanum, Hedera helix,* are accompanying forest species, indicating the floristic relation of the *Parietaria officinalis* community to the *Acer obtusatum* forest.

The *Parietaria officinalis* community is floristically related to the *Parietaria officinalis-Urtica dioica* community described in Mikro Papigo, a village close to the study area. However this community differs ecologically from the study one to the rather ruderal site conditions (BERGMEIER 1990b). On the contrary, the study community is floristically, structurally and ecologically similar to the *Parietaria officinalis* fringe community growing at shady and highly inclined sites adjacent to mesophilous forests and woodlands of the submontane zone in South Tyrol (BRANDES & BRANDES 1981).

The presence in the study community of character species of the *Alliarion* alliance and the *Glechometalia* order e.g. *Parietaria officinalis, Fallopia dumetorum, Lapsana communis, Cruciata laevipes, Geranium lucidum, G. robertianum*, and of the *Galio-Urticetea* class, e.g. *Galium aparine, Cuscuta europaea* and *Chaerophyllum temulentum*, supported the classification of the *Parietaria officinalis* fringe community to the respective syntaxonomical scheme (BRANDES & BRANDES 1981, BERGMEIER 1990a, MUCINA 1997).

4.1.3 Syntaxonomical outline of the plant communities

FORESTS AND WOODLANDS

Class: *Salicetea purpureae* Moor 1958

Order: *Populetalia albae* Br.-Br. 1931 ex auct.

Alliance: *Platanion orientalis* Karpati, I & Karpati, V. 1961

Platanus orientalis community

C: *Quercetea pubescentis* (Oberd. 1948) Doing Kraft 1955

O: *Quercetalia pubescentis* Br.-Bl. 1931

Al: *Ostryo-Carpinion orientalis* Horvat 1959

Juglans regia – Acer obtusatum community

Acer obtusatum – Ostrya carpinifolia community

Carpinus orientalis community

Quercus pubescens - Carpinus orientalis community

Carpinus orientalis – Quercus coccifera community

Al: Quercion frainetto

Quercus pubescens community typical form with *Quercus coccifera*

>> >> *Cornus mas* form

>> >> *Juniperus oxycedrus* form

C: *Quercetea ilicis* Br.-Bl.1936

O: *Quercetalia ilicis* Br.-Bl.1931 ex Br.-Bl. 1936 em. Riv.-Mart. 1974

Al: *Quercion ilisis* Br.-Bl. ex Br.-Bl. 1936 em. Riv.-Mart. 1974

Quercus ilex community

TREE HEDGES AND LOW SHRUBLANDS
C: *Rhamno-Prunetea spinosae* Riv.-God. et Bor.Carb. 1961

O: *Prunetalia spinosae* Tx.1952

Al: *Berberido - Prunion cocomiliae* Berg.1990

Rubus ulmifolius ssp.sanctus – Quercus pubescens community

Quercus coccifera - Juniperus oxycedrus community

Salvia officinalis – Carpinus orientalis community

PHRYGANA
C: *Cisto-Micromerietea julianae* Oberd. 1954

O: *Cisto-Micromerietalia julianae* Oberd. 1954

Al: *Micromerion julianae* Oberd. 1954

Phlomis fruticosa community

CHASMOPHYTIC VEGETATION
C: *Asplenietea trichomanis* (Br.-Bl. in Meier et Br.-Bl. 1934) Oberd. 1977

O: *Onosmetalia frutescentis* Quezel 1964

Al: *Campanulion versicoloris* Quezel 1964

Asperula chlorantha - Centaurea pawlowskii community

GRASSLANDS
C: *Thero-Brachypodietea* Br.-Bl.1947

O: *Thero-Brachypodietalia* (Br.-Bl.) R.Mol. 1934

Helianthemum nummularium - Trifolium dalmaticum community typical form

>> >> *Jasminum fruticans* form

Alyssum alyssoides - Poa bulbosa community

Trifolium nigrescens community typical form

>> >> *Dianthus viscidus* form

>> >> *Bellis perennis* form

NITROPHILOUS VEGETATION

C: *Artemisietea vulgaris* Lhoheyer et al. ex von Rochow 1951

O: *Onopordetalia* Br.-Bl.1952

Al: *Marrubion peregrini* Slavnic 1951

Marrubium peregrinum community

FOREST FRINGES

C: *Trifolio-Geranietea* Th. Müll. 61

O: *Origanetalia* Th. Müll. 61

Al: *Trifolion medii* Th. Müll. 61

Brachypodium sylvaticum community typical community form

>> >> Pteridium aquilinum form

C: *Galio-Urticetea* Passarge ex Kopecky 1969

O: *Glechometalia* Tx. in Tx. et Brun-Hool 75

Al: *Galio-Alliarion* Oberd.(57) 62 em. Siss.73

Parietaria officinalis community

4.1.4 Ecological gradients of the vegetation data

The indirect ordination has been applied in the vegetation data for detecting the main environmental gradients. Due to the long gradient length of the 1st axis (5.156 SD, Table 4.3) and the arch effect that was demonstrated in the data set, the Detrended Correspondence Analysis (DCA) was decided as the proper ordination method. The first two DCA axes explained 12,7 % of the variance of the species data. The rank correlation of the plots axis scores with the environmental-ecological data identified significant correlations among them (Table 4.4).

The plots scores on the first two ordination axis, along with the classification results (the plant communities) have been plotted (Fig. 4.4) to illustrate the identified environmental gradients and facilitate the interpretation of the results. The plant species ordination diagram (Fig. 4.5) helped to the verification of these gradients and revealed ones that could not be explained by the existing environmental data.

Table 4.3 Characteristics of the first four axis of the DCA of the vegetation data

Axes	1	2	3	4	Total inertia
Eigenvalues	.560	.329	.181	.156	6.976
Lengths of gradient	5.156	4.848	3.150	2.730	
Cumulative percentage variance of species data	8.0	12.7	15.3	17.6	

The 1st DCA axis of the plots ordination diagram (Fig.4.4) separates the forest vegetation from the open vegetation. The plots of forests, woodlands, tree hedges and forest fringes occupy the left part of the diagram, while the plots of the open vegetation are restricted to the right side. This is also validated by the significant correlation of the 1st axis to the structural and land-use data (negative correlation with the tree and shrub cover and the forest land use; positive correlation with the herbs cover, and the pasture and meadow land uses). Also the 1st axis is significantly correlated with the diversity indices, indicating thus an increase of the plant species diversity along the axis (Table 4.4).

The species ordination diagram (Fig. 4.5) also reflects a climatic and land use gradient along the 1st DCA axis, through species groups, which indicate specific habitats. Plant species of mesic, cool habitats and of forests, woodlands and forest fringes are confined at the left part of the diagram, while species of dry, warm habitats used for pasture and/or mowing are located at the right part of the diagram.

Table 4.4 Rank correlation matrix (Spearman's coefficient) between DCA plots scores and environmental and structural parameters.

Parameter	Axis 1	Axis 2
Altitude	**0,346**	-0,072
Inclination	**-0,316**	-0,006
Limestone	0,046	*0,279*
Rock	0,007	**0,323**
Pasture	**0,562**	**0,304**
Meadow	*0,248*	-0,187
Forest	**-0,662**	0,107
Tree cover	**-0,733**	-0,190
Shrubs cover	**-0,568**	0,057
Herbs cover	**0,604**	**-0,327**
Soil cover	**-0,463**	0,068
Richness10	**0,462**	0,096
Shannon10	**0,639**	0,016
Evenness10	**0,656**	-0,030
Simpson10	**-0,572**	-0,023
Richness100	**0,354**	*0,430*
Shannon100	**0,574**	0,267
Evenness100	**0,611**	0,134
Simpson100	**-0,529**	*-0,252*

Coefficients in bolt indicate a significant correlation at the .01 level (2-tailed).

Coefficients in italic indicate a significant correlation at the .05 level (2-tailed).

Shortly, the DCA axis 1 reflects a topographic-climatic & land-use gradient complex from inclined, mesic-cool sites, managed as forests (to the left) to more even, dry-warm sites, managed as grazing land or meadows (to the right). Plant species diversity increases also along this axis.

The 2nd ordination axis differentiates the forests and woodlands from the tree hedges and forest fringes by grouping the first to the upper left and the latter to the lower left side of the plots ordination diagram. The open vegetation was also differentiated along the 2nd axis, with the meadows and other secondary grasslands at the lower right side of the diagram, the rocky grasslands and low shrublands at the middle right and the chasmophytic vegetation at the upper right side (Fig. 4.4).

Spearman's rank correlation indicates a low, but significant correlation of axis 2 with the geological substrate (limestone) and the presence of rock. The underlying environmental gradient of the 2nd axis is better understood when looking at the species ordination diagram (Fig. 4.5). The grouping of chasmophytes and plants indicative of rocky habitats at the upper part of the diagram and the clustering of plants abundant in meadows and other grasslands and forest fringes (abundant in the previously agricultural land) at the lower part of the diagram, confirmed the geological - edaphological gradient of axis 2. Low 2nd axis scores indicate deep soil conditions, while high scores suggest swallow soil and high rocky content.

Also, the high presence of nitrophytes and therophytes at the lower part of the species ordination diagram and the increase in forest species and species of rocky habitats (mainly phanerophytes, chamaephytes and hemi-cryptophytes) along the 2nd axis indicate a decreased human influence on the vegetation (increased naturalness) along this axis.

Concluding, the 2nd DCA axis reflected a geological-edaphological gradient complex from habitats of deep soil conditions and more intensively used to habitats of swallow soil, high rocky content and increased naturalness.

An ecogram of the vegetation types in relation to altitude and climate is provided in Fig.4.6.

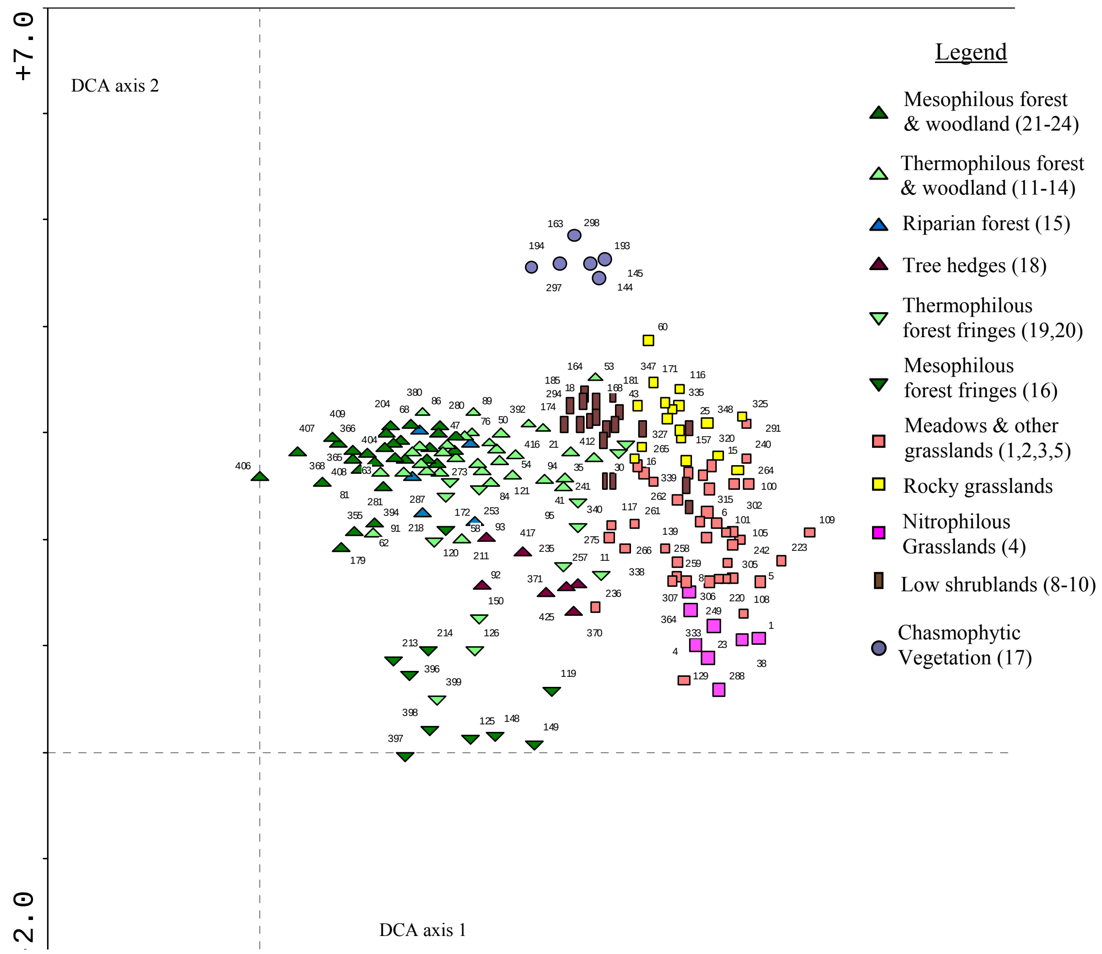

Fig.4.4 Two-dimensional plots ordination diagram derived from Detrended Correspondence Analysis (DCA) of the vegetation data. The numbers of the plant communities in parenthesis (legend) refer to the Vegetation Table.

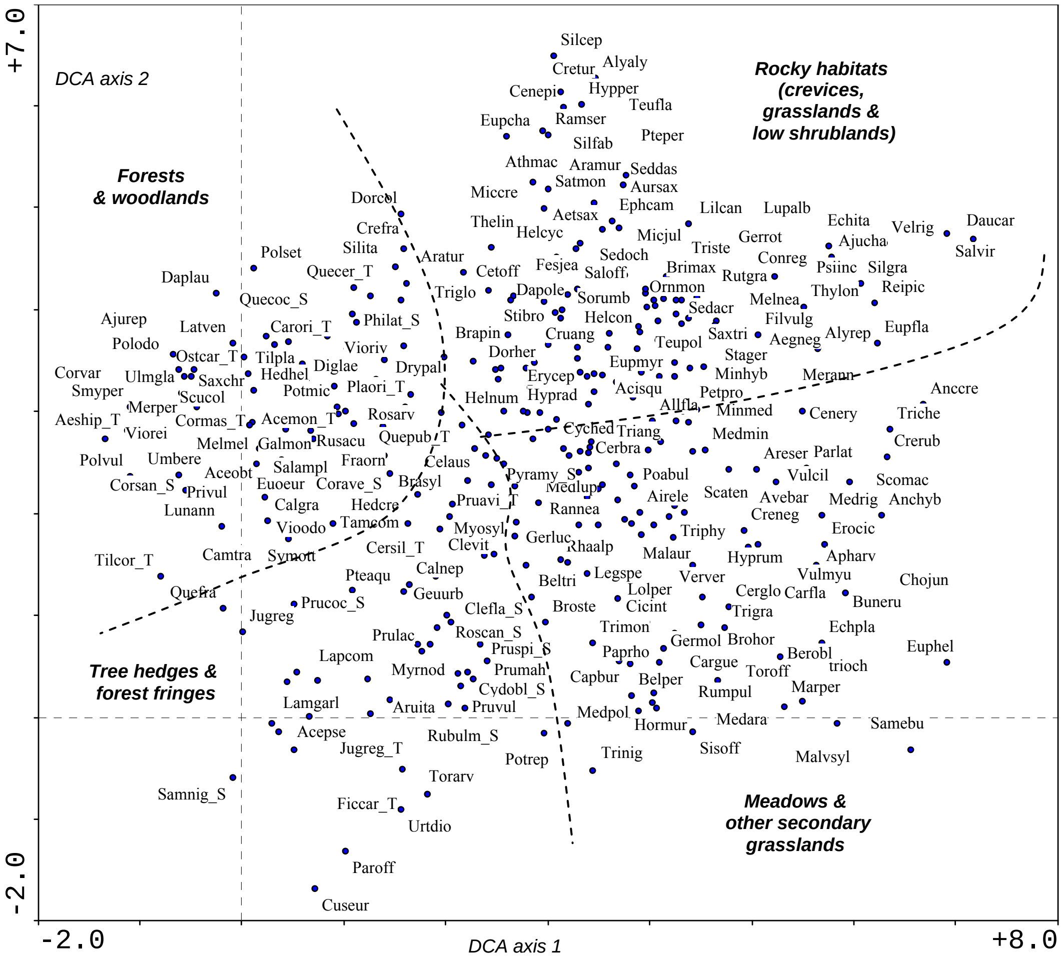

Fig.4.5 Two-dimensional species ordination diagram derived from Detrended Correspondence Analysis (DCA) of the vegetation data. The dotted lines were drawn to partition the floristic space into species groups indicating specific habitats.

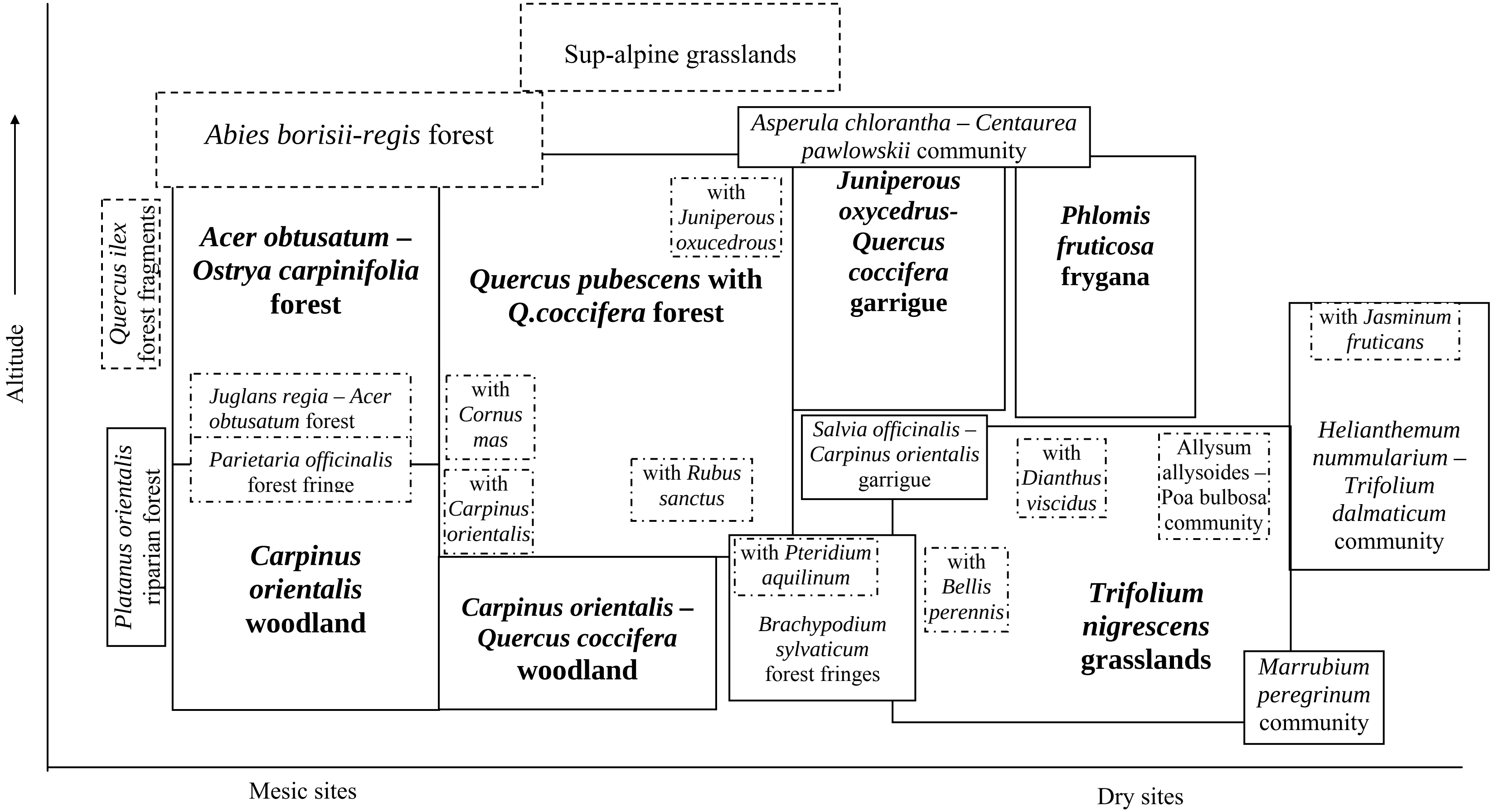

Fig.4.6 Ecogram of the vegetation types in relation to altitude and air humidity

4.2 Ecological evaluation

4.2.1 Vascular plant species diversity

DIVERSITY ANALYSIS OF THE PLANT COMMUNITIES

The Species richness, Shannon index, Gini index and Evenness were calculated for the nine plant communities, for which at least 10 relevés were available, and the condition of the same inventoried area could be met. All diversity indices were calculated at the 10 m^2 plot, the 100 m^2 plot and at the community level (Fig.4.5).

The average values of the diversity indices at the plot level are given in Table 4.5. At this level the phrygana of *Phlomis fruticosa* (Phl_fr8), the grassland of *Dianthus viscidus* (Di_vis2) and the open shrubland of *Juniperus oxycedrus* (Ju_ox10) had the highest diversity indices both at $10m^2$ and the $100m^2$ plot size. Diversity values of these three communities differed statistically significant from the others for all diversity indices (Table 6 in Annex).

Table 4.5 Average values of the diversity indices at the plot level

Plant community	Vegetation type	Number of Plots	S10	S100	H10	H100	E10	E100	G10	G100
Tri_ni3	G	10	35	86	2,4	3,9	67	87	0,81	0,97
Di_vis2	G	10	54	96	3,2	3,9	79	86	0,94	0,97
Phl_fr8	S	10	59	110	3,0	3,9	74	83	0,90	0,96
Ju_ox10	S	10	59	86	2,6	3,3	64	75	0,85	0,93
Q_coc11	W	10	28	67	1,6	3,1	49	75	0,71	0,92
Car_or21	W	10	28	49	1,3	2,5	40	66	0,60	0,84
Qp_Car22	F	10	32	58	1,7	2,8	49	68	0,71	0,88
Ac_Ost24	F	10	27	57	1,3	2,4	38	59	0,57	0,80
Qpub12	F	10	36	58	1,8	3,1	51	77	0,75	0,91

S10, S100: Species richness at the $10m^2$ and $100m^2$ plot size respectively. Similar coding applies also for Shannon index (H), Evenness (E) and Gini index (G). G: grasslands; S: Shrublands; W: Woodland; F: Forest

The woodland of *Carpinus orientalis* (Car_or21), the forest communities of *Quercus pubescens – Carpinus orientalis* (Qp_Car22) and *Acer obtusatum – Ostrya carpinifolia* (Ac_Ost24) presented the lowest diversity values, while the meadows of *Trifolium nigrescens* (Tri_ni3), the woodland of *Quercus coccifera* (Q_coc11) and the the forest fragments of *Q. pubescens* (Qpub12) exhibited intermediate values. No significant differences among the values of these communities were found for all diversity indices (Table 6 in Annex).

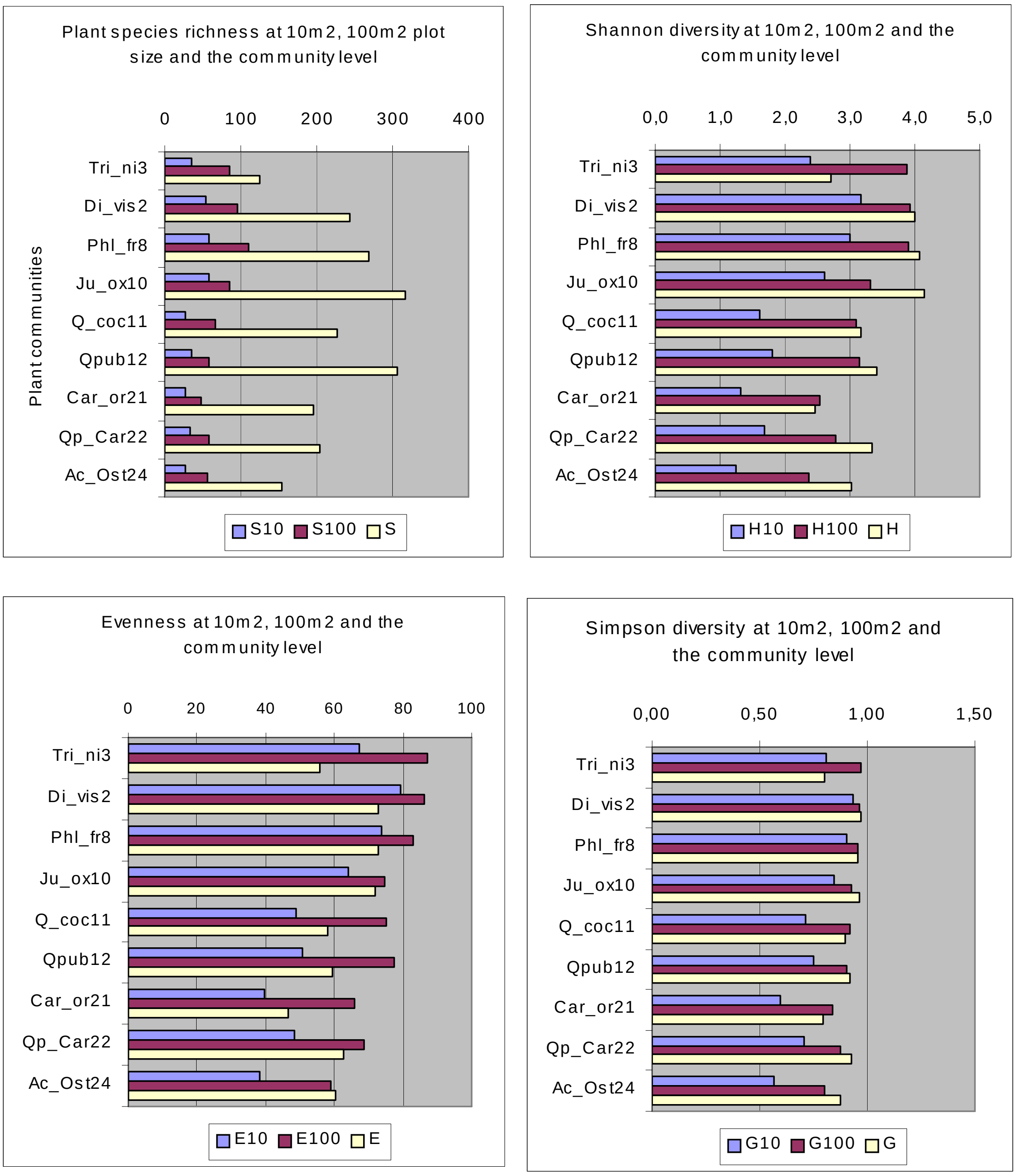

Fig.4.7 Diversity indices of nine plant communities represented with equal inventoried area. The plant communities are ordered from the more intensively used, such as the various open vegetation types (meadows, grazed grasslands and shrublands), to the less influenced such as the various woodlands and forests.

Concerning the diversity at the community level, the open shrubland of *Juniperus oxycedrus* (Ju_ox10) had the highest species numbers followed by the forest fragments of *Quercus pubescens* (Qpub12) and the phrygana of *Phlomis fruticosa* (Phl_fr8) (Table 4.6). On the contrary, the meadows of *Trifolium nigrescens* (Tri_ni3) exhibited the lowest species number, followed by the forest community of *Acer obtusatum – Ostrya carpinifolia* (Ac_Ost24) and the woodland of *Carpinus orientalis* (Car_or21).

The other diversity indices (Shannon, Simpson and Evenness) followed a similar pattern, with the two open shrubland communities of *Juniperus oxycedrus* (Ju_ox10) and *Phlomis fruticosa* (Phl_fr8) and the grassland of *Dianthus viscidus* (Di_vis2) to be the most diverse, and the forest community of *Acer obtusatum – Ostrya carpinifolia* (Ac_Ost24), the meadows of *Trifoliium nigrescens* (Tri_ni3) and the woodland of *Carpinus orientalis* (Car_or21) to be the least diverse.

Table 4.6 Diversity indices estimated at the community level

Plant community	Veg. type	Number of Plots	S	H	E	G
Tri_ni3	G	10	125	2,7	56	0,80
Di_vis2	G	10	243	4,0	73	0,97
Phl_fr8	S	10	268	4,1	73	0,96
Ju_ox10	S	10	317	4,2	72	0,96
Q_coc11	W	10	228	3,2	58	0,89
Car_or21	W	10	196	2,5	47	0,79
Qp_Car22	F	10	205	3,3	63	0,92
Ac_Ost24	F	10	155	3,0	60	0,87
Qpub12	F	10	306	3,4	60	0,92

S: Species richness, H: Shannon index, E: Evenness and G: Gini index
G: grasslands; S: Shrublands; W: Woodland; F: Forest

The community of *Quercus pubescens* (Qpub12) with the second highest species number at the community level demonstrated intermediate values for the other diversity indices. This could be attributed to the less equitable species distribution, as it is shown by its moderate Shannon and Evenness values (Table 4.6).

Concluding, the two open shrubland communities of *Juniperus oxycedrus* (Ju_ox10) and *Phlomis fruticosa* (Phl_fr8) exhibited the highest diversity indices both at the plot and community level, while the woodland of *Carpinus orientalis* (Car_or21) and the forest community of *Acer obtusatum – Ostrya carpinifolia* (Ac_Ost24) had the lowest diversity indices.

The classification of the nine communities with variables all diversity indices give an overall picture of the diversity among them (Fig.4.8). As it can be seen in the dendrogram, two clearly distinct groups representing high and low diversity levels are formed. The group of high diversity includes the grassland community of *Dianthus viscidus* (Di_vis2) and the two shrubland communities (Phl_fr8 and Ju_ox10). Grazing is the main land use in these communities.

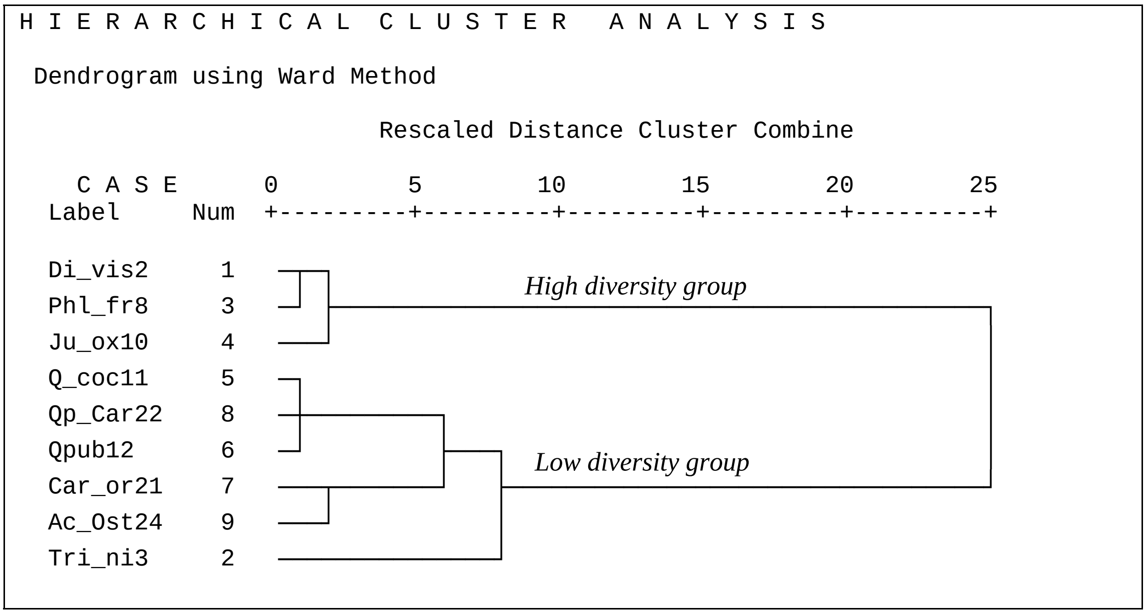

Fig.4.8 Diversity groups based on data of the same plot sizes and plot numbers

The remaining six communities exhibited lower diversity values in relation to the previous three communities and thus consisted the group of low diversity.

The changes in diversity along the successional stages, as they are represented by the studied plant communities, along with the possible factors controlling them are analyzed later in this chapter after the diversity evaluation of the 24 plant communities.

DIVERSITY EVALUATION OF THE PLANT COMMUNITIES

The 24 plant communities found in the study area were additionally classified with variables the diversity indices estimated for both $10m^2$ and $100m^2$ plot size, but for unequal plot numbers (Table 4.7 & Fig.4.9). There were identified three community clusters (groups), characterized by a specific range of each diversity index (Table 4.7) and different mean values (Table 4.8).

The grasslands of *Bellis perennis* (Bel_pe1), *Dianthus viscidus* (Di_vis2), *Poa bulbosa* (Poa_bu5), *Helianthemum nummularium* (Hel_nu6), *Jasminum fruticans* (Jas_fr7), along with the phrygana of *Phlomis fruticosa* (Phl_fr8), the *Salvia officinalis* garigue (Sal_of9) and the *Juniperus oxycedrus* garigue (Ju_ox10) consisted the group characterized by the highest average numbers of vascular plant species, and the highest values of all diversity indices (high diversity group). The main land use in these communities was grazing.

The *Carpinus orientalis* woodland (Car_or21), the *Acer obtusatum-Ostrya carpinifolia* forest (Ac_Ost24), and the *Juglans regia-Acer obtusatum* forest (J_Aobt23) had the lowest diversity values and thus formed the low diversity group. For long, coppicing, irregular low forest management and/ or grazing were the main land uses in this group. Nowadays, these stands being part of the core of the National Park are left to natural succession and only occasionally are grazed.

Intermediate species richness and values of diversity indices were characteristic for the meadows of *Trifolium nigrescens* (Tri_ni3), the nitrophilous *Marrubium peregrinum* community (Mar_pe4), the forest fringes of *Parietaria officinalis* (Par_of16) and *Pteridium aquilinum* (Pte_aq19), the *Quercus coccifera* woodland (Q_coc11), the forest fragments and hedges of *Quercus pubescens* (Qpub12, Ju_Qpu13, Co_Qpu14, Ru_Qpu18 and Qp_Car22). These communities formed the medium diversity group.

The three community groups were characterized by different mean values of all diversity indices as it is seen in Table 4.8 and thus they were considered of different diversity value (high, medium and low).

Three communities were excluded from the classification, because their diversity could not be estimated for both $10m^2$ and $100m^2$ plot size, due to missing data in one of these plot sizes (Table 4.7). These were the riparian forest of *Platanus orientalis*

(Pla_or15), the chasmophytic community of *Asperula chlorantha* (Asp_ch17) and the forest fringe community of *Brachypodium sylvaticum* (Br_syl20).

Because the 24 plant communities were represented by different plot numbers, their diversity indices could not be directly compared since these depend strongly on the inventory intensity. This was clearly demonstrated by the nine communities, for which the diversity indices were estimated twice, once for equal numbers of plots, and once for all of their plots (differing numbers)

As it can be seen in Tables 4.5 and 4.7 a specific plant community presented different diversity indices in the two inventory schemes (of equal and differing plot numbers). For instance, the phrygana of Phlomis fruticosa (Phl_fr8) had a richness of 59 species at the $10m^2$ plot size in the scheme of equal inventory intensity (1^{st} scheme), where it was represented by 10 plots (Table 4.5). In the scheme of differing inventory intensity (2^{nd} scheme), where the same community was represented by 24 plots, it exhibited a richness of 58 species (Table 4.7). The situation was similar for the richness at the $100m^2$ plot size. There the Phlomis fruticosa community had a mean richness of 110 species at the 1^{st} scheme (Table 4.5) and a mean richness of 96 species at the 2^{nd} scheme (Table 4.7). The situation was similar also for the other diversity indices and for the rest communities.

Nevertheless, an interesting point rises when comparing the diversity pattern (relative position) of these nine communities in both inventory schemes (Fig. 4.8 and Fig. 4.10). Specifically, <u>in both schemes</u>, the grassland of *Dianthus viscidus* (Di_vis2), the phrygana of *Phlomis fruticosa* and the shrubland of *Juniperus oxycedrus* (Ju_ox10) exhibited high diversity indices and were included to the cluster of high diversity value. Similarly, the woodland of *Carpinus orientalis* (Car_or21) and the forest community of *Acer obtusatum – Ostrya carpinifolia* (Ac_Ost24) presented low diversity indices and were aggregated to the cluster of low diversity value. Finally, the meadows of *Trifolium nigrescens* (Tri_ni3), the *Quercus coccifera* woodland (Q_coc11) and the forest of *Q. pubescens – Carpinus orientalis* (Qp_Car22) presented moderate diversity indices in both schemes. The agreement in the classification results of the two inventory schemes supported the sound basis of the classification of the 24 plant communities with the criterion of diversity.

Table 4.7 Classification of the plant communities in diversity groups, based on all relevés

Plant com/ity	Veg. type	Plots No 10m^2	Plots No 100m^2	S10	S100	H10	H100	E10	E100	G10	G100	Diversity value
Bel_pe1	G	14	4	42	65	2,7	3,5	74	83	0,88	0,94	high
Di_vis2	G	32	11	53	86	3,2	3,9	80	87	0,93	0,97	
Poa_bu5	G	22	7	48	76	2,9	3,7	76	85	0,9	0,96	
Hel_nu6	G	25	3	51	72	3,1	3,8	80	88	0,92	0,97	
Jas_fr7	G	25	4	56	99	3,2	4,0	79	88	0,93	0,97	
Phl_fr8	S	24	23	58	96	2,9	3,9	71	86	0,89	0,96	
Sal_of9	S	9	9	54	98	2,1	3,4	52	74	0,75	0,91	
Ju_ox10	S	13	13	57	103	2,4	3,5	60	76	0,81	0,91	
Tri_ni3	G	29	20	36	56	2,4	3,1	68	78	0,83	0,91	medium
Mar_pe4	G	19	5	35	54	2,4	3,2	67	80	0,82	0,92	
Par_of16	G	9	3	24	60	1,6	2,8	50	70	0,65	0,89	
Pte_aq19	G	6	2	30	74	1,8	2,8	55	65	0,7	0,88	
Q_coc11	W	20	26	29	66	1,7	2,9	51	70	0,72	0,89	
Qpub12	F	34	37	36	77	1,7	3,1	48	72	0,72	0,91	
Ju_Qpu13	F	6	9	43	75	2,2	3,1	58	71	0,82	0,92	
Co_Qpu14	F	9	9	30	67	1,7	2,9	50	69	0,75	0,9	
Ru_Qpu18	F	6	7	27	88	1,6	3,4	51	78	0,67	0,94	
Qp_Car22	F	21	24	31	60	1,6	2,9	46	71	0,68	0,9	
Car_or21	F	13	14	26	55	1,2	2,3	37	57	0,52	0,78	low
J_Aobt23	F	4	5	19	41	1,0	1,8	34	48	0,47	0,64	
Ac_Ost24	F	15	18	25	47	1,3	2,5	40	65	0,58	0,83	
Pla_or15	*F*	*0*	*6*		*49*		*1,5*		*39*		*0,59*	*
Asp_ch17	*G*	*7*	*0*	*29*		*2,2*		*66*		*0,85*		
Br_syl20	*G*	*14*	*0*	*39*		*2,5*		*68*		*0,84*		

** excluded from classification*

Table 4.8 Diversity values of the three diversity groups

Mean values	High diversity group	Medium diversity group	Low diversity group
S10	52	32	23
*Std.**	*5*	*5*	*4*
S100	87	68	48
Std.	*14*	*11*	*7*
H10	2,8	1,9	1,2
Std.	*0,4*	*0,3*	*0,2*
H100	3,7	3,0	2,2
Std.	*0,2*	*0,2*	*0,4*
E10	72	54	37
Std.	*10*	*8*	*3*
E100	83	72	57
Std.	*5*	*5*	*9*
G10	0,88	0,74	0,52
Std.	*0,06*	*0,07*	*0,06*
G100	0,95	0,91	0,75
Std.	*0,03*	*0,02*	*0,10*

** Std.:Standard deviation of the mean*

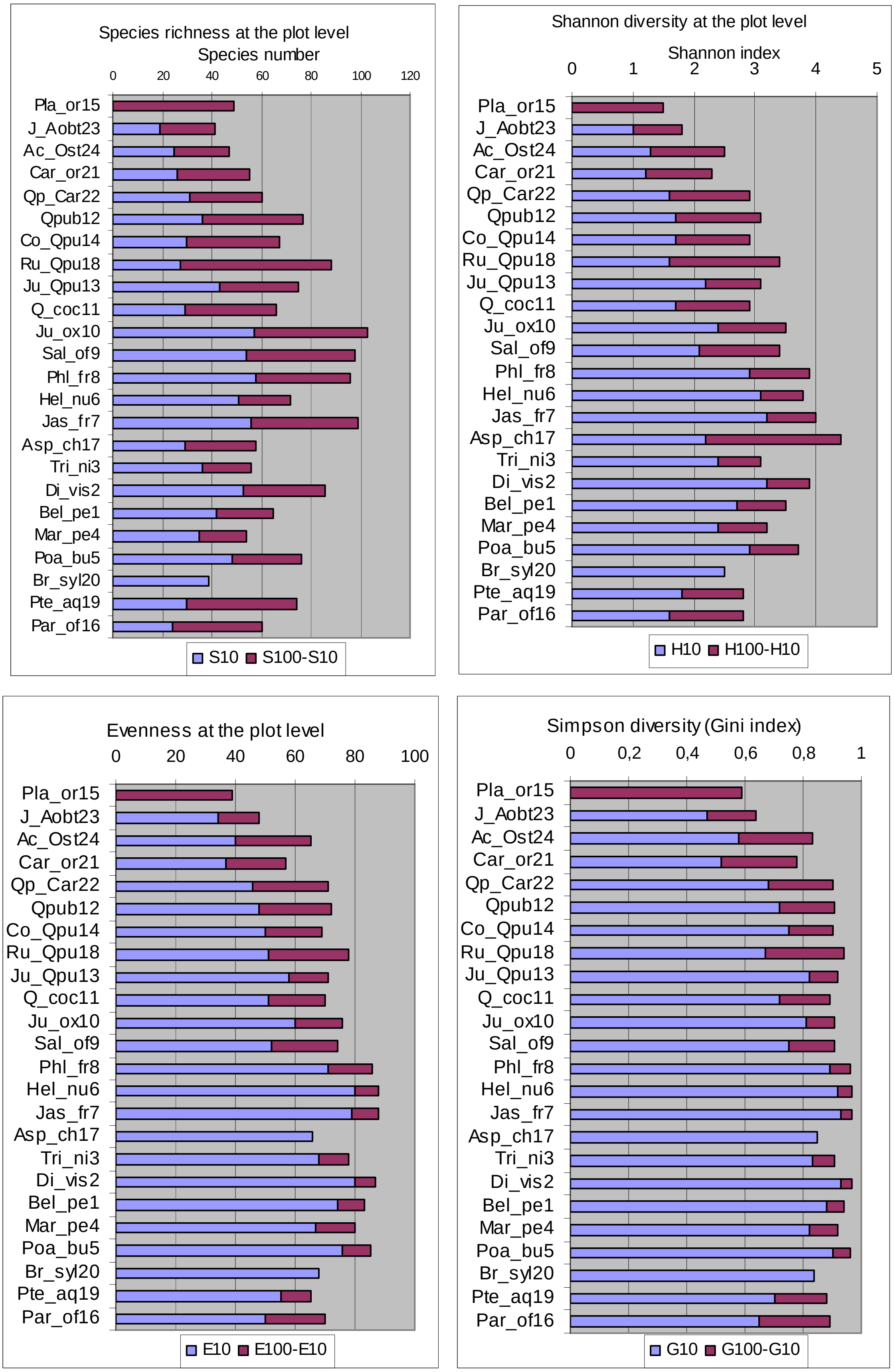

Fig.4.9. Diversity indices of the plant communities at 10m^2 & 100m^2 plot size levels, based on all plots. S10, H10, G10 & E10 refer to the Species Richness, Shannon index, Gini index and Evenness respectively, estimated at the 10m^2 plot level. The addition of the two bars for each community gives the respective index value at the 100m^2 plot level. The forest and woodland communities are ordered firstly, followed by the shrublands and various grasslands.

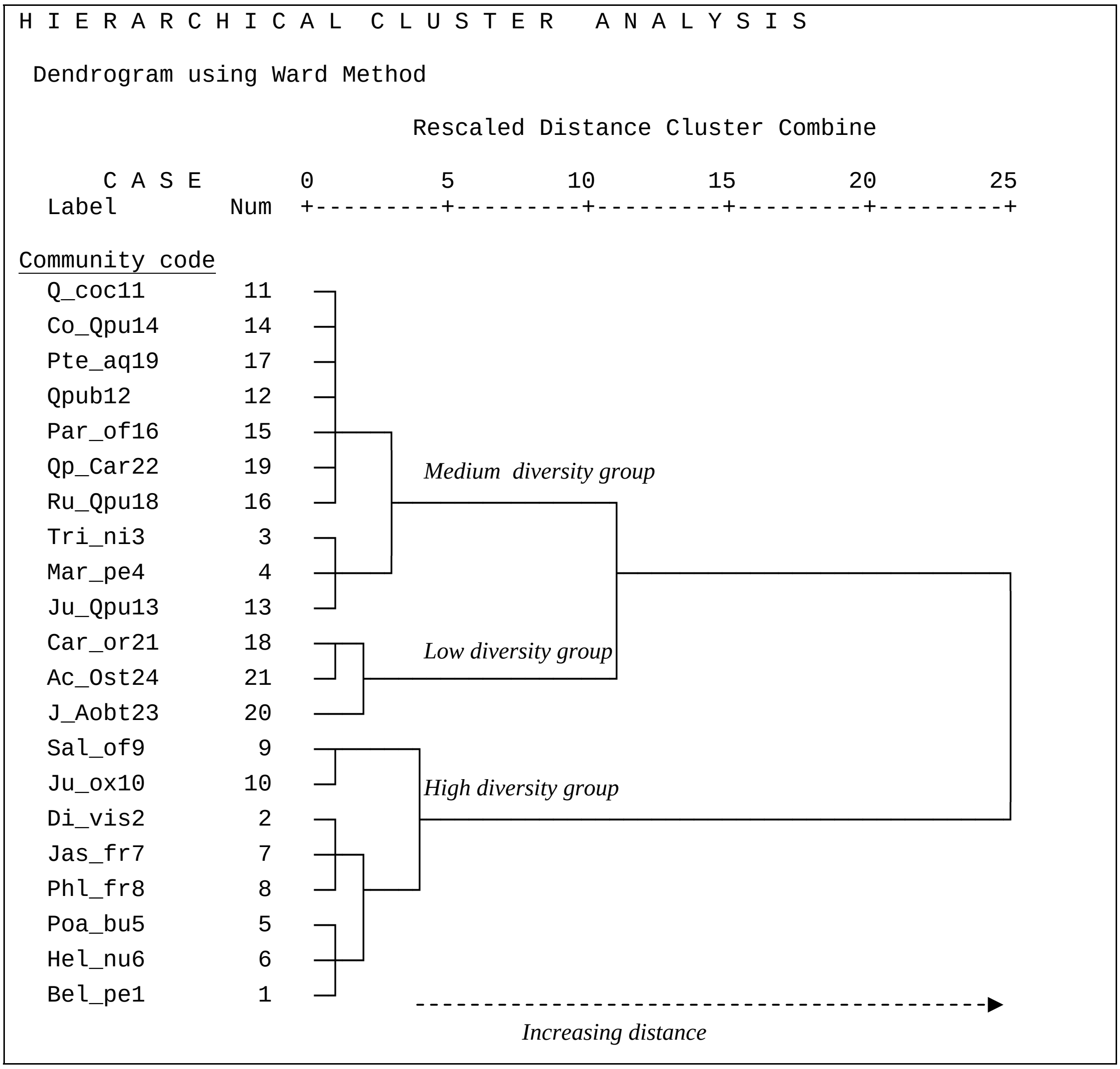

Fig.4.10 Dendrogram of the plant communities classification with variables the diversity indices estimated at the plot level ($10m^2$ and $100m^2$ plot size), based on all plots and resulted from unequal sampling intensity of the plant communities. The plant communities were classified in three major groups (of high, medium and low diversity) according their similarity in the diversity indices. Each group is consisted of plant communities characterized with specific range of diversity indices. The code names of the plant communities are shown.

Changes in diversity with increased plot size

In general, the value of the diversity indices of a community changed, when the plot size increased from $10m^2$ to $100m^2$ (Fig. 4.9). However, plant communities with high diversity at the $10m^2$ plot level, such as the *Phlomis fruticosa* phrygana, the *Juniperus oxycedrus* garigue and the *Dianthus viscidus* grassland, exhibited high diversity also at the $100m^2$ plot. The mesophilous woodland of *Carpinus orientalis* and the forest of *Acer obtusatum–Ostrya carpinifolia* (community 24) exhibited the lowest diversity values both at the $10m^2$ and $100m^2$ plot size.

An interesting feature showed the thermophilous woodland of Quercus coccifera and the forest fragments of Quercus pubescens (communities 11 & 12). These communities demonstrated low diversity values when inventoried with a $10m^2$ plot, but at the $100m^2$ plot size they reached intermediate diversity values and at the community level they presented high diversity.

These cases demonstrate firstly the influence of the plot size on the estimation of diversity, and secondly that a larger plot size than that of 10 m^2 is needed to unfold the species composition of shrublands and forests. Additionally, it was confirmed that from all diversity indices species richness is mostly affected by changes in the plot size. The other three diversity indices were influenced to a lesser degree. From the four studied diversity indices, species richness and Shannon diversity reached their highest values at the community level. Evenness is higher at the plot level, manifesting a more even species distribution at this level, while Simpson index has not shown a clear tendency, being higher either at the plot or at the community level.

In the study area the grazed grasslands and semi-open shrublands appeared to be the most diverse in all scale levels. NAVEH & WHITTAKER (1979b) reported higher diversity for moderately grazed ecosystems, in relation to the ungrazed or heavily grazed ecosystems and related their results to the "intermediate disturbance" hypothesis. According to this hypothesis the species diversity increases with increasing disturbance (the grazing pressure in this case) up to a point and thereafter it decreases (CONNELL 1978).

The high floristic and structural diversity of the mediterranean shrublands and woodlands are associated with moderate grazing pressure that maintains open habitats through regular disturbance. Altering an intermediate disturbance regime either through increasing or decreasing its land use intensity, land abandonment or protection has been found to reduce floristic diversity (NAVEH & WHITTAKER 1979, RUNDEL 1998). Similar are the effects to other organisms i.e. birds, reptiles, rodent and isopods (FARINA 1998).

Diversity changes in successional stages

Although the diversity of the studied plant communities differed according to the reference scale (10m^2 or 100m^2 plot size or community level) and the diversity measure (Richness, Shannon or Simpson diversity, Evenness), a similar diversity pattern was observed at each scale for all indices (Fig. 4.9).

In particular, at an early succession stage as it is represented by the meadows of *Trifolium nigrescens*, the diversity is low, probably due to the dominance of a few species favored by the mowing (such as *Trifolium* sp.). With the cease of mowing and the change of the land use into pasture the diversity increased, though in different degree among the various grasslands depending on the land use intensity and the various site factors. Two grassland and two semi-open shrubland communities presented the highest diversity indices (Fig. 4.9). Pasture is the main land use in all cases. In the case of the two grasslands it seems that grazing constrains the dominancy of a few species, creating thus niches for the coexistence of many species. The high diversity of the two semi-open shrubland communities is most likely an outcome of the mosaic-like structure of the community. The low cover of shrubs creates conditions for shade tolerant woodland species, fringe species and heliophilous species of the open grasslands. The garigue and phrygana are known to be of the richest in plant species vegetation types in the Mediterranean Region (BERGMEIER 1995, STRID & TAN 1997).

As the shrub or tree component increased in the communities, the diversity decreased. This is possibly associated to the canopy closure and the reduced light conditions. Vegetation types with low tree component or sparse canopy, such as the various forms of the *Quercus pubescens* forest, demonstrated higher diversity, in relation to the forest types with a denser canopy such as the forest types of *Acer obtusatum* and *Carpinus orientalis*. The loose forest crown in the case of the oak forest allows for optimal light conditions for many species (HOUSSARD et al. 1980, DEBUSSCHE et al. 2001).

Similar trends in plant species diversity along successional stages have been previously reported (NAVEH & WHITTAKER 1979, HOUSSARD et al. 1980, PLACHTER 1991, GUTKO et al. 2001). In these cases species diversity increased along the succession, with a maximum at the intermediate successional stages and decreased later as the succession proceeds to the forest.

The optimum disturbance (land use) intensity associated with the maximum in species diversity varies however among different biogeographical regions. So, in contrary to the study, there are cases where the traditional hay management is related with higher diversity in comparison to land abandonment of various age in Norway (LOSVIK 1999) or land use intensification in Germany (BRIEMLE et al. 2000). Obviously in both cases the traditional hay management represents the optimum disturbance regime for the respective ecosystems. Also, in contrast to the study and other Mediterranean ecosystems (NAVEH & WHITTAKER 1979) grazing on American grasslands is associated with decreasing species diversity (WHITTAKER 1977b). Such contrasting examples are often associated with the different evolutionary processes of the respective ecosystems. The high species diversity of the Mediterranean ecosystems are considered to be the combined result of a long evolutionary history under constant stress by drought, fire and grazing and the small-scale heterogeneity of the mountainous habitats (NAVEH & WHITTAKER 1979b, BLONDEL & ARONSON 1995 RUNDEL 1998, PIGNATTI & PIGNATTI 1999).

Diversity of vegetation types in related habitats and areas

Diversity indices of vegetation types similar to those of the study area are presented in Table 4.9, Table 4.10 and Table 4.11. They all refer to the plot level. As it concerns richness, the vegetation types of the study area exhibited higher richness than the majority of those in literature, with the exception of vegetation types from Israel (Table 4.9 and Table 4.10). Specifically, the plant communities of the study area demonstrated similar richness with the vegetation types from Israel at the $100m^2$, and higher at the $10m^2$ plot. This fact puts the communities of the study area among the richest in the Mediterranean region.

Table 4.9 Comparison of richness between vegetation types in Israel and Vikos area					
Israel (Source: NAVEH & WHITTAKER 1979)			Study area		
Vegetation type	Total vascular species		Total vascular species		Plant community
	10m^2	100m^2	10m^2	100m^2	
shrub grassland	42	105	58	96	Phlomis fruticosa phrygana
open shrubland	34	75	57	103	Juniperus oxycedrus garigue
maquis (closed shrubland)	8	26	29	66	Quercus coccifera pseudomacchie
oak woodland (grazed)	34-39	76-88	43	75	Quercus pubescens with Juniperus oxycedrus forest pasture
oak woodland (not grazed)	29	36	25	47	Acer obtusatum - Ostrya carpinifolia forest

The results from Israel agree with our results on that, semi-open shrublands and woodlands have higher plant species numbers than the dense woodlands and forests. Macchie and pseudomacchie vegetation types dominated by evergreen, sclerophyllous species such as *Quercus coccifera* and *Q. ilex* form a dense canopy with a poor herb layer and are species poor (HORVAT et al.1974, PIGNATTI & PIGNATTI 1999).

The Shannon diversity, Simpson diversity and Evenness of the studied plant communities can not be directly compared to those of the literature, because their estimation is not always referred to the same plot size or the same method (Table 4.11).

Table 4.10 Richness of vegetation types similar to those in Vikos area

Data from other studies				Study area			
Vegetation type	Plot no	Mean Cover * (%)	N	Plot size (m2)	N	Plant community	Mean Cover (%)
Alopecuro-Ranunculetum marginati with *Trifolium nigrescens* grassland [1]	10	93	19	100	56	*Trifolium nigrescens* meadows	81
Traditional meadows [2]	10	4.1[t]	49	100		>>	
Abandoned meadows for 30 years[2]	10	29.4[t]	35	100	86	*Trifolium nigrescens* community, *Dianthus viscidus* form	71
Poor grassland pasture - (Mesobromion)[3]	7	90	39	20	51	*Trifolium nigrescens* community, *Bellis perennis* form	75
Poor grassland pasture - *Mesobromion* (*Sesleria varia* with *Ranunculus bulbosus*)[3]	13	90	42	20	59	*Helianthemum nummularium – Trifolium dalmaticum* community	50
Grazed grassland - *Cynosurion (Festuco-Cynosuretum* with *Potentila erecta*)[4]	11	90	32	20	60	*H.nummularium – T.dalmaticum* community, *Jasminum fruticans* form	39
Quercus coccifera-Juniperus oxycedrus shrubland [5]	6	93	33	100	103	*Quercus coccifera-Juniperus oxycedrus* shrubland	33
Quercus ilex-Carpinus orientalis woodland [5]	10	94	26	100	60	*Quercus pubescens-Carpinus orientalis*	48
Lonicero etruscae-Carpinetum orientalis woodland [6]	3		32	100	55	*Carpinus orientalis* woodland	63
Quercus pubescens forest [5]	3	62	39	100	77	*Q.pubescens* forest	45
Lithospermo-Quercetum pubescentis forest [3]	10	85	34	100		>>	
Ostrya carpinifolia forest community[7]	16	70	60	200	55	*Acer obtusatum-Ostrya carpinifolia* forest	64
Dryopterido pallidae-Ostryetum carpinifoliae forest [5]	4	65	41	200		>>	

* : refered to shrubs or tree cover for shrubland or forest vegetation respectively.
N: Total number of vascular plant species, t: tree cover

Source: 1: RAUS 1983, 2 : LOSVIK 1999, 3: WITSCHEL 1980 (refering only to vascular plants), 4: REIF et al. 1989, 5: BERGMEIER 1990, 6: BLASI et al. 2001, 7: REIF & LÖBLICH-ILLE 1999.

Table 4.11 Diversity of vegetation types similar to those in Vikos area

Other areas				Vikos area *			
Vegetation type	H	E	D	Vegetation type	H	E	D
Meadows[1]	2,5		0,90	*Trifolium nigrescens* meadows	3,1	78	0,91
Hedges[1]	3,5		0,96	*Rubus ulmifolius sanctus - Q.pubescens* treehedges	3,4	78	0,94
Mesophilous grasslands[2]	3,6	90		*Trifolium nigrescens* with *Dianthus viscidus* form	3,9	87	0,97
Mesobrometum[3]	3,0	79		*T.nigrescens* with *Bellis perennis*	3,5	83	0,94
Xerobrometum[3]	2,8	82		*Hel.nummularium-Trif.dalmaticum* with *Jasminum fruticans* form	4	88	0,97
Grasslands-meadows[4]		70		Grasslands-meadows (mean)	3,6	83	0,95
Shrublands[4]		45		*Quercus coccifera* woodland	2,9	70	0,89
Oak forests[4]		56		*Quercus pubescens* forest	3,1	72	0,91
Beech forests[4]		48		*Acer obtusatum-Ostrya carpinifolia* forest	2,5	65	0,83
Alnus glutinosa forest[5]	2,6	66		*Platanus orientalis* riparian forest	1,5	39	0,59
Quercetum ilicis[6]	2,3			*Quercus ilex* community	2,4	59	0,85

H:Shannon index, E: Evenness, D: Simpson index
* the indices refer to the 100m^2 plot

Source: 1: WAGNER et al. 2000, 2: ALARD & POUDEVIGNE 2000, 3: FISCHER 1982, 4: HAEUPLER 1982, 5: ERDNÜSS 2000, 6: PIGNATTI & PIGNATTI 1999.

Diversity changes along gradients

The causes of the high phytodiversity of the area have not been investigated. This requires an experimental approach. However, the rank correlation of our environmental and structural data with the axis of the indirect ordination of the vegetation data demonstrated a significant correlation among diversity and environmental factors (Table 4.4). Diversity is negatively correlated to the cover of trees and shrubs and to the forest land use and possitively correlated to the cover of herbs and the land uses of pasture and mowing. Also the plots ordination diagram indicated an increase in diversiy along a climatic (moisture) gradient from mesic to moderately dry sites (Fig.4.4). These are in agreement to NAVEH & WHITTAKER (1979), who reported higher species diversity with decreasing moisture (precipitation) and also higher diversity in semi-open shrublands and moderately grazed open oak woodlands in relation to dense shrublands and protected woodlands.

LANDSCAPE DIVERSITY: COMPONENTS AND CONTROLING FACTORS

SPECIES RICHNESS S OF THE TRADITIONAL CULTURAL LANDSCAPE

The study area demonstrated a high number of plant species. In an area of 8 km^2 (6% of the area of Vikos Aoos National Park and 0,006% of Greece) 700 plant taxa are met, which corresponds to 80% of the total plant taxa of the National Park and 11% of the total plant taxa of Greece (Table 4.12).

Table 4.12 Extent and number of plant taxa in the study area & related geographical units

Geographical unit	Extent (E) in km^2	Number of plant taxa* (S)	S/E ** (taxa/km^2)
Study area (Vikos community)	8	700	88
Vikos-Aoos National Park [1]	129	873	7
Mount Tymfi [2]	500	1.750	4
Greece [3]	132.000	6.308	0,05
Mediterranean zone [4]	2.362.000	25.000	0,01
Europe [5]	10.107.000	11.047	0,001

*: species & subspecies, **: species density

Source: 1: KASIOUMIS & GATZOJANNIS 1996, 2: AUTHIER 1997, 3: STRID & TAN 1991, 4: SCHULZE et al. 2002, 5: PIGNATTI & PIGNATTI 1999

The high plant species richness (700 plant taxa) of the studied landscape is consisted of a mean community richness ($\overline{S}$wt) of 243 species and a between communities richness (Sbt) of 457 species. The mean community richness is again the sum of a mean plot* richness of 38 taxa and a between plots component of 205 taxa. Therefore, the contribution of the three diversity components, i.e. plot richness, between plots richness and between communities richness, to the landscape richness is given by the proportion 38/205/457 or in percent 6%/29%/65%.

The plot richness is directly related to the species composition of the plant communities. A plot of 10m2 in the study area had on average 38 plant taxa, which corresponded to 6% of the landscape richness. The between plots richness is indicative of the community heterogeneity and is rather related to the site conditions (relief, microclimate). The plots of a community differ to some extent in their species composition and that contributed by 29% to the landscape richness. The between communities richness is an expression of the landscape heterogeneity (when referring to its vegetation types) and is associated -among others- with the different species composition of the plant communities consisting the landscape. The study landscape is consisted of a wide range of plant communities (from forests to grasslands). The differences in species composition among the communities contributed the major proportion (65%) to the landscape richness.

In conclusion, the landscape richness depends mainly on its heterogeneity. Almost two thirds of the plant species number of the landscape is attributed to the unlike composition of the plant communities, while one third is related to the richness of the plant communities and their heterogeneity. Thus, the more different the composition of the various plant communities is, the higher the species richness of the landscape.

SHANNON DIVERSITY H AND SIMPSON DIVERSITY G OF THE LANDSCAPE

With Shannon index as the diversity measure, the landscape diversity (Hwl = 5.1) is partitioned into a between communities component (Hbt) of 1.9 and a mean community diversity ($\overline{H}$wt) of 3.2. The latter again is the sum of a mean plot diversity ($\overline{H}$wp) of 2.1 and the between plots diversity (Hbp) of 1.1.

Thus, the proportion of the three diversity components, i.e. plot diversity, between plots diversity and between communities diversity, to the landscape diversity is 2.1/1.1/1.9 H or 41%/22%/37%. Unlike the richness, Shannon diversity of the

* it refers to 10m^2 plot size.

landscape is mainly related to the mean plot component and less to the between plots or the between communities component. Specifically, 41% of the Shannon diversity of the landscape is attributed to the plot diversity, only 22% to the between plots diversity and 37% to the between communities diversity.

With the Simpson index G as the diversity measure, the landscape diversity (Gwl = 0.99) is partitioned into a between communities component (Gbt) of 0.11 and a mean community component ($\overline{G}$ wt) of 0.88. The mean community diversity is again the sum of a mean plot diversity ($\overline{G}$ wp) of 0.76 and a between plots diversity (Gbp) of 0.12. Similarly to Shannon diversity, the Simpson diversity of the landscape is attributed mainly to the plot diversity (77%) and only 12% to the between plots and 11% to the between communities components.

With Shannon or Simpson index as a measure, the landscape species diversity seems to be related mainly to the high plot diversity of the communities and less to the community, or to the landscape heterogeneity. This indicates that the landscape diversity is attributed mainly to the diversity of the plant communities and thus their plant species composition, and to a lesser degree to the heterogeneity of the landscape and thus its composition of plants communities in agreement to WAGNER et al. (2000).

4.2.2 Naturalness

The plant communities of the landscape were classified for the criterion of naturalness into three groups corresponding to high, medium and low naturalness value, based on the type and intensity of the land use / disturbance regime (Table 4.13).

Since the reference point for the naturalness of a plant community is the potential natural vegetation (pnV), the plant communities had to be compared to the respective pnV. Based on the results of the vegetation analysis, the pnV at the moderate sites above flysch should be the deciduous oak forest (*Quercion frainetto*) and above limestone the deciduous mixed broadleaved forest (*Ostryo-Carpinion*) (DAFIS & JAHN 1975, BERGMEIER et al. 2004). At the extreme site conditions, such as the precipitous rock cliffs, a chasmophytic vegetation type of the *Campanulion versicoloris* alliance is assumed to be the pnV (BERGMEIER 1990a, DIMOPOULOS et al. 1997). Finally at the valley of Vikos gorge along Voidomatis river the pnV is the riparian forest of the *Platanion orientalis* (HORVAT et al. 1974, GEORGIADIS at al. 1996).

The forests i.e. the *Platanus orientalis* riparian forest, the stands with *Acer obtusatum* and *Ostrya carpinifolia* and the forest fragments of *Quercus pubescens* (except the *Juniperus oxycedrus* community form 13) have been affected mainly by activities of low intensity, such as selective cutting, tree shredding or pollarding and occasional grazing. Consequently, the forests types and the chasmophytic community of *Asperula chlorantha* that is within human and animal reach, represent the vegetation types mostly close to the respective pnV and were thus classified as semi-natural (for the criterion of naturalness) or as oligo-hemerob (for the criterion of hemeroby). These vegetation types are considered to be the most natural of the studied ones and were thus granted with high ecological value.

On the other side, the plant communities of the phrygana, grasslands and meadows are the most intensively used since they provide for the daily pasture of the community livestock. The criterion of naturalness is low in these communities, so they were classified to the altered or euhemerob level and were considered of low naturalness value.

Finally, the woodlands, garigues, tree hedges and the woody pasture of *Quercus pubescens* with *Juniperus oxycedrus* are managed less intensively in comparison to the euhemerob communities, but they are subject to regular anthropo-zoogenous interventions, e.g. rotational grazing and tree shredding or pollarding, in comparison to the oligo-hemerob communities. For this reason they were ranked to the moderately altered or meso-hemerob communities and they were considered of medium naturalness value. At the same naturalness and hemeroby level there were also incorporated the abandoned fallow fields, which are in forest succession.

Table 4.13 Naturalness value of the plant communities

Plant com/ties	Vegetation types	Human impact	Hemeroby level	Naturalness level	Nat/ness value
Pla_or15	Veg/tion types close to the pnV	Forest exploitation of low intensity, occasional grazed	Oligo-hemerob	Semi-natural	High
Ac_Ost24					
J_Aobt23					
Qp_Car22					
Qpub12					
Co_Qpu14					
Asp_ch17					
Car_or21	Woodland, garigue, fallow fields	Periodical forest exploitation, rotational or occasional grazing	Meso-hemerob	Moderately altered	Medium
Ru_Qpu18					
Ju_Qpu13					
Q_coc11					
Ju_ox10					
Sal_of9					
Br_syl20					
Pte_aq19					
Par_of16					
Phl_fr8	Phrygana, grasslands, meadows	Daily grazing, annual mowing	Eu-hemerob	Altered	Low
Jas_fr7					
Tri_ni3					
Hel_nu6					
Mar_pe4					
Poa_bu5					
Di_vis2					
Bel_pe1					

4.2.3 Rare plant species

In the inventoried plots of the study area 66 rare plant taxa were found. Six more rare taxa were encountered outside of the plots. The overall 72 rare taxa include 14 Greek endemics, 40 wide endemics and 28 threatened taxa (Table 7 in Annex). Some of the threatened taxa are either Greek or wide endemics.

Although the percentage of rare taxa in the study area is low (10%) compared to the percentage of rare taxa in Greece (29%) (DAFIS et al. 1996), the concentration of rare taxa in the study area is high. In an area of only 8 km^2, 11% of the known Greek taxa are encountered, which corresponds to 4% of the rare taxa of Greece (Table 4.14).

Table 4.14 Rare plant species in Vikos area in relation to Greece

Area	Extent (km^2)	Number of plant taxa	Total rare taxa[1]	Greek endemics	Threatened taxa	Wide Endemics
Study area (A)	8	700	72 (10%)	14 (2%)	28 (4%)	40 (6%)
Greece* (B)	132.000	6.308	1852 (29%)	837 (13%)	252 (4%)	1015 (16%)
A/B *100 (%)	0.006	11	4	2	11	4

1: from DAFIS et al. 1996

The study area presents in percentages lower rare plant taxa numbers in relation to the respective for the Greek territory. However, due to the relatively small extent of the study area the concentration of rare taxa is high. Specifically, in an area of only 8 km2 there are found 11% of the total known Greek taxa, which includes 4% of the total Greek rare taxa.

The classification of the plant communities with variables the numbers of the Greek endemics, Threatened taxa, Wide endemics and Total rare taxa distinguished three community groups (Table 4.15, Fig.4.11). The three rarity groups differ in the species number and species distribution for each of the four rare taxa categories (Table 4.16).

The first community group (high rarity group) contained the forest fragments of *Quercus pubescens*, the phrygana of *Phlomis fruticosa*, the garigue community of *Juniperus oxycedrus*, the rocky grassland of *Jasminum fruticans* and the grassland of

Dianthus viscidus. The mean numbers of the four rare taxa types were the highest in this community group (27 Total rare taxa, which include 8 Greek endemics, 13 Wide endemics and 8 Threatened taxa).

Table 4.15 Rare plant species and rarity value of the plant communities

Plant com/ity	Veg/tion type	Total rare taxa	Greek endemics	Wide endemics	Threatened taxa	Rarity value
Qpub12	F	28	9	10	10	High
Phl_fr8	S	29	9	14	8	
Ju_ox10	S	25	8	14	5	
Jas_fr7	G	29	8	15	9	
Di_vis2	G	25	7	13	7	
Ju_Qpu13	F	18	6	9	4	Medium
Qp_Car22	F	17	5	6	8	
Ac_Ost24	F	18	5	11	6	
Q_coc11	W	22	5	10	10	
Car_or21	W	15	5	6	5	
Sal_of9	S	23	8	10	5	
Bel_pe1	G	18	8	6	5	
Poa_bu5	G	16	5	9	3	
Hel_nu6	G	18	5	7	8	
Asp_ch17	G	14	4	7	4	
Br_syl20	G	20	7	10	5	
Co_Qpu14	F	10	5	4	2	Low
Pla_or15	F	10	3	7	1	
Ru_Qpu18	F	13	6	6	1	
J_Aobt23	F	8	3	4	3	
Tri_ni3	G	10	4	5	1	
Mar_pe4	G	7	3	3	1	
Par_of16	G	8	3	5	1	
Pte_aq19	G	8	3	4	2	

The 3rd community group (low rarity group) includes four forest communities (the riparian forest, the *Quercus pubescens* forest stands with *Cornus mas*, the *Juglans regia - Acer obtusatum* forest and the tree hedges of *Rubus sanctus* and *Quercus pubescens*) and four grassland communities (the meadows of *Trifolium nigrescens*, the nitrophilous *Marrubium peregrinum* community, the forest fringes of *Parietaria officinalis* and the *Pteridium aquilinum* community). This group is characterized by the lowest mean rare taxa numbers (9 Total rare taxa, 4 Greek endemics, 5 Wide endemics, 2 Threatened taxa) (Table 4.16).

The rest communities exhibited intermediate values of rare taxa (18 Total rare taxa, 6 Greek endemics, 8 Wide endemics, 6 Threatened taxa) and consisted the medium rarity group. These were the wood pasture of *Juniperus oxycedrus - Quercus pubescens,* the forest community of *Quercus pubescens-Carpinus orientalis* and that of *Acer obtusatum – Ostrya carpinifolia*, the woodland of *Quercus coccifera* and that of *Carpinus orientalis*, the garigue shrubland of *Salvia officinalis*, and five grassland communities (the *Bellis perennis* community, the *Poa bulbosa* community, the *Helianthemum nummularium* community, the chasmophytic community of *Asperula chlorantha* and the two forest fringes of *Brachypodium sylvaticum*).

Table 4.16 Characteristic values of the three rarity groups

Rarity group		Total rare species	Greek endemics	Wide endemics	Threatened Taxa
High value	Mean species number per community	27	8	13	8
	Std.	2	1	2	2
	Total species of the rarity group	53	13	27	20
	Species distribution*	143	56	68	24
Medium value	Mean species number per community	18	6	8	6
	Std.	3	1	2	2
	Total species of the rarity group	58	10	34	22
	Species distribution	73	28	35	15
Low value	Mean species number per community	9	4	5	2
	Std.	2	1	1	1
	Total species of the rarity group	27	8	16	5
	Species distribution	19	8	9	3

Std.: Standard deviation of the mean species number

- The species distribution in each rarity group is expressed as the sum of the average plot number of each rare species in the communities of the group.

Apart from the mean numbers of rare taxa, the three rarity groups differ also in the total numbers of rare species and the species distribution (Table 4.16). Specifically, from the 13 Greek endemics all are present in the 1st rarity group, while only 10 and 8 are present in the 2nd and 3rd rarity group respectively. *Fritillaria thessala ssp.ionica, Prunus prostata* and *Silene niederi* were only present in the 1st rarity group, while *Biarum tenuifolium* and *Silene cephallenia* missed from the 3rd rarity group (Table 8 in Annex). Concerning the wide endemics, threatened taxa and total rare taxa, these are present with higher numbers in the 2nd rarity group, but lower distribution than in the 1st rarity group. The 3rd rarity group has both the lowest species numbers and distribution.

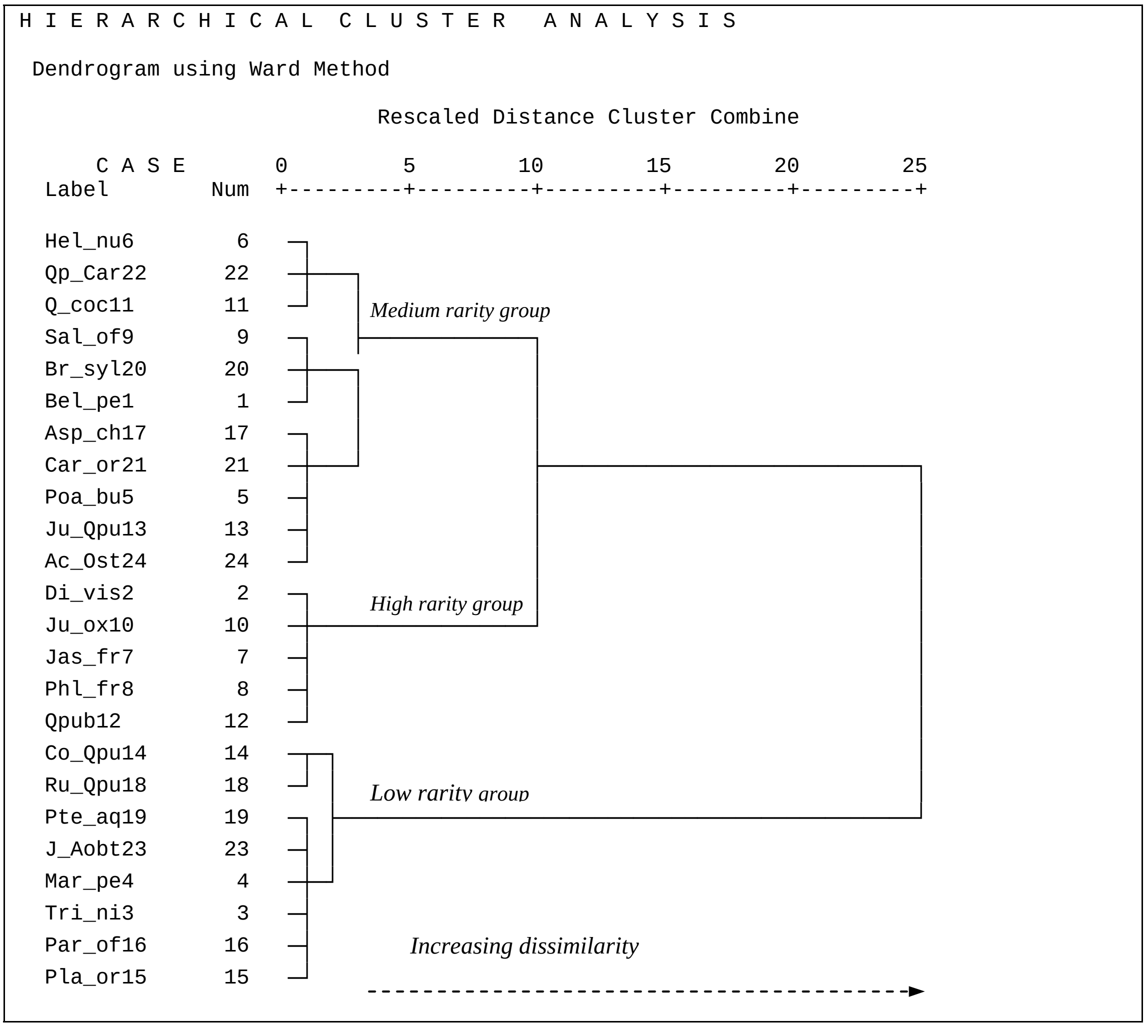

Fig.4.11 Dendrogram of the plant communities resulted from hierarchical classification based on the numbers of Greek endemics, Threatened taxa, Wide endemics and Total rare taxa. The communities were aggregated in three groups of high, medium and low rare taxa numbers representing three rarity groups of high, middle and low value.

When considering each rare taxon independently (Table 8 in Annex) we conclude to the following. Only 14 rare taxa showed fidelity greater than 50% to a specific plant community (Table 4.17). Four of these taxa were related to the forest community of *Acer obtusatum - Ostrya carpinifolia*, and four other taxa to the chasmophytic community of *Asperula chlorantha*. The remaining 6 taxa were related to 6 different communities.

The high fidelity of a rare species to a plant community adds to the conservation value of the community and directs its management to preserve the species. For instance, the survival in the study area of the threatened Greek endemic *Silene cephallenia* is directly connected with the preservation of the chasmophytic community of *Asperula chlorantha* (Asp_ch17) (Table 4.17). Thus, the management of the community should aim at the protection of the species from any human action that threatens its population. Moreover, the *Asperula chlorantha* community represents the main habitat also for other three rare species, including *Silene fabarioides, Centaurea pawlowskii* and *Teucrium flavum ssp. hellenicum.* Thus, the conservation value of the community is considered high and its preservation is prerequisite for the survival of these rare species in the study area.

Table 4.17 Rare taxa with high fidelity to plant communities

Rare species name	Rare species category	Species fidelity * (%)	Plant community code	Vegetation type
Aesculus hippocastanum	W, T	100	Ac_Ost24	forest
Malcolmia graeca ssp. bicolor	W	83		
Corylus colurna	W, T	67		
Saxifraga chrysospleniifolia	W	55		
Galanthus nivalis	T	75	Qp_Car22	forest
Lilium chalcedonicum	W, T	100	Q_coc11	woodland
Silene cephallenia	G, T	80	Asp_ch17	chasmophytic
Silene fabarioides	W	60		
Centaurea pawlowskii	W	60		
Teucrium flavum ssp. hellenicum	W	57		
Achillea holosericea	W	80	Ju_ox10	shrubland
Lilium canditum	W, T	60	Jas_fr7	grassland
Onobrychis montana ssp. scardica	W	78	Hel_nu6	grassland
Serapias vomeracea	T	75	Di_vis2	grassland

W: wide endemic, T: threatened taxon, G: Greek endemic

* expressed as percentage of the community plots containing the species to the total plots the species was found.

With the exception of the rare taxa listed in Table 4.17, the rare taxa with more than 2 plots were mainly distributed either in the 1st or 2nd rarity group, while no rare taxon exhibited fidelity to any community of the 3rd rarity group or the group (Table 8 in Annex I).

RARE SPECIES NUMBERS OF THE NINE PLANT COMMUNITIES REPRESENTED BY EQUAL INVENTORY INTENSITY

The numbers of the Greek endemics, Threatened taxa, Wide endemics and Total rare taxa have been counted also for each of the nine plant communities, which were represented by equal inventory intensity (Table 4.18, Fig.4.12).

The classification of the communities based on the four rare taxa categories resulted in two groups (Fig.4.13). The 1st group aggregated the communities with the highest rare species numbers and consisted the high rarity group. These communities are the garigue of *Juniperus oxycedrus* (Ju_ox10), the phrygana of *Phlomis fruticosa* (Phl_fr8), the grassland of *Dianthus viscidus* (Di_vis2) and the forest fragments of *Quercus pubescens* (Qpub12). The remaining five communities demonstrated lower rare species numbers than the previous ones and formed the low rarity group. Among them, the meadows of *Trifolium nigrescens* presented the lowest rarity values. The other communities, which were the two woodlands of *Carpinus orientalis and Quercus coccifera* and the two forest communities of *Quercus pubescens – Carpinus orientalis* (Qp_Car22) and *Acer obtusatum - Ostrya carpinifolia* (Ac_Ost24), presented intermediate values of rare taxa.

Table 4.18 Rare plant taxa of nine communities with equal inventoried area

Plant community	Greek endemics	Threatened taxa	Wide endemics	Total rare taxa
Tri_ni3	2	0	3	5
Di_vis2	7	4	9	20
Phl_fr8	8	3	12	22
Ju_ox10	8	5	12	24
Q_coc11	3	4	5	11
Qpub12	6	5	8	19
Car_or21	5	5	4	14
Qp_Car22	5	6	5	15
Ac_Ost24	5	5	7	14

Although the nine communities exhibited different rare species numbers in the two different inventory schemes (equal vs. different inventory intensity), however the same rarity pattern (relative position) was observed in both cases for the nine communities, as it can be seen from the respective dendrograms (Fig.4.11 & Fig.4.13). Specifically, in both inventory schemes, the communities 2, 8, 10 and 12 had high numbers of rare taxa and thus were aggregated at the high rarity group. The communities 11, 21, 22 and 24 showed intermediate values and were clustered at the medium rarity group, while community 3 had low rarity values in both cases. The agreement in the classification results of the two inventory schemes support the sound basis of the aggregation of the studied communities in the three rarity groups.

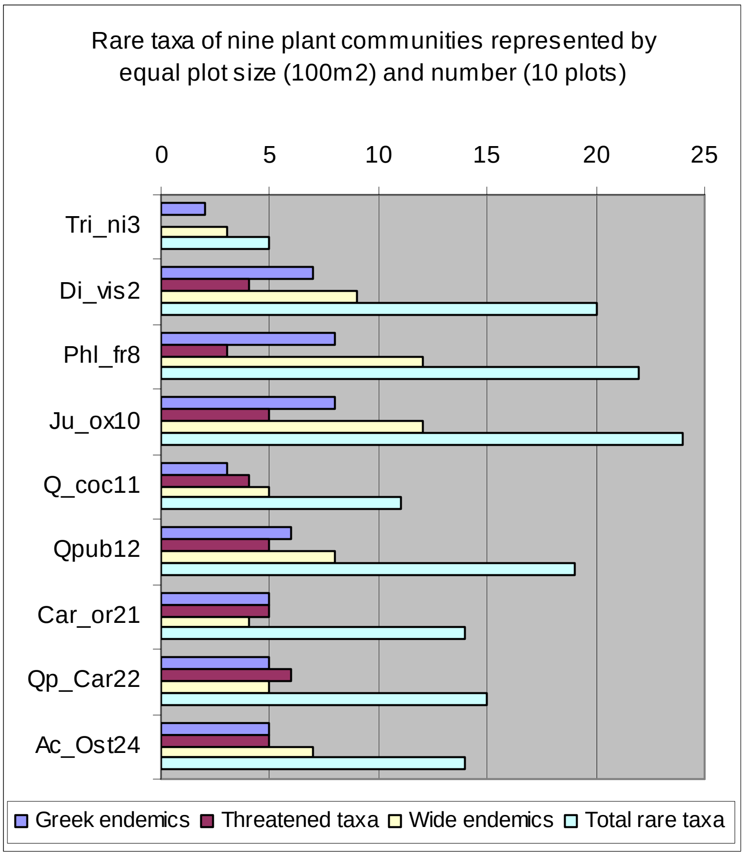

Fig.4.12 Rare plants of nine plant communities with equal inventoried area

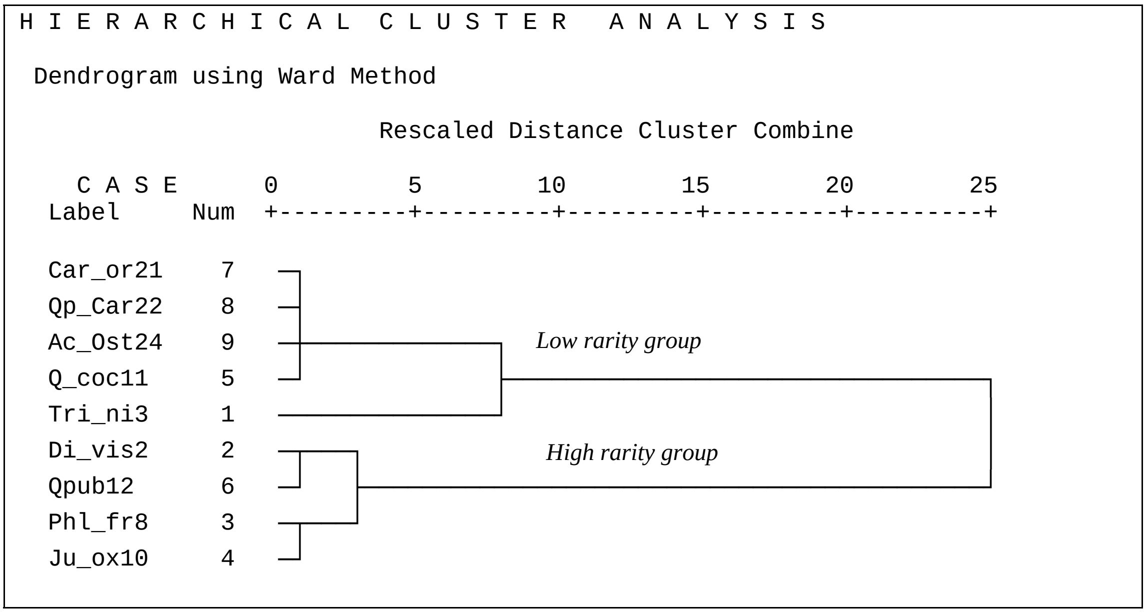

Fig.4.13 Hierarchical classification of the nine plant communities represented by equal inventory intensity. The classification was carried out with variables the numbers of Greek endemics, Threatened taxa, Wide endemics and Total rare taxa.

4.2.4 Restorability

The vegetation types were evaluated for the criterion of restorability based on a scale that partitions the succession / restoration time in three classes of short, medium and long basis (Table 4.19). So, the communities were ranked in three restorability classes corresponding to low, medium and high restoration value.

At the first (I) restorability class the succession / restoration time is relatively short (< 20 years) and thus the criterion of restorability has the lowest value in this class. Three plant communities, i.e. the *Trifolium nigrescens* meadows, the *Marrubium peregrinum* nitrophilous grassland and the *Parietaria officinalis* forest fringe were classified to this class due to the relatively short succession time and the rather ruderal character of these communities.

At the second (II) restorability class the time ranges between 20 and 50 years. The rest grasslands, the shrublands and the woodlands were aggregated at this class and reckoned with moderate value for this criterion. The grasslands of this class might have a succession age shorter than 20 years, however they were placed to the II restorability class due to their long lasting use for grazing (>20 years), which has influenced their species composition .

Finally, the chasmophytic plant community and the various forest types because of the relatively long succession / restoration time (>50 years) consisted the III restorability class and granted with high ecological value.

This evaluation scheme is based on a rough approximation of the real time a plant community needs to recover after a destruction and attain the typical species composition and structure. The actual restoration time, which can vary from the time approximated by the present scheme depending on the specific climatic and site conditions, remains unknown and changes in the classification could be possible.

For instance, some forest stands of *Quercus pubescens* or *Acer obtusatum* might have an age of less than 50 years. In this case they should have been set at the II restorability class. Also in some stands of the relatively closed and extensive forests of *Acer obtusatum*-Ostrya carpinifolia, or those of the highly inclined and relatively inaccessible sites of the gorge, there might be some very old trees (of age >200 years), an element that gives higher value to these forest stands in relation to the rest. Especially the sites factors (soil) of the old growth forest stands of the gorge have been remained relatively undisturbed from the human influence, as well as the rocky habitat of the *Asperula chlorantha* community, and increase thus the restorability value of these vegetation types. In both cases the destruction of the habitat requires much more time than 50 years to be restored.

Table 4.19 Restorability of the plant communities

Plant com/ity code	Vegetation type	Succession/ restoration time	Restorability class	Rest/ity value
Tri_ni3	meadows	< 20years	I	Low
Mar_pe4	nitrophilous grassland			
Par_of16	forest fringe			
Bel_pe1	grassland	20-50 years	II	Medium
Di_vis2	grassland			
Poa_bu5	grassland			
Hel_nu6	rocky grassland			
Jas_fr7	rocky grassland			
Phl_fr8	shrubland			
Sal_of9	shrubland			
Ju_ox10	shrubland			
Q_coc11	woodland			
Car_or21	woodland			
Ru_Qpu18	tree hedge			
Br_syl20	forest fringe			
Pte_aq19	forest fringe			
Asp_ch17	chasmophytic	>50 years	III	High
Qpub12	forest			
Ju_Qpu13	forest			
Co_Qpu14	forest			
Pla_or15	forest			
Qp_Car22	forest			
J_Aobt23	forest			
Ac_Ost24	forest			

4.2.5 Overall nature conservation evaluation

The classification of the plant communities with variables the four nature conservation criteria, i.e. diversity, naturalness, rarity and restorability identified three community groups (Table 4.20 & Fig.4.14). The 1st community group was characterized by high naturalness and restorability value and medium to low diversity and rarity value. The group included three forest communities with *Quercus pubescens* (communities 12, 14 and 22) and the two communities of *Acer obtusatum* (communities 23 and 24). *Platanus orientalis* and *Asperula chlorantha* communities, which had been excluded from the classification, due to incomplete diversity data, were subjectively included in the 1st community group. The high naturalness and restorability value of these communities suggested their inclusion to this community group. The ecological value of the communities of the 1st group is related to their high naturalness and restorability value, attributes which should be safeguarded and thus direct their future management.

The 3rd community group was consisted of the shrubland communities of *Phlomis fruticosa* (Phl_fr8), *Salvia officinalis* (Sal_of9) and *Juniperus oxycedrus* (Ju_ox10) and five grassland communities. These communities were characterized by high diversity, medium to high rarity, medium restorability and medium to low naturalness. The nature conservation value of these communities is related to their high plant species diversity and rarity, characteristics that can be preserved through an active management that favors the traditional land uses such as extensive grazing.

The 2nd community group aggregated communities exhibiting low to medium values for all four nature conservation criteria. The forest pasture of *Quercus pubescens* (Ju_Qpu13), the tree hedges (Ru_Qpu18), the woodlands of *Quercus coccifera* (Q_coc11) and *Carpinus orientalis* (Car_or21), the forest fringes of *Parietaria officinalis* (Par_of16) and *Pteridium aquilinum* (Pte_aq19), the meadows of *Trifolium nigrescens* (Tri_ni3) and the nitrophilous community of *Marrubium peregrinum* (Mar_pe4). These plant communities can be subject to a flexible land management scheme and can either provide for traditional land uses, or be set aside for nature conservation or future use.

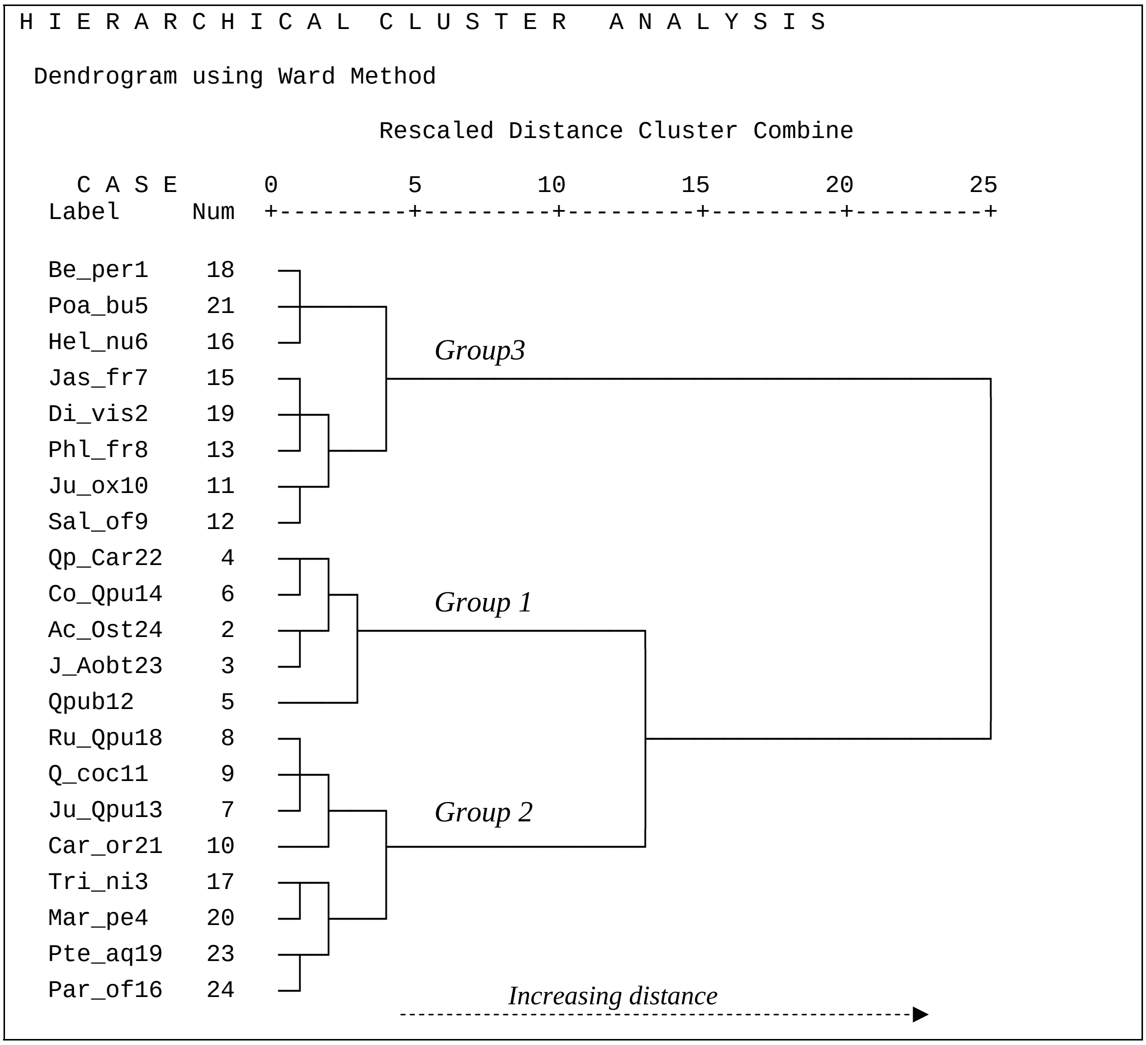

Fig.4.14 Dendrogram of the plant communities resulted from hierarchical classification with variables the four nature conservation criteria, i.e. diversity, naturalness, rarity and restorability. The communities were clustered in groups of similar pattern in the four criteria. The group 1 incorporated the communities characterized by high naturalness, the group 3 aggregated those characterized by high diversity and the group 2 contained the communities with medium values of the criteria.

The Principal Component Analysis (PCA) of the four nature conservation criteria of the communities identified two components that explained 86% of the total variance in the dataset. The component matrix (Tables 9 & 10 in Annex) revealed the association (correlation) between the nature conservation criteria and the two components. The PCA axis 1 was positively correlated with the criteria of naturalness and restorability, while the axis 2 was positively correlated with diversity and rarity (Fig.4.15). By plotting the PCA scores of the communities along with the classification results, the characteristics of the three community groups were demonstrated.

Table 4.20 Overall ecological evaluation of the plant communities

Plant community	Vegatation type	Naturalness value	Restorability value	Diversity value	Rarity value	Community group
Qpub12	F	**High**	**High**	Medium	High	1
Qp_Car22	F	**High**	**High**	Medium	Medium	
Co_Qpu14	F	**High**	**High**	Medium	Low	
Ac_Ost24	F	**High**	**High**	Low	Medium	
J_Aobt23	F	**High**	**High**	Low	Low	
Ju_Qpu13	F	Medium	Medium	Medium	Medium	2
Ru_Qpu18	F	Medium	Medium	Medium	Medium	
Q_coc11	W	Medium	Medium	Medium	Medium	
Car_or21	W	Medium	Medium	Low	Medium	
Pte_aq19	G	Medium	Medium	Medium	Low	
Par_of16	G	Medium	Low	Medium	Low	
Tri_ni3	G	Low	Low	Medium	Low	
Mar_pe4	G	Low	Low	Medium	Low	
Ju_ox10	S	Medium	Medium	**High**	High	3
Sal_of9	S	Medium	Medium	**High**	High	
Phl_fr8	S	Low	Medium	**High**	High	
Di_vis2	G	Low	Medium	**High**	High	
Jas_fr7	G	Low	Medium	**High**	High	
Be_per1	G	Low	Medium	**High**	Medium	
Poa_bu5	G	Low	Medium	**High**	Medium	
Hel_nu6	G	Low	Medium	**High**	Medium	
Pla_or15	F	**High**	**High**	-	Low	*
Asp_ch17	G	**High**	**High**	-	Low	
Br_syl20	G	Medium	Medium	-	Medium	

- *omitted from the classification*

The bold characters in a specific plant community group indicate the criterion(-ria) that should direct the management of the specific communities.

The application of the same classification procedure twice more, once by giving weight to the criterion of naturalness (1st scenario: supporting the naturalness) and once to diversity (2nd scenario: enhancing the plant species diversity), resulted to the same groupings with the initial analysis that was applied with no weight to any of the criteria. This was considered to validate the results of the applied evaluation scheme.

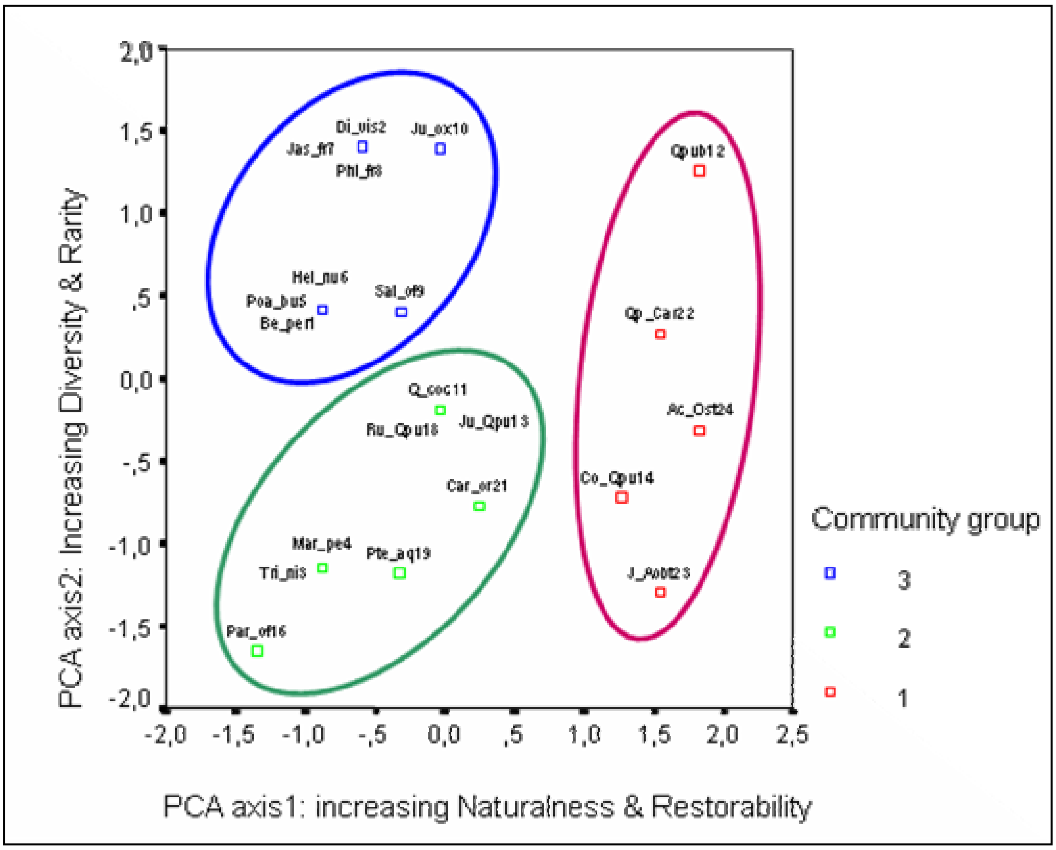

Fig.4.15 Scatter plot of the factor scores of the plant communities, resulted from Principal Component Analysis (PCA) of the community matrix with the four nature conservation criteria, i.e. naturalness, restorability, diversity and rarity. The 1st PCA factor is positively correlated to naturalness and restorability. The 2nd PCA factor is positively correlated to diversity and rarity. The hierarchical classification of the plant communities with variables the four nature conservation criteria resulted in three community groups that were superimposed at the scatter plot. Some communities had the some position in ordination space and they were slightly moved so that to distinguish their names.

5 Discussion

5.1 Evaluation of the traditional cultural landscape

The ecological evaluation is essential precondition to the scientifically based landscape management. For this reason the evaluation method and criteria influence the planning and management process along with the conservation of the landscape, its ecosystems (landscape elements) and the associated flora and fauna and functions. However, since the conservation value of the landscape is an expression of the human esteem, then the choice of the appropriate evaluation method and the applied criteria can never be disconnected from subjective decisions (SPELLERBERG 1992).

In the applied evaluation scheme the ecological value of the traditional cultural landscape in Vikos area was identified means of four important nature conservation criteria, namely diversity, rarity, naturalness and restorability, in order to provide the necessary basis for its conservation management.

5.1.1 Diversity

The floristic composition of the plant communities provided the base for the quantification of the plant species diversity by the application of four widely used diversity indices. Plant species richness, Shannon and Simpson diversity and evenness were applied at three scales, i.e. for each plot, each plant community and the studied landscape.

For a specific diversity index a plant community can be more diverse than another at the plot level, but not at the community level or for another diversity index. It was concluded that the plant species diversity is related to the diversity measure, the scale level of reference, the community type and the sampling intensity, both in terms of plot size and plot number. The diversity of a plant community needs to be seen in relation to these parameters, in order to be meaningful and comparable with other communities.

Each diversity index demonstrates a specific aspect of the diversity of a plant community. Richness is the most sensitive of the four examined diversity indices to the sampling intensity. Shannon diversity, Simpson diversity and Evenness react less in changes of the sampling intensity, because they depend both on the plant species number and abundance.

However, for all diversity indices and for both plot and community scales a similar diversity pattern was observed. Specifically, the diversity increased from plant communities representing early succession stages such as specific grasslands, to intermediate succession stages, such as the open shrublands (phrygana and garigue) and decreased again to advanced succession stages represented by the woodlands and forest communities. Nevertheless, there is a rather wide range of diversity values within each plant formation, i.e. within grasslands, shrublands, woodlands or forests. Within grasslands for instance, there are plant communities such as the *Jasminum fruticans* or the *Dianthus viscidus* community exhibiting high diversity indices, and others with moderate to low diversity, such as the meadows of *Trifolium nigrescens* or the forest fringe of *Parietaria officinalis*. Also within forest and woodlands there are communities such as the various forms of *Quercus pubescens* community that exhibited higher diversity indices in relation to the woodland of *Carpinus orientalis* or the forest types with *Acer obtusatum*.

Although the causes of the differences in the diversity between the various communities have not been investigated in the present study, it seems to be related with factors controlling the distribution of the plant species and specifically with those that prohibit the dominance of one or a few species. Communities dominated by one or a few species present low diversity, in relation to those characterized by the coexistence of many species.

Species dominance is usually related to site conditions, such as soil moisture and depth or the land use, which favor highly antagonistic species. For example, high moisture and good soil conditions favor in abandoned fields species such as *Parietaria officinalis* and *Urtica dioica*, which can develop quickly high biomass preventing thus the development of slowly growing species through unfavorable light conditions. Similarly, the mowing in the southern terraces favors *Fabaceae* and *Gramineae* species. Pasture as a disturbance factor prevents the dominance of one or few species, however in cases of overgrazing it leads to the dominance of non-palatable plants, as it is the case with *Phlomis fruticosa* and *Marrubium peregrinum* community.

In forest communities the presence of a dense tree component seems to be related to the lower diversity, as it is the case with the *Acer obtusatum-Ostrya carpinifolia* and the *Juglans regia-Acer obtusatum* forest communities. In contrary, the *Quercus pubescens* forest types with more favorable light conditions due to the loose canopy permits the coexistence of more plant species in relation to the previous forest types.

Plant species diversity is an important ecosystem characteristic related to ecosystem stability, which however, should be regarded in relation to the typical species composition of an ecosystem, excluding cosmopolitic species resulting from human interference (PLACHTER 1991, BASTIAN & SCHREIBER 1994). For this reason the evaluation of the plant communities cannot be based solely on the criterion of diversity, but it has to take into account also other important for nature conservation criteria.

Diversity in relation to environmental factors and human influence

Our results agree with PIGNATTI & PIGNATTI (1999) that in Mediterranean zone the general high species diversity is created by secondary vegetation types, in agreement also to PLACHTER (1991). BLONDEL & ARONSON (1995) report also that the highest diversity of the Mediterranean ecosystems, in terms both of species richness and diversity, does not occur in a climax oak forest, but rather in agro-silvo-pastoral systems, such as those prevailed in many parts of the Mediterranean Basin from the Middle-Age to the mid of the 20th century.

In the Mediterranean ecosystems the floristic diversity increases with temperature and water availability up to an optimum and thereafter it decreases, depending also on the geomorphology and the extent of the territory. The more diversified the topography of a land, the more niches are created and thus the more species can be hosted (NAVEH & WHITTAKER 1979, HOUSSARD et al.1980, PIGNATTI & PIGNATTI 1999). These three ecological parameters (temperature, water availability, topography) seem to be also related with the high richness of the study area, along with the human influence that has created a variety of habitat types through the traditional land use practices.

The high diversity in the vegetation of the Mediterranean area is considered to be the result of a long evolutionary process under constant stress by drought, fire and grazing and the small-scale heterogeneity of the mountainous habitats (NAVEH & WHITTAKER

1979b). The variable micro relief and soil depth, the rocky outcrops, along with the various vegetation layers (trees, shrubs, and herbs), the litter cover etc. create a complex mosaic of micro sites. The constant grazing pressure shifts advantage to smaller plants that can divide the soil microsites more finely. Further morphological, physiological adaptations of the plants, for instance to the climatic variation (seasonal, annual or periodical), the livestock preferences and the various stress factors resulted to high niche differentiation among the plant species and thus to a high floristic diversity. The pastures and open shrublands have been part of a man-modified landscape that is relatively stable, and is considered to be much richer in plant species than the natural landscape that had proceeded. Where grazing pressure is removed and the woody canopy increases, there is a drastic reduction in species richness. Management of grazing, with intensity somewhere near the optimum in relation to which these communities have evolved is needed to maintain the floristic richness and the flowering beauty of these landscapes (NAVEH & WHITTAKER 1979b, HOUSSARD et al. 1980, PIGNATTI & PIGNATTI 1999).

The high conservation value that is often observed in Mediterranean areas with long interaction among human and nature is usually related not only to their rich flora, but also to the fact that they provide valuable habitats to a rich fauna (VOS & STORTELDER 1992, CORREIA 1993, FARINA 1995, PINEDA & MONTALVO 1995, KATSADORAKIS 1996, WORKING GROUP OF ZAGORI 1999).

5.1.2 Rarity

There is a positive relation among the plant species diversity (richness) of a community and the abundance of rare plant taxa. In our study the most diverse communities such as the phrygana of *Phlomis fruticosa*, the garigue of *Juniperus oxycedrus* and the grassland of *Dianthus viscidus* exhibited also the highest numbers of rare plants.

However, there are communities of moderate diversity, such as the *Acer obtusatum – Ostrya carpinifolia* forest community and the *Asperula chlorantha* chasmophytic community, which presented moderate numbers of rare taxa, but some of these taxa are highly restricted to these communities (Table 4.17). Thus, the protection of both communities is prerequisite for the conservation of these rare species.

The conservation of rare species requires well knowledge of their biology, which is often incomplete or exists only for certain endangered species of Red Lists (PLACHTER 1991, SPELLERBERG 1992). This makes difficult the efficient protection of rare species, especially when this is related to active management, as it is the case with the shrublands and grasslands of the study area.

In these cases the long extensive grazing regime that is related to the existence of these vegetation types, is associated from the one side with the high vascular plant species diversity, but also with problems to the survival of some rare species e.g. *Orchidaceae* and *Liliaceae,* setting thus pressure to their conservation. In such cases the regulation of the grazing time, for instance after the blossom of the rare species, or the application of a rotational grazing regime spatially differentiated from year to year is considered effective in overcoming the problem (NOY-MEIR & ORON 2001).

An other element important for the management of the study area is the fact that from the 66 inventoried rare species (Table 8 in Annex) only 12 species are forest species and 5 forest fringe species. The rest 49 species are open vegetation species. From these, only 3 forest species and 2 forest fringe species have a constancy ≤10%, while only 6 rare open species have a constancy >10%.

In conclusion, the majority of the rare species in the study area are found in the open vegetation types namely the low open shrublands and grasslands. Thus, the preservation of the rare species in the study area depends greatly on the conservation of the open vegetation types.

5.1.3 Naturalness

In an intensively used world the existence and conservation of unspoiled intact nature is of high priority (SPELLERBERG 1992). However, in an area for long inhabited and transformed by man, as it is the traditional cultural landscape of Vikos, it is hardly possible to find intact/natural ecosystems. Thus, vegetation types influenced in a small degree by human, in relation to the intensively used agricultural, forest or urban areas, and have hold part of their natural composition and structure, such as the various forest types and the chasmophytic vegetation of the study area are considered of high conservation priority.

The semi-natural character of these vegetation types is considered of higher value than their moderate diversity or rarity (SPELLERBERG 1992) and is associated mainly with specific ecological functions that are preserved in these ecosystems, such as soil, water and climate protection, and the relatively high stability especially in extreme incidents (REIF et al. 2001), but also with the presence of highly specialized organisms such as various invertebrates e.g. insects and lower plants e.g. lichens (KIRBY 1988, PLACHTER 1991, BASTIAN & SCHREIBER 1994).

For these reasons the conservation management in the study area should focus at the preservation of ecosystems / vegetation types with high naturalness and only secondary should aim at the improvement of the diversity, which is representative for the specific vegetation types.

5.1.4 Restorability

Similarly to naturalness, the forest communities along with the chasmophytic vegetation type were characterized of high value for the criterion of restorability, in comparison to the other vegetation types of the study area, due to the relatively long time they need to be restored after a disturbance. The long restoration time and thus the high restorability value of these vegetation types is associated both with their specific species composition and especially with their ecotopes, namely the specific site conditions. The long time that is required in order the specific ecosystems to be restored after destruction, makes their restoration practically difficult and thus their conservation value high.

The classification scheme applied for the criterion of restorability in the present case was based on a rough estimation of the time needed in order a specific vegetation type/ plant community to attain the typical species composition and structure that had prior to the disturbance. In this evaluation scheme the exact restoration/ regeneration time of a specific vegetation type remains unknown and thus it could lead to different classification of the same vegetation type when applied by different people, which is a disadvantage of the applied evaluation method (SPELLERBERG 1992). However the restoration time of a specific vegetation type depends apart from this floristic composition and structure also on many different ecological factors e.g. soil, climate, relief, land use that makes extremely difficult its precise estimation (PLACHTER 1991, BASTIAN & SCHREIBER 1994).

In the study case the criterion of restorability is related up to a point to the criterion of naturalness. The more natural a community is the longer the time it had to evolve and thus the longer time is required to be restored after a potential destruction. So, the most natural communities of the study area, such as the forests and the chasmophytic vegetation are valued also high for their restorability. However, this cannot be regarded as a general tread since there can be also nearly – natural vegetation types, such as some riparian woods and scrubs (for instance from the *Salicetea purpureae* class), which can be restored in relatively short to moderate time (DIMOPOULOS et al. 2000, MERTZ 2000, REIF et al. 2001).

5.1.5 Other nature conservation criteria

Apart from the nature conservation criteria applied in the present study case, namely diversity, rarity, naturalness and restorability, there are also other important criteria for identifying priorities in nature conservation. Such criteria are among others the extent, the representativeness – typicalness and the stability-resilience. Up to now the application of these criteria has been limited, mainly due to the luck of the necessary information for an effective scaling (MARGULES 1981, PLACHTER 1991, SPELLERBERG 1992, BASTIAN & SCHREIBER 1994).

Extent

The extent of an area or habitat is an important criterion for the evaluation schemes oriented to species conservation and it is widely used especially in ornithological assessments. A habitat should have a minimum size or extend (minimal area) to satisfy the conservation needs of a specific species or community and to safeguard the ecosystem functions. As an orientation for the identification of the minimal area it is used the Species-Area curve, which describes the relation between the species number of a community or habitat and its extent (BASTIAN & SCHREIBER 1994).

In general it is accepted that an ecosystem or community should be large enough to be viable in respect to the resistance of the flora and fauna to edge effects and against random events that may lead to loss of species and colonization by invasive, unwanted species. On the other side, there are no standard rules on the area requirements of different communities and at the time being there is information only on the minimal area of a few animal species (SPELLERBERG 1992).

Related to the criterion of extent are characteristics such as the fragmentation and isolation of the biotopes/communities and their configuration/connectivity with the same or other biotopes in the landscape. These characteristics are also important for the conservation of species or communities. However, the necessary information is lucking in order these criteria to be incorporated to an evaluation (PLACHTER 1991, BASTIAN & SCHREIBER 1994).

Representativeness & Typicalness

The criterion of representativeness is based on the knowledge that each region, due to its specific ecological and biogeographical characteristics, favors a specific spectrum of species, communities, and ecosystems. In nature conservation it is important that in each region the best examples of these units to be selected and preserved (PLACHTER 1991).

Often the criterion of typicalness is differentiated from that of representativeness and is judged as less general and applicable to an area independently from others. It is based on the idea that it is necessary in nature conservation to represent the typical and common (widely spread) habitats, communities or species within a country or region (SPELLERBERG 1992).

However, both criteria of representativeness and typicalness are related and thus the best examples of characteristic and common communities and ecosystems should be chosen for conservation, and then the system should be completed with special or rare units

Stability & resilience

The preservation or restoration of the stability in ecosystems is of priority in nature conservation. With the term stability is meant primarily that under constant external conditions the size of the species populations in a community only slightly or shortly fluctuate around a mean situation, namely the equilibrium. This is achieved through self-regulation mechanisms and the ecosystems are called stable. Such types of ecosystems are considered the climax communities or those near to their climax. The ecosystems found in succession are considered instable, since they change with the time due to internal self-regulated mechanisms (PLACHTER 1991).

Managed ecosystems can fluctuate around a specific situation, which is specified from their land use and thus the human needs. Such managed ecosystems, although they represent specific succession stages, they are not considered instable, as long as their self-regulation capacity is maintained.

On the other side, the capacity of the ecosystem/community to compensate sudden external influences (natural or human) and to return to equilibrium is termed elasticity or resilience. Many stable ecosystems are sensitive to external influences, such as the tropical forests. On the contrary, instable ecosystems such as the various managed ecosystems are especially elastic, since they compensate well the regular intervention related to the land use, as long as the site conditions do not change drastically. Stable but of low elasticity ecosystems should be protected from any anthropogenous influence since many of them require very long development time and can not be easily replaced by others (PLACHTER 1991).

A stable, but relatively inelastic ecosystem represents the chasmophytic vegetation of the study area, mainly due to the extreme site conditions. All the other studied plant communities, which represent different stages of the succession to a climax vegetation type, are more or less stable, since they maintain their self-regulation capacity to fluctuate around a mean situation, as it is specified by their land use. They should be considered also elastic (although with an unknown degree of resilience) since they compensate the regular intervention specified by their land use, and they can return to a stage near their climax, when the land use stops, under the condition that the site factors have not changed drastically.

5.1.6 Nature conservation value of the traditional cultural landscape

The present evaluation scheme means of four important nature conservation criteria, namely diversity, rarity, naturalness and restorability identified the ecological value of the studied cultural landscape and set priorities in the conservation of the various landscape elements, which are related to the applied criteria and direct the conservation management.

In an area that has been influenced by the human and shaped by traditional agro-silvo-pastoral land uses for long, 24 different vegetation types have been traced with more than 700 plant species, including 72 rare taxa.

The plant species diversity ranged among the various vegetation types and the highest diversity values were detected in intermediate and relatively early successional stages represented by the low open shrublands and specific grassland communities of the study area. This was attributed to the relatively equitable plant species distribution (evenness) and the low dominance value (SIMPSON diversity in the form of GINI index) characterizing the species composition of these vegetation types, which were associated with the moderate disturbance regime of the traditional grazing system.

Apart from the high numbers of vascular plant species and diversity, the study area demonstrated also high density of rare plant taxa, with 14 Greek endemics, 40 wide endemics and 28 threatened taxa registered there. Although the numbers of rare taxa varied among the studied vegetation types, these exhibited in general a similar pattern to that of plant species richness and diversity. Thus, the open vegetation types that had presented high plant species diversity, exhibited also high numbers of rare taxa.

The fact that the majority of the plant species and also the rare taxa in the study area are species that have their main distribution in open vegetation types, demonstrates the importance of these habitats in the conservation of the plant species diversity and rarity. The fact also that these habitats are all of anthropogenous origin and are related to the traditional land use system makes obvious the need to preserve the open vegetation types by applying specific management regime (active management) and not simply by protecting them from any use.

Thus the conservation of the open vegetation types characterized with high diversity and rarity can be succeeded only with the continuation of the traditional land use system (LUKAS 1992, SPELLERBERG 1992, IUCN 1994, PHILLIPS 2002), or with the development of alternative management practices that imitate the traditional ones and maintain the plant species diversity and rarity (KIRBY 1988, SPELLERBERG 1996).

However, the high vascular plant species richness, diversity and rarity is only one part of the ecological value of the studied cultural landscape and this is related mainly to the non-forest vegetation types, which are the most human influenced in the study case.

From the other side, there is another part of the landscape, namely specific landscape elements that are characterized with high naturalness and restorability value. These landscape elements are the less human influenced and thus, semi-natural vegetation types, namely the various forests and woodlands. The ecological value of these ecosystems is related not only to their importance for the preservation of their associated vascular flora, but also to their high structural complexity that is essential to many lower plants and animal species, and also the various ecosystems functions and processes that are preserved there (watershed, soil and climate protection, conservation of the water and nutrient cycles, carbon fixation etc.). Furthermore, the fact that these forests and woodlands require long restoration time in case of their distraction or disturbance makes obvious the need to protect them from any use that can harm their high naturalness and restorability value.

In conclusion, the ecological evaluation of the landscape made obvious the need for a conservation regime that should take into account the ecological values of all landscape elements (ecosystems), and it should be based on a management scheme that not only preserves for the future generations the biodiversity that is representative for each ecosystem, but also protects the high naturalness and restorability value of the landscape.

Thus, a management scheme that combines both strict protection in specific parts (elements) of the landscape and integrates also traditional land uses in the management of other landscape elements, is considered as the proper one for preserving its ecological value.

5.1.7 Contemporary functions and values of the traditional land use system

Cultural landscapes are not static and have been always underlying changes and still change (MCNEILL 1992, HALSTEAD 1996). In the study area the increased depopulation after the 2nd world war led among others to the gradual abandonment of the traditional land use system. The production functions of the system are much reduced nowadays in relation to the past. A few elderly people are still occupied in activities concerning tree shredding, cultivation of small gardens, mowing of grass and small scale animal rising. The grazing pressure in the community land is also reduced in relation to the past. This has affected the ecosystems that appear to be in a process of rehabilitation. However, some livestock still grazes the customary community pastureland found partially inside the core of the National Park, raising thus conflicts with the Forest Service.

The protection functions of the agroforestry system, which requires much effort for its maintenance, are also modified. From the one side the vegetation succession at the abandoned fields mitigate soil erosion, from the other the destruction of the stone fences and the terraces that are not maintained anymore, let the soil unprotected against the strong rainfalls in the highly inclined terrain.

The main nowadays functions of the traditional agroforestry system are concentrated mainly to its role in biodiversity conservation, and to its cultural, historical, aesthetic and recreational value (Fig.2.5). The traditional land use system along with the diverse relief has created a diverse vegetation mosaic, which provides habitat to a large number of plant and animal species. The system functions as a gene pool not only for the wild fauna and flora, but also for indigenous breeds of domestic animals and varieties of cultivated plants. Concerning the domestic animals, three races; one for sheep (the mountain race of Epirus), a race of goat and a race of horse have been acknowledged for the area of Pindos (PD 434/95). According to local statements, individuals or even herds of these animals exist locally also in the area of Vikos-Aoos National Park (pers. com.). It is also possible the existence of local varieties or cultivars among the cultivated plants, referring mainly to legumes or fruit trees.

Also, the long human presence in the wider area of Zagori has enriched the mountainous landscape with historical monuments of remarkable traditional architecture of high cultural and historical value (NTIA & STAMATOPOULOU 1983), which along with the rare and attractive scenic are of special aesthetic and recreational value (KASIOUMIS & GATZOJANNIS 1996, PAPAGEORGIOU & BROTHERTON 1999). Part of the cultural history disappears nowadays with the destruction of old traditional constructions (watermills, bridges, threshing floors, stone pavements, and fences) and the afforestation of the terraced land.

On the other side, international experience on protected areas management suggest that traditional agroforestry systems found inside or adjacent to protected areas can function as buffer zones (transition zones) of integrated land uses between strictly protected areas and their surroundings by reducing the pressures on the more natural ecosystems (NAIR 1993, PHILLIPS 2002). According to this attitude the ecological, cultural etc. values of the traditional cultural landscape could be preserved for the future generations by supporting the traditional land use system and integrating it in the management of the protected areas (LUCAS 1992, SPELLERBERG 1992). In such cases the traditional cultural landscape can be used as a reference system for the future landscape development and may direct its management.

There are paradigms of successful integration of traditional land uses in the management of protected areas in Greece, such as those of the Protected Forest in Dadia and the Lake Prespa National Park (KARAVELLAS et al. 2003), which are also related with economic benefits to the local communities. In these cases traditional land uses, such as non-intensive grazing and forestry consist basic tools for achieving specific ecological-conservation goals, for instance for maintaining small openings inside forest areas that are important for the wildlife. On the other side, the presence of the protected area promotes also the economic development of the local communities by supporting environmental-friendly activities, such as organic farming and the production of biological products, and services related with non-intensive recreation and ecotourism (IUCN 1994). Apart from the direct ecological and economic benefits, the support of the traditional land use system supports the preservation of the local tradition and culture and thus the traditional character of the landscape that is maintained not as museum, but as a living entity (PAPAGEORGIOU & BROTHERTON 1999).

Economic activities related to ecotourism take place also within the area of Vikos-Aoos National Park. Thus, in contrary to the immigration that prevailed in the past and led to the depopulation of the land, nowadays there are cases of young people, who either remain or return back to their land. These people being conscious of the ecological, historical-cultural and aesthetic value of the land, take advantage of its premising ecotouristic potential and establish their livelihood and economy there providing touristic services related to small pensions, hostels, cafes, restaurants, sight-seeing and sports centres (KASIOUMIS & GATZOJANNIS 1996).

5.2 Management of the traditional cultural landscape

5.2.1 Guiding principals, objectives and general management frame

The contemporary perceptions on protected areas have much changed from the initial ones that wanted them under strict protection, where the human had to be kept away in order the ecosystems to be left to their natural succession. Nowadays it is widely recognized that there are cases where the long interaction between human and nature has created healthy ecosystems and landscapes, often of high biological diversity, rich cultural tradition and high aesthetics; the conservation there can not be undertaken without the involvement of the local people that remain close to the resources. The successful conservation of highly valued traditional cultural landscapes apart from the necessary legislative consolidation and application of the adequate management requires also the acceptance and participation of the local communities and all those that use the natural resources. The difficulties rising from the involvement of all stakeholders makes the management of a protected area a challenging task (LUCAS 1992, IUCN 1994, KASIOUMIS & GATZOJANNIS 1996, PHILLIPS 2002, KARAVELLAS et al. 2003).

The existing political framework in nature conservation, both at the European level (e.g. Directives 79/409 and 92/42) and the National level (e.g. Laws 2742/99 and 3044/2002) recognizes the importance of traditional land use systems for the conservation of specific ecosystems and their associated flora and fauna and promotes them financially. Furthermore, the new Reform of the Common Agricultural Policy favors also areas with traditional land use systems of low intensity. For instance, the new Agri-environmental Regulations provide financial support to marginal areas with high nature-conservation value, in order to compensate the inhabitants for the lost income resulting from the low intensity of the land use practices. The current revision of the CAP for the livestock sector, which involves area-payments instead of headage-payments premise further support to low intensity grazing systems. Important condition however, to the support of the local land use systems is that they are compatible to and safeguard the conservation objectives of the specific case.

The world-wide concern and experience on protected areas has led to the formulation of specific guiding principals for an effective management of highly valued traditional cultural landscapes. Thus, the management of such areas should involve the collaboration of all stakeholders (the managers of the National Park, local populations, related authorities etc.), which is known as joint or co-management. Special attention is set upon the support and involvement of the local people in the planning and management processes, which should include the public discussion, respect the rights and needs of the local people and take into account the traditional knowledge in the sustainable land use (LUKAS 1992, IUCN 1994, PHILLIPS 1995 & 2002).

The scientific evaluation of the ecological and other characteristics of the traditional cultural landscapes forms the basis for setting the management objectives and planning its management. Conserving the specific ecological characteristics and the biodiversity that is representative for the specific landscape and its ecosystems are the main management objectives. However, special attention is also drawn on maintaining the harmonious interaction of nature and culture and the continuation of traditional land uses; supporting lifestyles and economic activities in harmony with nature; and eliminating improper land uses and activities (SPELLERBERG 1992, PHILLIPS 2002).

Zoning as an approach to differentiated land use planning, is an important management tool that makes possible a high degree of protection in one part of an area, and also some level of non-damaging uses, such as non-intensive traditional activities in other parts (IUCN 1994). Zoning is considered as the best approach for planning inhabited protected areas and is also applied in the National Parks in Greece.

Apart from the specific conservation measures and the necessary planning, the management scheme should also regulate the participation of all involved stakeholders in the management of the protected area, set the frame for the sustainable use of the resources (farming, livestock, forestry) and the development of sustainable tourism, and plan the necessary processes and take measures for raising public awareness and support.

Nevertheless, the whole management process is important to be monitored, evaluated and re-adjusted (adaptive management), in order to avoid possible negative effects on the ecosystems and any deviation from the conservation and the other goals (LUCAS 1992, IUCN 1994, CHATZISTATHIS & ISPIKOUDIS 1995, KASIOUMIS & GATZOJANNIS 1996, SPELLERBERG 1996, PHILLIPS 2002, KARAVELLAS et al. 2003).

5.2.2 Management alternatives

Since 1971 a large part of the study area has been incorporated in the core of the Vikos-Aoos National Park and is thus under strict protection status. This management scheme (1st scenario) and its influences on the cultural landscape are further discussed, in conjunction to a second alternative (2nd scenario) that takes into account the contemporary perceptions on protected areas and the specific ecological and other characteristics of the study area.

1ST SCENARIO: STRICT PROTECTION IN THE CORE OF VIKOS-AOOS NATIONAL PARK

The first management scenario follows the strict protection scheme as it is regulated by the legislative status (core) of the National Park (PD 213/1973) and the respective legislation of the National Parks in Greece (Law 996/71). According to these, no use of the natural resources is permitted in the core of the National Park. The core zone that covers Vikos gorge includes an extended part of the local traditional cultural landscape and the village itself.

According to this management scheme the ecosystems are set under strict protection and are left to their natural succession, while traditional land uses are permitted only at the surrounding buffer zone. The strict protection favors the forest and woodland types and their associated plant and animal species. Depending on the specific climatic and site conditions, the various open shrublands (garigue and phrygana) in the area of the core will turn into dense shrublands and woodlands. The small openings among the shrubs will close and the various grasslands will be covered by shrubs and trees. This process, although it is relatively slow in the Mediterranean area, will lead to the gradual decrease and finally to the disappearance of the open elements of the landscape. Thus the landscape will turn into a more homogenized one with consequences in the flora and fauna, as it is usual in similar cases (VOS & STORTELDER 1992, FARINA 1995, PINEDA & MONTALVO 1995).

So, the populations of many vascular plants growing at open habitats (including some rare species) will decrease in the future, which will probably lead to a decrease in the species diversity of the area. Some of these species might also disappear, leading thus to biodiversity loss. Threatened species (Table 8 in Annex I), the populations of which will probably decrease in the future are most of the *Orchidaceae* growing at the various grasslands and the open shrublands, such as *Anacamptis pyramidalis, Himantoglossum caprinum, Orchis morio, O. quantripunctata, Ophrys scolopax ssp.cornuta* and some *Liliaceae* e.g. *Lilium canditum*. According to this management scheme, endangered species with sparse occurrence in the study area, such as *Orchis tridentata, O. ustulata, Ophrys mammosa, Lilium chalcedonicum* and some Greek endemics, such as *Biarum tenuifolium* and *Fritillaria thessala ssp. ionica* might disappear.

On the other side, the naturalness of the vegetation will be enhanced and structurally more diverse ecosystems will be developed, creating thus niches for other (probably new) species such as various lower plants and dwellers of the forest canopy and the ground, mainly invertebrates. Thus, the species diversity related to the forest ecosystems will be probably enhanced. Also the expansion of forest will rehabilitate the soil through a better protection against erosion, to which the area is susceptible to, due to the high inclination. Also the various ecosystem functions such as water and nutrient cycles, soil development, carbon sink, climate stabilization etc. will be enhanced and conserved. Favored rare and threatened species of the forest flora (Table 8 in Annex I) are several orchids e.g. *Dactyloriza saccifera, Epipactis helleborine* and *E. microphylla* and other species such as *Digitalis laevigata ssp.graeca*.

By taking into consideration that from the 617 plant species of the Vegetation Table* (Annex II), 411 are open vegetation species and only 206 forest species, then it could be easily inferred that the reduction of the open vegetation types will lead to plant species impoverishment of the cultural landscape and a decrease in the related diversity component. However, such as a hypothesis needs to be tested, since it does

* after the data reduction and the removal of the species found in less than 3 plots.

not take into account, neither the new forest species that might appear after the colonization of the new habitats, nor the changes in the abundances of the forest plant species, which influence along with the species number the estimation of the species diversity of an area.

Apart from the flora, also the animal species associated to open ecosystems, which are anthropogenous in most cases, will decrease in the future, lowering thus further the species diversity of the area. The strict protection status favors mainly the fauna of forest habitats. Specifically, the expansion of forests and woodlands and the enhancement of their structural complexity in combination with the decreased human influence will affect positively important large mammals, such as *Ursus arctos* (bear), *Canis lupus* (wolf), *Sus scrofa* (wild boar) and *Lynx lynx* (lynx), and priority bird species of the deciduous broadleaved forests and woodlands, such as *Accipiter gentilis, Aegolius funereus*, *Bubo bubo, Bonasa bonasia, Columba oenas, Dendrocopus leucotos, D. syriacus, D. medius, Junx torquilla*, *Picus viridis, Sitta europaea, Strix aluco, Turdus torquatus,* (KATSADORAKIS 1996, ROCAMORA 1997).

The strict protection status does not favor however, important large raptors of the area, such as *Circaetus gallicus, Aquila chrysaetos, A. heliaca* and *Neophron percnopterus,* which breed in open forests, but they require extended semi-open areas for their nutrition, which in most cases are of anthropo-zoogenous origin and are related to traditional activities (ROCAMORA 1997, TSIAKIRIS 1999). Such areas are considered necessary also for the nutrition of bear and wolf (WORKING GROUP OF ZAGORI 1999).

If however, there will be an increase or decrease in the species diversity of the area in general, is not easy to be answered since this requires long-term monitoring and research on various biotic communities of both plants (vascular and non-vascular) and animals (of various taxonomic groups).

Though more than thirty years since the establishment of the National Park, the present management scheme still faces the opposition of part of the local community occupied on traditional activities (farmers raising livestock). These people face restrictions in utilizing the customary communal grazing land and their properties located inside the core of the Park without ever to be compensated and they are often subject to legal persecution. To the requested re-orientation from their traditional occupation to other forms that do not raise conflicts with the legislative status of the National Park, e.g. eco-touristic activities, these people stand up for the right on their present occupation as part of their cultural tradition and heritage, and present their will for alternative and more flexible occupation in times of changes, or economic crisis that limit touristic demand (pers. com.). Also, it is often argued if such an area with a long human presence should be incorporated under a strict protection status, since this contradicts to its anthropogenous character. As it was discussed previously, the strict protection scheme, if it ever applies, will lead to changes in the *"diverse flora and fauna"* that the establishment of the National Park aims to preserve (PD 213/1973).

2ND SCENARIO: INTEGRATION OF THE TRADITIONAL LAND USE SYSTEM IN THE MANAGEMENT OF THE PROTECTED AREA

The 2nd management scheme is presented as an alternative to the conservation of the traditional cultural landscape in Vikos area and recognizes the human made character of the landscape and the associated ecological, cultural-historical, aesthetic and economic values. This scenario takes into account the specific ecological characteristics of the landscape; it recognizes the importance of some traditional land uses in the conservation of specific landscape elements and their plant and animal species and proposes a management scheme that combines both strict protection and non-intensive traditional land uses, which however should be spatially differentiated according to a proper planning. The traditional cultural landscape is used as a reference system (model) for the future landscape development and directs its management. Main management objectives are the protection of the ecological values and the conservation of the biodiversity that is representative for the specific landscape and its ecosystems (LUKAS 1992, SPELLERBERG 1992, KASIOUMIS & GATZOJANNIS 1996, PHILLIPS 2002).

According to this management scheme the forests and woodlands of the gorge and those at highly inclined sites near the village should be set under strict protection similarly to the 1st management scheme. These ecosystems will be let to natural processes to become mature and old growth forests. The aim in this case is to enhance the naturalness and structural complexity of these ecosystems and to safeguard their biodiversity. This protection status will affect positively the typical for these ecosystems fauna and flora. Also the related ecosystem functions will be safeguarded and improved.

On the other side, non-intensive traditional activities, such as animal grazing, tree pollarding and wood cutting, mowing, cultivation on terraces could be integrated in the management of the anthropo-zoogenous landscape elements (shrublands, grasslands, tree hedges and various woodlots), in the degree that this is compatible to and essential for the conservation of the associated flora and fauna.

Thus, this management scheme supports the conservation of both forest and non-forest ecosystems and thus the plant species diversity of the whole cultural landscape including all involved rare taxa (Table 8 in Annex).

As it concerns the fauna, it is well-known that the traditional cultural landscape with the mosaic structure and the combination of cultivated and fallow fields, the hedges with the fruit trees and shrubs and the various grasslands, shrublands, woodlots and forests fragments attracts a great number of animals, which nest, breed or feed there. The high floristic and structural richness favors many small birds and mammals, reptiles and invertebrates, which in turn attract larger predators.

Threatened reptiles that find habitat there are for instance *Testudo hermanni, T. marginata, Lacerta trilineata, Podacris muralis, Vipera ammodytes, Coluber najadum.* Among the numerous favored small birds *Lanius collurio, Turdus merula*, *Troglodytes troglodytes, Dendrocopus syriacus, Parus caeruleus, P. major, Carduelis chloris, C. carduelis,* and *Otus scops* are some of those with conservation priority in Europe. Among the large predators are included raptors such as *Aquila chrysaetos, A. heliaca, Neophron percnopterus, Ciraetus gallicus, Falco peregrinus, F. tinnunculus, Bubo bubo, Athene noctua* and mammals such as *Ursus arctos, Canis lupus, Sus scrofa* and *Vulpes vulpes*.

In general the mosaic landscape with the rich structure, the availability of rich food resources and the various ecotones provides niches to a large number of animal species and has thus a significant role in their conservation. On the other side, the animals use the various habitats in different ways during the year due to the seasonality of the food, their different physiological and ecological needs and their intra- and inter-specific relations (antagonism, complementarity etc.) (DAFIS 1986, FARINA 1998, RUNDEL 1998). In such cases the continuation of the traditional land uses associated with the moderate disturbance regime, helps to achieve the optimum mixture of forest, pseudomacchie woodlands, garigue, grasslands and rocky habitats, which is necessary for the preservation of the rich fauna including many rare and endangered species (ROCAMORA 1997) and at the same time it preserves the traditional cultural landscape.

The application of a zoning system in the land use planning makes possible both a high degree of protection in one part of the area, which can be maintained as a core, and also non-intensive traditional land uses in other parts, mainly nearby the village. The other parts can be incorporated to a more flexible management status that can involve the traditional land use regime or land use practices compatible to the conservation objectives (IUCN 1994, KASIOUMIS & GATZOJANNIS 1996, PHILLIPS 2002).

This management scheme is considered more appropriate to the ecological and cultural characteristics of the study area in relation to the strict protection, and is thus proposed for the management of the study area. It combines nature protection and biodiversity conservation and at the same time it favors also the sustainable development of the local communities, being thus much closer to the foundation objectives of the National Park in relation to the previous scheme. Furthermore, the traditional character of the cultural landscape is preserved along with the associated historical, cultural and aesthetic values. In this way the traditional landscape is maintained also as a living entity.

Within this frame some general management recommendations are proposed for the three plant community groups as they resulted from the ecological evaluation, along with specific management measures for each plant community (Table 5.1; WITSCHEL 1980, BRIEMLE et al. 1991, ARBEITSKREIS FORSTLICHE LANDESPFLEGE 1993, SPELLERBERG 1996, BEINLICH 1999, BRIEMLE et al. 2000, REIF et al. 2001, PHILLIPS 2002).

5.2.3 Management recommendations

According to the proposed management scheme, the mosaic-like structure of the landscape with the small terraces and the tree hedges, the various grasslands, shrublands, woodlands and the forests and forest fragments should be conserved according to a proper land use planning that combines both strict protection in a specific part of the landscape and non-intensive traditional land uses in another part.

1st community group

For the first community group (Table 4.20 & Table 5.1), which includes the various forest types and the chasmophytic community of the study area, the aim should be the preservation of their high naturalness and restorability value. For this reason their protection from any productive use is of priority. The forests and woodlands of the gorge and the inclined sites near the village should be left to natural processes and to become old growth and mature high forests, enhancing thus their protection function and influencing positively important ecosystem services. The typical forest fauna of these habitats will be enriched with species of the old growth forests.

For the forest fragments of *Quercus pubescens* on the slopes near the village and the agricultural land, small scale shredding / pollarding and selective cutting could maintain the loose crone, which supports the high plant species diversity and the associated rare species (mainly orchids) and at the same time preserves this traditional element of the cultural landscape. Care should be given however to maintain some old or dead trees and avoid planting non-native tree species. Maintaining the floristic and structural diversity of these forest fragments is very important also for the fauna since this landscape element, due to its direct vicinity to the agricultural land, consists important habitat to a large number of small birds, mammals, reptiles and invertebrates, but also to typical forest birds and some raptors.

3rd community group

The 3rd community group incorporates the low shrublands and grasslands characterized with high phyto-diversity and medium to high numbers of rare plant species and is found in an area that have been extensively grazed for long. In order to preserve these landscape elements and their conservation value, a rotational grazing system of low intensity, differentiated spatially from year to year, which will take into account the rare plant species (NOY-MEIR & ORON 2001) and it will be based on the carrying capacity of the ecosystems, is considered to be the appropriate for maintaining the open structure of these vegetation types, along with their plant species composition and diversity.

Special care should be given though to avoid overgrazing, which diminishes floristic and faunal diversity and soil fertility (erosion), and if it appears, it should be regulated. Although the acceptable levels of grazing pressure range between 0.3-1.4 animal units/Ha for sheep and goats, and between 0.3-1.9 animal units for cows (MINISTRY OF AGRICULTURE 2003), however the grazing carrying capacity of a specific ecosystem depends on its specific ecological and biological characteristics and thus it has to be estimated for the specific ecosystem type.

The conservation of the low shrublands and grasslands is important for maintaining the semi-open character of the cultural landscape that is essential for the nutrition of many priority animal species, and which in combination with the various dispersed rocky sites consist important habitats for many of them. The maintenance of the extensive grazing regime favors not only the various animals groups that have their habitat there, e.g. insects, reptiles, small and large mammals, but also some of the mammal and bird species that inhabit forests and woodlands, but search for their food in shrublands, grasslands and other anthropogenous habitats, including the bear, wolf and many large raptors.

Finally, the extensive livestock grazing system represents a quite old and significant element of the local traditional way of living and its preservation is considered important both for the local cultural tradition and economy.

2nd community group

The 2nd community group includes plant communities characterized with moderate to low values of the four nature conservation criteria. Here are included the tree hedges and the forest pasture of *Quercus pubescens*, the woodland of *Q. coccifera* and that of *Carpinus orientalis*, the meadows of *Trifolium nigrescens*, the nitrophilous *Marrubium peregrinum* community and the forest fringe communities. Although these communities have their own intrinsic value in nature conservation since they support their own flora and fauna, their present situation allows for their use in two alternative ways, which grants with flexibility the proposed management scheme.

Specifically, these communities could provide supplementary land for traditional land uses to satisfy the needs of the local populations. For instance, they could be used either for livestock pasture under the proper stocking level, as it could be the case with the wood pasture of *Quercus pubescens* with *Juniperus oxycedrus*, and also for small scale firewood cutting as in the case of the two woodlands, or for agricultural purposes in the form of organic farming for the production of biological products as it could be the case with the forested fields.

If however there is not a necessity or interest for productive activities, they could be set aside for nature conservation. In this case the natural succession to more advanced vegetation types will enhance their structural complexity and naturalness and occasionally also their biodiversity, as it could be the case with *Marrubium peregrinum* community and the meadows of *Trifolium nigrescens,* or the abandoned fields.

An important floristic element of this community group is the presence of the threatened *Lilium chalcedonicum*, which was found only in small rocky openings of the pseudomachie woodland (Q_coc11). Thus, small scale woodcutting is essential for the maintenance of the small openings in the woodland and the preservation of the threatened taxon, but also for maintaining the plant species diversity of this vegetation type.

In such a diverse and inclined relief the application of fire as a tool for preventing forest or shrub expansion is problematic due the difficulties in controlling it. For this reason fire is usually not permitted in such areas, due to the detrimental effects on the ecosystems, when it gets out of control (KAILIDIS 1981, HAMILTON & MCMILLAN 2004). If necessary for environmental reasons however, it could be applied on a small scale, such as a field under specific conditions, e.g. in late autumn or winter and by trained personnel.

The fauna associated to this community group include both forest and open vegetation species. However, the importance of these anthropogenous vegetation types for the fauna lies on the fact that these along with the other open vegetation types complete the spectrum of the anthropogenous habitats that form the landscape mosaic, which is important for the nutrition of the majority of animal species.

With special reference to the avifauna, it is known for instance that although some bird species are restricted to specific habitat-types, the majority of priority species actually need a mixture of woodland, shrubland and rocky habitat within their foraging area. Traditional land use systems combining non-intensive practices of agriculture, livestock grazing and forestry (coppices with standards) are closely linked to the biological requirements of many species and are necessary for the maintenance of suitable habitats for them, while the complete abandonment of non-intensive agriculture and livestock grazing is considered highly detrimental and as the main threat for many priority species (ROCAMORA 1997).

The proposed management scheme supports the traditional land use system and integrates it in the management of the National Park by proposing sustainable land use practices. Detailed studies will define the carrying capacity of the ecosystems for the traditional land use that is considered compatible to each case. Local inhabitants, such as farmers could be involved to the specific management scheme, or they can be trained in adopting management techniques that imitate traditional ones with similar conservation benefits.

In case that there is no interest from the local communities in maintaining the traditional land use system, the ecosystems will be probably left to their natural succession. Locally and spatially limited some land use practices imitating the traditional ones could be financed and applied for the conservation of rare plant and animal species. For this reason, it is necessary the development of alternatives to the traditional land use practices that could bring similar conservation benefits.

Table 5.1 Management recommendations for the plant communities

Plant community	Vegetation type	Management priorities / measures	Com/ity group
Qpub12	Forest	Small scale tree pollarding for maintaining its traditional cultural character and keeping the canopy loose for enhancing phytodiversity.	1
Qp_Car22	Forest	No use, enhance naturalness and old growth	
Co_Qpu14	Forest	>>	
Ac_Ost24	Forest	>>	
J_Aobt23	Forest	>>	
Pla_or15	Forest	>>	
Asp_ch17	Grassland	No use	
Ju_Qpu13	Forest	Moderate grazing based on the ecosystem carrying capacity; keep the small openings for maintaining the plant species diversity.	2
Ru_Qpu18	Tree hedge	Every a few years (5-10) part of the trees and shrubs to be cut at the stock. Small scale pollarding for maintaining the traditional character. Moderate grazing for enhancing species diversity.	
Q_coc11	Woodland	Small scale firewood cutting for keeping the small openings and enhancing thus the plant species diversity. The firewood could be supplied to the inhabitants.	
Car_or21	Woodland	>>	
Pte_aq19	Forest fringe	Left to forest succession unless there is a need for another moderate use, e.g. small scale grazing or biological cultivation	
Par_of16	Forest fringe	>>	
Br_syl20	Forest fringe	>>	
Mar_pe4	Grassland	Avoid overgrazing at inclined sites to prevent soil erosion.	
Tri_ni3	Grassland	Continue mowing each May and grazing in autumn and winter.	
Ju_ox10	Shrubland	Moderate grazing, keep the semi open structure	3
Sal_of9	Shrubland	Moderate grazing, avoid extensive stock cutting, remove groups of shrubs for maintaining a semi-open structure	
Phl_fr8	Shrubland	Avoid overgrazing; apply rotational grazing differentiated spatially and keep ungrazed a different part of the land each year for supporting rare species (e.g. orchids).	
Di_vis2	Grassland	>> Allow firewood cutting every a few years for preventing shrubs expansion and maintaining the small openings.	
Be_per1	Grassland	Avoid overgrazing, apply rotational grazing.	
Poa_bu5	Grassland	>>	
Jas_fr7	Grassland	Moderate grazing for preventing shrubs extension and allow firewood cutting every few years (5-10)	
Hel_nu6	Grassland	>>	

Summary

Traditional cultural landscapes represent the long interaction of man with nature and are often characterised with high nature conservation value as habitats of rare and endangered species, or for their high diversity in plants and animals species. Such areas are also associated with specific traditional, cultural, aesthetic and economic values.

Thus, it is necessary to develop procedures that identify traditional cultural landscapes; describe their main components and elements; analyse their functions and changes along with the traditional land use system and other influencing factors; and properly evaluate them, in order to achieve a scientifically-based landscape conservation management.

The present study investigated the traditional cultural landscape in the area of Vikos-Aoos National Park, NW Greece. The landscape at the hilly and mountainous zone of the National Park has been influenced by traditional agro-silvo-pastoral land uses, practiced there for centuries. The cultural landscape is a mosaic of small terraced fields with tree hedges, fallow grasslands and rocky sites, grazed open shrublands and woodlands, and various forests and forests fragments, which are the landscape elements.

The area appears nowadays strongly depopulated, due to the immigration that took place after World War II. The gradual abandonment of the traditional rural economy and the land use system has affected the cultural landscape. The forest succession and the accelerated invasion of woody species affect the mosaic structure of the landscape, which has begun to lose some landscape elements.

Thus, the study aimed to assess the ecological value of the traditional cultural landscape in Vikos-Aoos National Park, which will set the basis for its conservation management. The main components and elements of the cultural landscape were identified and described along with the traditional land use system.

The ecological evaluation was based on the vegetation and vascular flora of the landscape. For this reason the vegetation inventory of the landscape elements preceded and led to the identification of more than 700 plant taxa. The vegetation data were numerically analysed and 24 vegetation types (plant communities and subunits)

were identified, phytosociologically described and incorporated to the syntaxonomical system of Greece.

FOREST VEGETATION

Eleven (11) plant communities (including subunits) describe the forests and woodlands of the studied cultural landscape. The *Platanus orientalis* community represents the riparian gallery forest along Voidomatis stream that is an azonal vegetation type related to the specific site conditions and was syntaxonomically ordered to the *Salicetea purpureae* class.

The other forests and woodlands of the study area were divided into mesophilous and thermophilous units. Mesophilous are those influenced by the high air humidity and cool temperatures that prevail at the narrow parts of Vikos gorge. These are found upon limestone and represent submediterranean deciduous forests of the *Ostryo-Carpinion* alliance (*Quercetea pubescentis*). Two community groups have been identified: a) the *Acer obtusatum* community group that characterized the forests of the middle and upper slopes of highly inclined sites. It included two forest types: the *Juglans regia – Acer obtusatum* community that covers limited area near Vikos village and is dominated by *Acer obtusatum*; and the *Acer obtusatum - Ostrya carpinifolia* community that forms extended stands in the forested part of the gorge and is rich in tree species. The communities have been influenced by small scale selective cutting, tree shredding or occasional summer grazing.

b) The *Carpinus orientalis* community group characterizes the woodlands and forests of the lower altitudes found at relatively accessible sites and included the coppiced woodland of *Carpinus orientalis* and the low forest of *Quercus pubescens - Carpinus orientalis*. The communities have been influenced by activities related to periodical wood cutting and yearly forest grazing.

The thermophilous forest and woodlands are those found at the middle slopes of the open part of the gorge and the ridge of Vikos village. These included: a) the community of *Rubus ulmifolius ssp. sanctus – Quercus pubescens*, which represents the tree hedges of the terraced agricultural land near the village. These are abundant in photophilous and thorny woody species resistant to animal grazing, consist secondary formations of the zonal forest and are syntaxonomically classified to the *Rhamno-Prunetea spinosae*; b) the forest fragments of *Quercus pubescens* community that are found on flysch, near former cultivated sites and represent the climax forest type (*Quercion frainetto, Quercetea pubescentis*). These have been maintained in order to provide fodder (tree shredding) for the livestock; c) the community of *Carpinus orientalis - Quercus coccifera,* which represents the low coppiced pseudomacchie woodland that was grazed on a daily basis from autumn till spring, and d) the forest fragments of *Quercus ilex*, which represent extra-zonal Mediterranean forest elements (*Quercetea ilicis*) found at rocky sites of the low and middle zone of the gorge.

OPEN VEGETATION

Here are included the low shrublands and grasslands that are structurally characterized by the presence only of the herb layer and occasionally of a low sparse shrub layer.

Three communities of low shrublands were identified in an area that has been grazed on a daily basis: the garigue communities of a) *Quercus coccifera - Juniperus oxycedrus* and b) *Salvia officinalis – Carpinus orientalis,* both classified to the *Rhamno-Prunetea spinosae* class, and c) the phryganic community of *Phlomis fruticosa* (*Cisto-Micromerietea julianae*). The three communities are secondary formations related to forest degradation resulted from the long and excessive grazing pressure.

The community of *Asperula chlorantha - Centaurea pawlowskii* describes the chasmophytic vegetation (*Asplenietea trichomanis* class) that was found on exposed limestone cliffs of the lower and middle slopes.

Thermophilous rocky grasslands occupy small openings among the woody formations. These are represented by the *Helianthemum nummularium -Trifolium dalmaticum* community and are rich in annuals and low grown herbs and grasses of the *Thero-Brachypodietea* class.

Overgrazed sites adjacent to the village are characterized by the *Marrubium peregrinum* community of the *Artemisietea vulgaris* class, which is a perennial nitrophilous and ruderal vegetation type that occupies sunny sites above limestone.

Secondary grasslands dominated by annual and low-grown herbs and grasses, characterize the vegetation of the former agricultural land. Two communities have been identified and incorporated to the *Thero-Brachypodietea* class: a) the *Alyssum alyssoides - Poa bulbosa* grassland community found at rocky trampled and intensively grazed sites near the village, and b) the *Trifolium nigrescens* community of the terraces established upon flysch. Three community forms were identified and related to the different land use, i.e. mowing, extensive or occasional grazing.

Finally, two forest fringe communities represent the vegetation of the abandoned terraces: a) the *Brachypodium sylvaticum* community of the *Trifolio-Geranietea* class related to the thermophilous forests and b) the *Parietaria officinalis* community of the *Galio-Urticetea* class associated with the mesophilous forests.

ECOLOGICAL GRADIENTS OF THE VEGETATION

The main ecological gradients of the vegetation were investigated means of an indirect ordination analysis (Detrended Correspondance Analysis - DCA) of the vegetation data and the rank correlation of the ordination axis with the environmental data. The analysis indicated two main ecological gradients; firstly, a topographic-climatic & land-use gradient from inclined, mesic-cool sites, managed as forests to more even, dry-warm sites, managed as grazing land and meadows (1^{st} DCA axis); plant species diversity increased also along this gradient. Secondly, a geological-edaphological gradient from habitats of deep soil conditions and more intensively used to habitats of swallow soil, high rocky content and increased naturalness (2^{nd} DCA axis).

ECOLOGICAL EVALUATION

Based on standard nature conservation criteria all plant communities were further evaluated for their contribution in nature conservation. Thus, the phytodiversity and the presence of rare plant species were quantified, while their naturalness and restorability were qualitatively assessed on the basis of specific ecosystem characteristics. For each criterion the communities were classified in classes of low, middle and high value, either numerically (for diversity and rarity) or subjectively (for naturalness and restorability). Each class aggregated the communities exhibiting similar pattern for the respective criterion. Moreover the communities were further classified on the basis of all four criteria (diversity, naturalness, rarity and restorability) simultaneously into three classes. The communities of each class demonstrated specific pattern on the criteria, which provided the basis for their management.

<u>Diversity and Rarity</u>

Species richness, SHANNON diversity, SIMPSON diversity and Evenness are the four indices applied for the quantification of the plant species diversity. All indices were estimated at three scales, namely for each plot, each plant community and the studied landscape.

For a specific diversity index a plant community can be more diverse than another at the plot level, but not at the community level. It was concluded that the plant species diversity is related to the diversity measure, the scale level of reference, the community type and the sampling intensity. The diversity of a plant community needs to be seen in relation to these parameters, in order to be meaningful and comparable to other communities.

The plant species diversity ranged among the various vegetation types and the highest richness and diversity values were detected in intermediate and relatively early successional stages represented by the low open shrublands and specific grasslands. This was associated with the relatively equitable species distribution (evenness) and low dominance value of their species composition, which were further related to the moderate disturbance regime of the traditional grazing system.

Landscape diversity was also quantified with the same diversity indices and related to the diversity of the lower hierarchical scales, namely the plant community and the plot scale. This was based on the identification of within- and between-diversity components at each scale. Thus, it was demonstrated that the landscape diversity is the combined effect of the community and the plot diversity. The diversity of the studied landscape was attributed mainly to its plot specific component. On the contrary, the landscape richness was mainly related to the between communities component and thus to the landscape composition.

This approach could be particularly useful when comparing the diversity between landscapes. In such a case, the hierarchical scale producing the greater difference between the landscapes could be examined, for instance if the plots of the more diverse landscape are themselves more diverse or whether the difference in diversity derives from a greater between communities component.

Concerning the criterion of diversity it was concluded that a) 11% of the Greek plant taxa are concentrated in an area of only 8 Km^2; b) the various vegetation types have high vascular plant species numbers and diversity, in relation to similar types from the

literature including also some from the Mediterranean area and c) most of the plant species have the optimum of their distribution in open vegetation types of anthropogenous origin.

As it concerns the criterion of rarity the study area demonstrated also high density of rare plant taxa, with 14 Greek endemics, 40 wide endemics and 28 threatened taxa registered there. Although the numbers of rare taxa varied among the vegetation types, these exhibited in general a similar pattern to that of diversity. Thus, the open vegetation types characterized with high plant species diversity, exhibited also high numbers of rare plant taxa.

It was concluded that a) the conservation of the open vegetation types is necessary for maintaining the high diversity and rarity of the cultural landscape; b) an active management scheme is needed for conserving these landscape elements and their associated biodiversity; and c) the management should be based on the continuation of the moderate regime of the traditional land use system and the development of alternative practices that imitate the traditional ones.

Naturalness and Restorability

The high vascular plant species richness, diversity and rarity of the open landscape elements represent only one part of the ecological value of the cultural landscape. There is another part of the landscape, i.e. specific landscape elements, that are characterized with high naturalness and restorability value. These are the less human influenced and thus more natural landscape elements, such as the various forests and woodlands and the rockcliffs with the chasmophytic vegetation. The ecological value of these ecosystems is related not only to the conservation of their biodiversity, but also in the cases of the forests and woodlands, to the high structural complexity and the enhanced ecosystem functions. These characteristics, along with the long restoration time that these ecosystems require in case of destruction, make obvious the need to protect these landscape elements from any use that can harm their high naturalness and restorability value.

LANDSCAPE MANAGEMENT

The overall ecological evaluation of the landscape made obvious the following points, on which management should focus:

- The conservation of the ecological values of the traditional cultural landscape in Vikos area requires a management scheme that should take into account the ecological values of all landscape elements.
- The landscape conservation management should aim both to preserve the biodiversity that is representative for the cultural landscape and its ecosystems, and also to protect its high naturalness and restorability.
- Thus, the proper management scheme should combine both the strict protection of specific elements of the landscape, such as the forests and rockcliffs, and also the active management of the open landscape elements, which should be carried out by integrating the traditional land use regime in their conservation.

Following these points a certain conservation management scheme for the traditional cultural landscape has been proposed, its impacts were discussed in conjunction to the present strict protection status of the area (as core of Vikos-Aoos National Park) concluding to specific management recommendations.

Zusammenfassung

Traditionelle Kulturlandschaften spiegeln die lange Wechselwirkung des Menschen mit der Natur wieder. Als Lebensräume von seltenen und gefährdeten Arten oder wegen ihrer hohen floristischen und faunistischen Diversität sind sie naturschutzfachlich gesehen oft sehr wertvoll. Weiterhin können spezielle traditionelle, kulturelle, ästhetische und ökonomische Leistungen wertgebend sein.

Folglich ist es notwendig, Verfahren zu entwickeln, die verbliebenen traditionellen Kulturlandschaften zu identifizieren; ihre Komponenten und Elemente zu beschreiben; ihre Funktionen und deren Änderungen in Zusammenhang mit dem Aufhören von traditionellen Landnutzungssystemen aufzuzeigen; und valide Bewertungen für ein wissenschaftlich begründete Landschaftsplanungen vorzunehmen.

Die vorliegende Studie befasst sich mit der traditionellen Kulturlandschaft im Gebiet des Vikos-Aoos Nationalparks in NW Griechenland, mit besonderer Berücksichtigung der Gemarkung von Vikos als Fallstudie. In den hügeligen und submontanen Vorbergen dieses Nationalparks ist die Landschaft von jahrhundertenlangen traditionellen agro-silvo-pastoralen Landnutzungen bis heute geprägt. Die Kulturlandschaft beinhaltet neben den Siedlungen und Wegen ein reichhaltiges Strukturmosaik von Gärten, kleinen Ackerterrassen mit Baumhecken, Wiesen und Weiden; mit Felsen; fragmentierten und geschlossenen Wäldern.

Das Gebiet um Vikos und des Nationalparks ist heute nur mehr dünn besiedelt. Dies ist eine Folge der Abwanderung, die nach Zweitem Weltkrieg stattgefunden hat. Das allmähliche Auflassen der traditionellen Nutzungen haben die Landschaft beeinflusst. Die zurückgehende Nutzung und daraus resulterende Waldsuksessionen verändern die Landschaftsstruktur. Insbesondere verschwinden arbeitsintensive Landschafts-elemente, zum Beispiel die kleinen Öffnungen mit Wiesen.

Ziel dieser Arbeit was es, die Kulturlandschaft um die Bergdörfer im Vikos-Aoos Nationalpark ökologisch zu analysieren und naturschutzfachlich zu bewerten. Darauf aufbauend können fundierte Bewirtschaftungs- oder Pflegekonzepte entwickelt werden. Die Komponenten und Elemente der traditionellen Kulturlandschaft wurden identifiziert und in Zusammenhang mit dem traditionellen Landnutzungssystem beschrieben, mit besonderer Berücksichtigung der Pflanzengesellschaften.

Die ökologische Bewertung basiert im wesentlichen auf der Vegetation der Gefäßpflanzen. Hierzu wurde die Flora des Gebiets mit über 700 Pflanzentaxa erfasst, wurde dieVegetation inventarisiert. Die Vegetationsdaten wurden numerisch analysiert. 24 Vegetationstypen wurden identifiziert, phytosoziologisch beschrieben und dem in Griechenland gebräuchlichen syntaxonomischen System angeschlossen.

WALDVEGETATION

Elf (11) Pflanzengemeinschaften und ihre Untereinheiten beschreiben die Wälder und die Gebüsche der Landschaft. Die *Platanus orientalis*-Gesellschaft bildet den Auwald entlang des Voidomatis Bachs. Dies ist ein azonaler Vegetationstyp, der an die speziellen Standortsbedingungen angepasst und in die Klasse der *Salicetea purpureae* eingeordnet ist.

Die Wälder und Gebüsche der terrestrischen Böden wurden in mesophile und thermophile Einheiten unterteilt. Die mesophilen Vegetationstypen sind durch die hohe Luftfeuchtigkeit und kühlen Temperaturen beeinflusst, welche an den engen Teilen von Vikos Schlucht vorherrschen. Spezifische Gesteine und Böden prägen die Waldvegetation, insbesondere die Kalke .

Daher wurden diese Wälder dem *Ostryo-Carpinion*-Verband (*Quercetea pubescentis*) angeschlossen. Zwei Gesellschaftssgruppen wurden identifiziert: a) die *Acer obtusatum* Gesellschaftsgruppe, welche die Wälder der Mittel- und Oberhänge an stark geneigten Stellen charakterisiert. Zwei Waldtypen sind miteingeschlossen: die *Juglans regia – Acer obtusatum*-Gesellschaft, welche in einem begrenzten Gebiet nahe des Dorfes Vikos vorkommt, und von *Acer obtusatum* beherrscht wird; und die *Acer obtusatum - Ostrya carpinifolia*-Gesellschaft, welche eine ausgedehnte Fläche in der Schlucht einnimmt und reich an Baumarten ist. Diese Gesellschaften sind bis heute in geringem Ausmaß von Holznutzung, Schneitelung oder gelegentlicher Sommerweide beeinflusst.

b) Die *Carpinus orientalis*-Gesellschaftsgruppe charakterisiert die Wälder und Gebüsche der Unterhänge. sie umfasst Gebüsche mit *Carpinus orientalis* und Niederwald vom Typ der *Quercus pubescens - Carpinus orientalis* -Gesellschaft. Die Gemeinschaften sind von periodischen Holzschneiden und jährliche Waldweide beeinflusst.

Thermophile Wälder und Gebüsche wurden an den mittleren Hängen des offenen Teiles der Schluchtes gefunden. Diese beinhalten die folgenden Pflanzengesellschaften: a) die *Rubus ulmifolius ssp. sanctus – Quercus pubescens*-Gesellschaft, welche die Baumhecken der Äckerterrassen nahe des Vikos-Dorfes bildet. Diese stellen anthropogene Ausbildungen und Überformungen der zonalen Wälder dar; sie sind reich an photophilen und weidefesten, dornigen Gehölzarten, und werden der Klasse der *Rhamno-Prunetea spinosae* zugeordnet; b) die fragmentierten Wälder der *Quercus pubescens*-Gesellschaft, welche den Klimaxwald repräsentieren (*Quercion frainetto, Quercetea pubescentis*), und welche auf früherem Kulturland auf Flysch als Folge von Verbrachung und Sukzession sich eingestellt haben. Die Struktur und Artenzusammensetzung dieser Wälder lässt sich nur erhalten, wenn auch weiterhin Futterlaub durch Schneitelung praktiziert wird; c) die *Carpinus orientalis - Quercus coccifera*-Gesellschaft, mit Stockausschlagbäumen („Pseudomacchie“) und Lichtungen, in denen im Winterhalbjahr täglich beweidet wird, und d) die fragmentierten Wälder von *Quercus ilex*, welche als mediterran-immergrüne Waldfragmente aus der Klasse der *Quercetea ilicis* extrazonal an Felsen der unteren und mittleren Zone der Schlucht sich halten.

VEGETATION DER OFFENEN BEREICHE

Die Offenlandvegetation umfasst niedrige Gebüsch- und Grünlandvegetation, sie wird strukturell durch eine Krautschicht und gelegentlich spärliche entwickelte Strauchschicht charakterisiert.

Drei Gesellschaften, aufgebaut von niedrigwüchsigen Gehölzen, wurden im Gebiet identifiziert, welche die tägliche beweideten Hänge charakterisieren: die „Garigues“ von a) *Quercus coccifera-uniperus oxycedrus* und b) *Salvia officinalis–Carpinus orientalis*, beide aus der Klasse der *Rhamno-Prunetea spinosae*, und c) die „Phrygana“-Bestände der *Phlomis fruticosa*-Gesellschaft (*Cisto-Micromerietea julianae*). Diese drei Pflanzengesellschaften sind sekundäre Degradationsformen des Waldes, entstanden durch langen und übermäßigen Weidedruck .

Die *Asperula chlorantha-Centaurea pawlowskii*–Gesellschaft aus der Klasse der *Asplenietea trichomanis* besiedelt exponierte, strahlungsreiche Felsen der unteren und mittleren Hanglagen.

Eine thermophile Offenlandvegetation findet man in kleinen Lichtungen von Gebüschen und Wäldern. Diese werden als *Helianthemum nummularium-Trifolium dalmaticum*_Gesellschaft gefasst, sie sind reich an annuellen und niedrigwüchsigen Kräutern und Gräsern Klasse der *Thero-Brachypodietea*.

Stark überbeweidete Bereiche unmittelbar am Dorfrand werden von der *Marrubium peregrinum*-Gesellschaft aus der Klasse der *Artemisietea vulgaris* eingenommen. Die Vegetation ist geprägt von mehrjährigen nitrophilen und ruderalen Arten auf besonnten Kalkböden.

Sekundäre Grünlandtypen, welche von annuellen oder niedrigwüchsigen Kräutern und Gräsern beherrscht wird, charakterisieren die ehemaligen landwirtschaftlichen Flächen. Zwei Pflanzengesellschaften wurden identifiziert und der *Thero-Brachypodietea* Klasse zugeordnet: a) die *Alyssum alyssoides-Poa bulbosa*-Gesellschaft auf steinigen, betretenen und intensiv beweideten Stellen nahe des Dorfes, und b) die *Trifolium nigrescens*-Gesellschaft auf Terrassen, die auf Flysch angelegt worden waren. Drei Gesellschaftsformen wurden identifiziert und auf die jeweilige Bodennutzung zurückgeführt; insbesondere das Mähen sowieumfangreiches oder gelegentliches Weiden erwiesen sich als bedeutsam.

Zwei Waldrandergesellschaften bilden die Vegetation von aufgelassenen Terrassen: a) die *Brachypodium sylvaticum*-Gesellschaft aus dr Klasse der *Trifolio-Geranietea* und b) die *Parietaria officinalis*-Gesellschaft aus der *Galio-Urticetea*-Klasse, die eine floristische Ähnlichkeit zu mesophilen Wäldern aufweist

ÖKOLOGISCHE GRADIENTEN DER VEGETATION

Die für die Vegetation relevanten ökologischen Hauptgradienten wurden mittels einer indirekten Ordinationsanalyse (Detrended Correspondance Analyse - DCA), der Vegetationsdaten und der Rangkorrelation von Ordinationachsen mit Umweltdaten analysiert. Die Analyse ergab zwei Hauptgradienten: (a) einen topografisch, klimatisch und durch Landnutzungsgradienten bedingten Gradienten von mäßig kühl-feuchten Standorten mit Waldnutzung zu mehr flachgründigen und trockenwarmen Stellen, die als Weide und Wiesen genutzt werden (1. DCA Achse); die Pflanzendiversität nimmt entlang der Gradienten zu. (b) ein geologisch-edaphischer Gradienten von Lebensräumen, welche für tiefgründigere, intersiver genutze Böden bezeichnend sind und eine höhere Naturnähe aufweisen (2. DCA Achse).

ÖKOLOGISCHE BEWERTUNG

Alle Pflanzengesellschaften des Untersuchungsgebietes wurden auf der Basis von vier wichtigen und häufig benutzten Kriterien naturschutzfachlich bewertet, nämlich durch Diversität, Seltenheit, Natürlichkeit und Restituierbarkeit. Die jeweilige Pflanzenartendiversität und Seltenheit wurden quantifiziert, die Natürlichkeit und Restituierbarkeit wurden aufgrund qualitativer Indikatoren abgeschätzt. Für jedes Kriterium wurden die Pflanzengesellschaften in Klassen vom niedrigen, mittleren und höheren Werten zusammengefasst, und entweder numerisch (für die Diversität und Seltenheit) oder expertengestützt-subjektiv (für die Natürlichkeit und Restituierbarkeit) ordinal skaliert. Die jeweils zusammengefassten Pflanzengesellschaften verhalten sich ähnlich bezüglich ihrer naturschutzfachlichen Wertigkeit

Diversität und Seltenheit

Artenreichtum, Shannon Diversität, Simpson Diversität und Evenness sind die vier Indizes, die zur Quantifizierung der Pflanzendiversität benutzt wurden. Alle Indizes wurden für jede Probefläche und jede Pflanzengesellschaft abgeleitet.

Die Pflanzendiversität hängt methodisch gesehen vom Maßstabniveau, vom spezifischen Gesellschaftstyp und der Inventurintensität ab. Die Diversität einer Pflanzengemeinschaft muss in Verhältnis zu diesen Parametern gesehen werden, um sinnvolle Aussagen ableiten zu können.

Die Artendiversität zwischen den verschiedenen Vegetationstypen variiert stark. Der größte Artenreichtum und die größte Diversität sind in aufgelichteten Gebüschen und bestimmten Grünlandvegetationstypen anzutreffen, welche frühe und intermediäre Suksessionsstadien darstellen. Damit einher gehen eine relativ gleichmäßige Verteilung der Artdeckungen (Evenness) und ein niedriger Dominanzwert (Simpson Diversität), weiter auch ein eher mäßig starkesn Störungsregime durch die traditionelle Weidenutzung.

Insgesamt zeigt sich bei Betrachtung der Vielfalt (Phytoddiversität), dass (a) 11% der griechischen Pflanzentaxa in einem Gebiet von nur 8 km^2 auftreten; (b) die verschiedenen Vegetationstypen relativ hohe Gefäßpflanzenzahlen und –diversität aufweisen, verglichen mit ähnlichen Vegetationtypen in der Literatur; und (c) die meisten Pflanzentaxa das Optimum ihrer Verbreitung in offenen, anthropogen geprägten Vegetationtypen haben.

Bei Betrachtung des naturschutzfachlichen Kriteriums des Seltenheit zeigt sich, dass das Untersuchungsgebiet auch eine hohe Dichte von seltenen Pflanzentaxa aufweist. Allerdings variiert die Anzahl von seltenen Taxa zwischen den Vegetationstypen sehr. Dennoch zeigt sich, dass die Vegetationstypen des Offenlandes, welche eine hohe Pflanzendiversität aufweisen, haben eine relativ große Anzahl von seltenen Pflanzentaxa beherbergen.

Daraus kann geschlossen werden, dass (a) die Erhaltung des Offenlandcharakters und der damit verbundenen Pflanzengesellschaften notwendig ist für das Bewahren der hohen Diversität und Seltenheit der Kulturlandschaft ist; und (b), dass ein aktives Managementschema für die Bewahrung dieser Landschaftselemente und ihre biologische Vielfalt notwendig ist; und (c), dass das Management auf der Fortführung des traditionellen Landnutzungsregimes und der Entwicklung alternativer Praktiken basieren sollte, welche die traditionellen Landnutzungen imitieren.

Natürlichkeit und Restituierbarkeit

Der hohe Pflanzenreichtum, die Diversität und das Auftreten seltener und gefährdeter Arten sind wertgebende Kriterien für die Landschaftselemente der offenen Kulturlandschaft. Entgegengerichtet ist die eher niedrige Naturnähe und geringwertige Restituierbarkeit. Diese Kriterien entsprechen Eigenschaften von Lebensräumen, welche vielfach vom Menschen weniger stark geprägt sind, zum Beispiel Wälder und Gebüsche, sowie die Felsvegetation mit den chasmophytischen Arten.

Ein Erhalt dieser Ökosysteme ist nötig zur Erhaltung der ökologischen und biologischen Vielfalt (insbesondere auch auf dem Landschaftsniveau), aber auch aufgrund ihrer hohen strukturellen Komplexität und den damit verbundenen Ökosystemfunktionen (z.B. für die Entomofauna). Die Naturnähe, der Strukturreichtum sowie die schwierige Wiederherstellbarkeit dieser Ökosysteme begründen ihre Schutzwürdigkeit..

LANDSCHAFTSMANAGEMENT

Auf der Basis der landschaftsökologischen Bewertung können folgende Empfehlungen ausgesprochen werden:

- Die Bewahrung der ökologischen Werte der traditionellen Kulturlandschaft im Vikos-Gebiet erfordert ein Managementschema, welches die ökologischen Wertigkeiten aller Landschaftselemente berücksichtigt.

- Das Schutzmanagement soll nicht nur die biologische Vielfalt bewahren, welche repräsentativ für die Kulturlandschaft und ihre Ökosysteme ist, sondern auch die Elemente mit hoher Naturnähe und schwerer Restituierbarkeit erhalten.

- Ein regionaltypisches, die Lebensräume und Biodiversität erhaltendes Management sollte eine Kombination darstellen von (a) strengem Schutz spezifischer Lebensräume (Wälder, Gebüsche, Felsvegetation) und (b) Pflege der Lebensräume des Offenlandes. Beide Komponenten sollten im Managementplan integriert werden, sollten zusammen das traditionelle Landnutzungsregime fortführen oder imitieren.

Aus diesen Gründen sollte für traditionelle Kulturlandschaften ein Managementsystem entwickelt werden, welches die vorhandenen Biotoptraditionen fortführt, jedoch auch menschliche Einflüsse in streng geschützten Kernzonen verhindert. Hierzu sind neben strengem Schutz auch spezifische Nutzungen bzw. Pflegemaßnahmen anzuwenden. Umgesetzt werden kann dies entweder im Fall eines Nationalparks durch eine Einteilung in den (streng geschützten) Nationalparkbereich und daran angrenzend eine (im traditionellen Stil genutzte) Pufferzone, oder durch Ausweisung eines Biosphärenreservats mit besonderer Entwicklung traditioneller Nutzungen und unter Einschluß eher kleinerer, streng geschützter Kernzonen.

References

AFIFI, A.A & CLARK, V. 1990: Computer-aided multivariate analysis. New York.

ALARD, D. & POUDEVIGNE, I. 2000: Diversity patterns in grasslands along a landscape gradient in northwestern France. J.Veg.Sc. 11: 287-294.

ALEXANDRIDIS, CH. 1999: The sheep farming system in the Pogoni area in Epirus-Greece. Options mediterraneenne Serie B 27: 65-79.

ALEXANDRIS, S. & DAFIS, S. 1989: Die Standorts- und Waldverhältnisse Griechenlands. AFZ 4: 77-79.

ARBEITSKREIS FORSTLICHE LANDESPFLEGE (Hrsg.) 1993: Biotop-pflege im Wald. Kilda. Greven.

ARBEITSKREIS FÜR STANDORTSKARTIERUNG (Hrsg.) 1996: Forstliche Standortsaufnahme: Begriffe, Definitionen, Einteilungen, Kennzeichnungen, Erläuterungen. 5. Aufl. IHW. Eching bei München.

ATHANASIADIS, N. 1984: Forest Phytosociology (in Greek). AUTH.

ATHANASIADIS, N. & DROSSOS, E. 1990: Flora and Vegetation of Mount Paiko. Sc. Annals Dep. Forestry & Natural Environment LC (1): 37-148.

ATHANASIADIS, N., THEODOROPOULOS, K., ELEFTERIADOU, E. & DROSSOS, E. 1996: Riparian forest communities of Pinios River (Thessalia, Hellas). Sc. Annals Dep. Forestry & Natural Environment 39 (2): 881-902.

AUTHIER, P. 1997 : La flore de la region des monts Timfi (Epire, nord-ouest de la Grece): un premier bilan. Bocconea 5: 477-485.

BACKHAUS, K., ERICHSON, B., PLINKE, W. & WEIBER, R. 2000: Multivariate Analysemethoden. Eine anwendungsorientierte Einführung. 9. Aufl. Springer. Berlin.

BAILEY, G. LEWIN, J.M., MACKLIN,G. & WOODWARD, J.C. 1990: The "Older Fill" of the Voidomatis valley, North-West Greece and its relationship to the Palaeolithic Archaeology and Glacial History of the region. Journal of Archaeological Science 17: 145-150.

BARBERO, M. & QUEZEL, P. 1976: Les groupements forestiers de Grece Centro-Meridionale. Ecologia Mediterranea 2.

BASTIAN, O & SCHREIBER, K-F. 1994: Analyse und ökologische Bewertung der Landschaft. G-Fischer. Stuttgart.

BEINLICH, B. 1999: Landschaftsplege in verschiedenen Lebensräumen. Kalkmagerrase, Wacholderheiden. In: KONOLD, W., BÖCKER, R. & HAMPICKE, U. (Hrsg): Handbuch Naturschutz und Landschaftspflege: Kompendium zu Schutz und Entwicklung von Lebensräumen und Landschaften. ecomed. Landsberg am Lech.

BERGMEIER, E. 1990: Wälder und Gebüsche des Niederen Olymp (Kato Olimbos, NO-Thessalien). Ein Beitrag zur systematischen und orographischen Vegetationsgliederung Griechenlands. Phytocoenologia 18 (2/3): 161-342.

BERGMEIER, E. 1990a: Spontanvegetation Nordgriechischer Bergdörfer. Folia Geobot. Phytotax. 25: 27-62.

BERGMEIER, E. 1995: Die Höhestufung der Vegetation in Südwest - Kreta (Griechenland) entlang eines 2450 m Transektes. Phytocoenologia 25 (3): 317-361.

BERGMEIER, E. 2002: The vegetation of the high mountains of Crete – a revision and multivariate analysis. Phytocoenologia 30 (2): 205-249.

BERGMEIER, E., DIMOPOULOS, P., THEODOROPOULOS, K. & ELEFTERIADOU, E. 2004: Zonale sommergrüne Laubwälder der südlichen Balkanhalbinsel – eine Übersicht. Tüxenia 24: 89-111.

BLASI, C., PIETRO, D.R., FILESI, L. & FORTINI, P. 2001 : Syntaxonomy, chorology and dynamics of Carpinus orientalis communities in Central Italy. Phytocoenologia 31 (1): 33-62.

BLONDEL, J. & ARONSON, J. 1995: Biodiversity and ecosystem function in the Mediterranean Basin: Human and non-human determinants. In: DAVIS, G.W. & RICHARDSON, D.M. (eds.): Mediterranean-type ecosystems: the function of biodiversity. Ecological Studies 109: 43-106.

BLUME, H-P., & SUKOPP, H. 1976: Ökologische Bedeutung anthropogener Bodenveränderungen. Schr.-R. f. Vegetationskunde 10: 75-89.

BÖHLING, N. 1995: Zeigerwerte der Phanerogamen-Flora von Naxos (Griechenland). Ein Beitrag zur ökologischen Kennzeichnung der Mediterranen Pflanzenwelt. Stuttgarter Beiträge zur Naturkunde A (533): 1-75.

BOLOS, O. DE, MASALLES, R.M., NINOT, J.M. & VIGO, J. 1996: A survey on the vegetation of Cephalonia (Ionian islands). Phytocoenologia 26 (1): 81-123.

BOTTEMA, S. 1974: Late quaternary Vegetation History of North-Western Greece. Groningen.

BRANDES, D. & E. BRANDES. 1981: Ruderal- und Saumgesellschaften des Etschtals zwischen Bozen und Rovereto. Tuexenia 1: 99-134.

BRAUN-BLANQUET, J., ROUSSINE, N. & NEGRE, R. 1952 : Les groupements vegetaux de la France Mediterraneenne. C.N.R.S.

BRAUN, H.J. 1982: Lehrbuch der Forstbotanik. G-Fischer.

BRIEMLE, G., ECKERT, G. & NUßBAUM, H. 2000: Landschaftsplege in verschiedenen Lebensräumen. Wiesen und Weiden. In: KONOLD, W., BÖCKER, R. & HAMPICKE, U. (Hrsg): Handbuch Naturschutz und Landschaftspflege: Kompendium zu Schutz und Entwicklung von Lebensräumen und Landschaften. ecomed. Landsberg am Lech.

BRIEMLE, G., EICKHOFF, D. & WOLF, R. 1991: Mindestplfege und Mindestnutzung unterschiedlicher Grünlandtypen aus landschaftsökologischer und landeskultureller Sicht. Praktische Anleitung zur Erkennung, Nutzung und Pflege von Grünlandgesellschaften. Beih. Ver. Naturschutz Landschaftspflege Bad.-Württ. 60: 1-160.

BÜHL, A. 2001: SPSS - Vers. 10. Einführung in die moderne Datenanalyse unter Windows. Addison-Wesley. München.

BURGGRAFF, P. & KLEEFELD, K-D. 1998: Historische Kulturlandschaft und Kulturlandschaftselemente. Angew. Landschaftsökologie 20.

BURSCHEL, P. & HUSS, J. 1997: Grundriß des Waldbaus. Parey. Berlin.

CHATZISTATHIS, A. & ISPIKOUDIS, I. 1995: Nature conservation (in Greek). Jiachoudi – Jiapouli. Thessaloniki.

COBHAM, R. & ROWE, J. 1994: Die Bewertung der Tier- und Pflanzenwelt von Agrarlandschaften: Eine Hilfe für den Naturschutz. In: USHER, M. B. & ERZ, W. (Hrsg.): Erfassen und Bewerten im Naturschutz: Probleme – Methoden – Beispiele: 187-211. Quelle & Meyer. Heidelberg – Wiesbaden.

CONNEL, J.H. 1978: Diversity in tropical rain forests and coral reefs. Science 199: 1302-1309.

CORREIA, T.P. 1993: Threatened landscape in Alentejo, Portugal: the montado and other agro-silvo-pastoral systems. Landscape and Urban Planning 24: 43-48.

COUNCIL OF EUROPE 2000: European Landscape Convention. Florence. European Treaty Series 176.

DAFIS, S. 1975. Vegetationsgliedung Griechenlands. Ver. Geob. Inst. ETH 55 (1): 23-36.

DAFIS, S. 1986. Forest Ecology (in Greek). Jachoudi-Japouli. Thessaloniki.

DAFIS, S. & JAHN, G. 1975: Zum heutigen Waldbild Griechenlands nach ökologisch-pflanzengeographischen Gesichtspunkten. Ver. Geob. Inst. ETH 55 (1): 99-116.

DAFIS, S., PAPASTERGIADOU, E., GEORGHIOU, K., BABALONAS, D., GEORGIADIS, TH., PAPAGEORGIOU, M., LAZARIDOU, TH. & TSIAOUSSI, V. (eds) 1996: Directive 92/43/EEC. The Greek Habitat Project Nature 2000 (in Greek). EKBY.

DEBUSSCHE, M., DEBUSSCHE, G. & LEPART. J. 2001: Changes in the vegetation of *Quercus pubescens* woodland after cessation of coppicing and grazing. Journal of Vegetation Science 12: 81-92.

DIERSCHKE, H. 1984: Naturlichkeitsgrade von Pflanzengesellschaften unter besonderer Berücksichtigung der Vegetation Mitteleuropas. Phytocoenologia 12: 173-184.

DIMOPOULOS, P. 1993: Floristic and phytosociological research of Mount Kyllini (in Greek). Dissertation. University of Patra.

DIMOPOULOS, P., BERGMEIER, E., SYKORA, K., PAPASTERGIADOU, E. 2000: Evaluation system of the relative importance of vegetation syntaxa for nature conservation in Greece. Biologia Bratislava 55 (1): 57-67.

DIMOPOULOS, P. & GEORGIADIS. TH. 1995: Present state of the phytosociological research on the Greek mountains. Syntaxonomy and future perspectives. ANNALI DI BOTANICA LIII: 119-133.

DIMOPOULOS, P., PAPASTERGIADOU, E., SYKORA, K., TH. GEORGIADIS, BABALONAS, D, DAFIS, S. 1995: Collection and analysis of phytosociological data of the Greek vegetation (in Greek). EKBY.

DIMOPOULOS, P., SYKORA, K., MUCINA, L. & GEORGIADIS, TH. 1997: The high-rank syntaxa of the rock-cliff and scree vegetation of the mainland Greece and Crete. Folia Geobot. Phytotax. 32: 313-334.

DROSSOS, E. & ATHANASIADIS, N. 1989: Contribution to the research of the pastures of Mount Paiko. Flora and Vegetation (in Greek). Sc. Annals Dep. Forestry & Natural Environment 13 (3): 281-320.

ECONOMIC COMMISSION FOR EUROPE (ECE) (ed.) 1991: European Red List of Globally Threatened animals and plants. United Nations.

ELEFTHERIADIS, N. 2002: Aesthetic evaluation of natural landscapes (in Greek). In: Proc.10th Greek Forestry Conference: 156-166.

ELLENBERG, H. 1996: Vegetation Mitteleuropas mit den Alpen. 5. Aufl. Eugen Ulmer. Stuttgart.

ERDNÜSS, F. 2000: Die naturnahen Erlenwälder des Westerwaldes: Soziologie, Ökologie und Diversität unter Einbeziehung der Moose und Flechten. Martina Galunder. Wiehl.

EUROPEAN COMMISSION (ed) 1997: Understanding biodiversity. An agenda for research into biodiversity prepared by the European working group on research and biodiveristy. Brussels.

EUROPEAN COMMISSION (ed) 1998: Europe's environment: the second assessment. DG for Environment. Brussels.

EUROPEAN COMMISSION (ed) 1999: Interpretation Manual of European Union Habitats. Eur 15 (2). DG for Environment. Brussels.

EUROPEAN COMMISSION (ed) 2003: Agriculture and Environment. Fact Sheet. DG for Agriculture. Available at: www.europa.eu.int/comm/agriculture/index.en.http.

EUROPEAN ENVIRONMENTAL AGENCY (EEA) (ed.) 2004: High nature value farmland. Characteristics, trends and policy challenges. EEA Reports 1. Copenhagen. Available at: www.reports.eea.eu.int/report_2004_1

EWALD, K.C. 1994: Traditionelle Kulturlandschaften. Der Bürger im Staat 44 (1): 37-42.

FARINA, A. 1995: Cultural landscapes and fauna. In: VON DROSTE, B., PLACHTER, H. & RÖSSLER, M. (eds): Cultural Landscapes of Universal Value – Components of a Global Strategy: 60-77. G.Fischer. Jena.

FARINA, A. 1995b: Upland farming systems of the Northern Apennines. In: HALLADAY, P. (ed): Conserving biodiversity outside protected areas - The role of traditional agro-ecosystems: 123-135. IUCN.

FARINA, A. 1998: Bird diversity in a changing landscape (Tuscany, Italy). In: RUNDER, PW., MONTENEGRO, G. & JAKSIC, F.M (eds): Landscape disturbance and biodiversity in Mediterranean-type ecosystems. Ecological Studies 136: 349-368. Springer. Stuttgart.

FERRIS, R. & HUMPHREY, J. W. 1999: A review of potential biodiversity indicators for application in British forests. Forestry 72 (4): 313-328.

FISCHER, A. 1982: Zur Diversität von Pflanzengesellschaften. Ein Vergleich von Gesellschaftskomplexen der Böschungen im Rebgelände. Tüxenia 2: 219-231.

FORMAN, R. T. T. & GODRON, M. 1986. Landscape ecology. Wiley. New York.

FREY, W. & LÖSCH, R. 1998: Lehrbuch der Geobotanik. Pflanze und Vegetation in Raum und Zeit.G-Fischer. Stuttgart.

GALANOPOULOU-SENDOUCA, S. & KONTSIOTOU, H. 1999: Traditional Greek agrisystems in mountainous areas for integrated rural development. In: PAPANASTASIS, V., FRAME, J. & NASTIS, A.S. (eds.): Grasslands and Woody Plants in Europe: 277-280. Proceedings of the International Occasional Symposium of the European Grassland Federation. Thessaloniki.

GALATSIDAS, S. 2001: Development of an inventory system for non-timber functions of forests in the frame of management inventories: the case of Greece. Dissertation. University of Freiburg.

GAMISANS, J. & HEBRARD, J. P. 1979: A propos de la vegetation des forets d' Epire et de Macedone Grecque Occidentale. Documents phytosociologiques IV: 290-341.

GANIATSAS, K. 1971: Botanical research in Vikos Gorge (in Greek). Epirotiki Estia 228: 1-28.

GANIATSAS, K. 1974: Research of the pharmaceutic plants of VIkos Gorge (in Greek). Epirotiki Estia KG: 212-229 & 394-411.

GASTON, K. J. 1996: What is Biodiversity? In: Gaston, K. J. (eds.): Biodiversity: a biology of numbers and difference: 1-9. Blackwell Science. Oxford.

GATZOJANNIS, St. 1996: Development and harmonisation of monitoring systems for forest resources management in Europe. The case of Greece. Project report. FRI. Thessaloniki.

GEORGIADIS, T., DIMOPOULOS, D. & DIMITRELLOS, G. 1996: Vegetation and flora of Vikos-Aoos National Park. In: KASIOUMIS, K. & GATZOJANNIS, S.: Management plan of Vikos-Aoos National Park (in Greek). Part A:18-41.

GERASIMIDIS, A. & ATHANASIADIS N. 1995: Woodland history of Northern Greece from the Mid-Holocene to recent time based on evidence from peat pollen profiles. Veget. Hist. Archaeobot. 4: 109-116.

GLAVAC, V. 1996: Vegetationsökologie: Grundfragen, Aufgaben, Methoden. G-Fischer. Jena.

GLOWKA, L., BURHENNE-GUILMIN, F. & SYNGE, H. 1994: A guide to the Convention on Biological Diversity. IUCN.

GRABHERR, G., KOCH, G. & KIRCHMEIR, H. 1998: Naturnähe Österreichischer Wälder. Bildatlas. Sonderdruck Österr. Forstz. 1/97.

GROVE, A.T., ISPIKOUDIS, J., KAZAKLIS, A., MOODY, J.A., PAPANASTASIS, V. & RACKHAM, O. 1993: Threatened Mediterranean Landscapes: West Crete. Final Report.

GROVE, A.T. & RACKHAM, O. 1993: Threatened landscapes in the Mediterranean: examples from Crete. Landscape and Urban Planning 24: 279-292.

GUTKO, Z., BRUMELIS, G., LIEPINS, I., NIKODEMUS, O. & TABORS, G. 2001: Plant species Richness, Shannon diversity and Evenness during secondary succession on abandoned agricultural land in Latvia. In: Proceedings of the Latvian Academy of Sciences: 36-42.

HAEUPLER, H. 1982: Evenness als Ausdruck der Vielfalt in der Vegetation. Dissertationes Botanicae: 65. Cramer. Vaduz.

HALSTEAD, P. 1987: Traditional and ancient rural economy in Mediterranean Europe. Journal of Hellenic Studies CVII: 77-87.

HALSTEAD, P. 1996: Mediterranean mountain economy in Pindus (in Greek). In: Municipality of Konitsa (ed.): Proceedings of the conference "The county of Konitsa in space and time": 63-73. Konitsa.

HALSTEAD, P. 1998: Ask the fellows who lop the hay: Leaf-fodder in the mountains of Northwest Greece. Rural History 9 (2): 211-234.

HAMILTON, L. & MCMILLAN, L. 2004: Guidelines for planning and managing mountain protected areas. IUCN. Gland.

HANLIDOU, E., KOKKALOU, E. & KOKKINI, S. 1999: Distribution of taxa with alkaloids and/or related compounds in Vikos-Aoos National Park (NW Greece). Nordic Journal of Botany 19 (1): 27-40.

HANLIDOU, E. & KOKKINI, S. 1997: On the flora of Vikos-Aoos National Park (NW Greece). Willdenowia 27: 81-100.

HEYWOOD, V. H. (ed.) 1995: Global biodiversity assessment. Cambridge.

HORVAT, I. 1954: Pflanzengeographische Gliederung Südosteuropas. Vegetatio V/VI: 434-447.

HORVAT, I. 1958: Laubwerfende Eichenzonen Südosteuropas in pflanzensoziologischer, klimatischer und bodenkundlicher Betrachtung. Angewandte Pflanzensoziologie 15: 50-61.

HORVAT, I., GLAVAC, V. & ELLENBERG, H. 1974: Vegetation Südosteuropas. G-Fischer. Stuttgart.

HOUSSARD, C., ESCARRE, J. & ROMANE, F. 1980: Development of species diversity in some Mediterranean plant communities. Vegetatio 43: 59-72.

ISPIKOUDIS, J., KAKOUROS, P., ARIANOUTSOU, M. & PAPANASTASIS, V. 1999: Effects of pastoral activities on woody-plant community distribution and landscape diversity in western Crete. In: PAPANASTASIS, V., FRAME, J. & NASTIS, A.S. (eds.): Grasslands and Woody Plants in Europe: 287-291. Proceedings of the International Occasional Symposium of the European Grassland Federation. Thessaloniki.

ISPIKOUDIS, J., LYRINZIS, G. & KYRIAKAKIS, S. 1993: Impact of human activities on Mediterranean landscapes in western Crete. Landscape and Urban Planning 24: 259-271.

IUCN (ed) 1994: Parks for Life: Action for Protected Areas in Europe.

JANCEY, R. C. 1979: Species ordering on a variance criterion. Vegetatio 39 (1): 59-63.

JONGMAN, R.H.G., TER BRAAK, C.J.F. & VAN TONGEREN, O.F.R. (eds.) 1995: Data analysis in community and landscape ecology. Cambridge.

KAENNEL, M. 1998: Biodiversity: a diversity in definition. In: BACHMANN, P., KÖHL, M. & PÄIVINEN, R. (eds): Assessment of biodiversity for improved forest planning: 71-81. Monte Verità. Switzerland. Kluwer. Dordrecht.

KAILIDIS, D. 1981: Forest Fires (in Greek). Thessaloniki.

KARAVELLAS, D, KATSADORAKIS, G., MARAGOU, P. & SVORONOU, E. (eds.) 2003: Protected areas management. Ministry of Environment - WWF. Athens.

KARPATI, I. & KARPATI, N.V. 1961: Die zönologischen Verhältnisse der Auenwälder Albaniens. Acta bot. Acad. Scient. Hung.7: 235-301.

KASIOUMIS, K. & GATZOJANNIS, S. 1996: Management plan of Vikos-Aoos National Park (in Greek). Bd. I & II. Thessaloniki.

KASIOUMIS, K., PAPANASTASIS, V., GERAKIS, P., LEGAKIS, A., GATZOJANNIS, ST., NTOUROS, G., PROIMAKIS, Z. & TSIPIRAS, K. 1998: Protected Areas: analysis of the present situation and proposals for the improvement of the protected areas system (in Greek). Athens.

KATSADORAKIS, G. 1996: The fauna of Vikos-Aoos National Park. In: KASIOUMIS, K. & GATZOJANNIS, S.: Management plan of Vikos-Aoos National Park (in Greek). Bd. I & II. Thessaloniki.

KATSIKATSOS, G. 1992: Geology of Greece (in Greek). Athens.

KENT, M. & COKER, P. 1992: Vegetation description and analysis. Belhaven. London.

KIRBY, K. 1988: Conservation in British woodland. Adapting traditional management to modern needs. In: BIRKS, H.H.H, BIRKS, H.J.B., KALAND, P.E. & MOE, D. (eds.): The cultural landscape past, present and future: 79-89. Cambridge.

KIRBY, K. 1994: Die Bewertung von Wäldern und Gehölzbeständen. In: USHER, M. B. & ERZ, W. (eds): Erfassen und Bewerten im Naturschutz: 167-186. Quelle & Meyer. Heidelberg – Wiesbaden.

KOCH, G. & GRABHERR, G. 1998: Wie natürlich ist der Wald in Österreich? Klassifikation nach Hemerobiestufen. Ber. d. Reinh. Tüxen Ges. 10: 43-59.

KOKKINI, S., IATROU, G., GEORGIOU, K., ARTELARI, P., BAZOS, I., GEORGIADIS, TH., DROSOS, E., CHANLIDOU, E., KAROUSOU, R., KRIGAS, N., KIPRIOTAKIS, Z., & TZANOUDAKIS, D. 1996: Other important plant species of “Nature 2000” Network. In: DAFIS, S., E. PAPASTERGIADOU, K. GEORGHIOU, D. BABALONAS, T. GEORGIADIS, M. PAPAGEORGIOU, T. LAZARIDOU, & V. TSIAOUSSI (eds): Directive 92/43/EEC - The Greek Habitat Project Nature 2000: 470-488. EKBY.

KONOLD, W. 1996: Naturlandschaft – Kulturlandschaft: die Veränderung der Landschaften nach der Nutzbarmachung durch den Menschen. ecomed. Landsberg am Lech.

KORNECT, D., SCHNITTLER, M., KLINGENSTEIN, F., LUDWIG, G., TAKLA, M., BOHN, U. & RUDOLF, M. 1998: Warum verarmt unsere Flora? Auswertung der Roten Liste der Farn- und Blütenpflanzen Deutschlands. Schr.-R. f. Vegetationskunde 29: 299-444.

KOUTSIAS, N. 2001: Remote sensing and GIS in the evaluation and mapping of burned areas in Mediterranean ecosystems (in Greek). Dissertation. University of Thessaloniki.

KOWARIK, I. 1999: Natürlichkeit, Naturnähe und Hemerobie als Bewertungskriterien. In: KONOLD, W., BÖCKER, R. & HAMPICKE, U. (Hrsg.): Handbuch Naturschutz und Landschaftspflege: Kompendium zu Schutz und Entwicklung von Lebensräumen und Landschaften. ecomed. Landsberg am Lech.

KREBS, J.C. 1989: Ecological Methodology. Harper & Row. New York.

LANDE, R. 1996: Statistics and partitioning of species diversity and similarity among multiple communities. OIKOS 76: 5-13.

LAZARIDIS, K. 1980: Ecological problems of Zagori (in Greek). In: Research Centre of Zagori (ed): Proceedings of an ecological meeting in Zagori: 57-65.

LEWIN, J., MACKLIN, M.G. & WOODWARD, J.C. 1991: Late Quaternary fluvial sedimentation in the Voidomatis basin, Epirus, Northwest Greece. Quaternary Research 35: 103-115.

LOSVIK, M. H. 1999: Plant species diversity in an old, traditionally managed hay meadow compared to abandoned hay meadows in Southwest Norway. Nordic Journal of Botany 19: 473-487.

LUKAS, P.H.C. 1992: Protected landscapes. A guide for policy-makers and planners. Chapman & Hall. London.

LÜTH, M. 2002: *Cinclidotus confertus* (Musci, *Cinclidotaceae*), a new species from Greece. *Cryptogamie, Bryologie* 23 (1): 11-16.

LÜTH, M. 2003: Moose in der Umgebung des Dorfes Vikos, im Vikos-Aoos Nationalpark (NW Griechenland). http://www.bryologie.uni-bonn.de /Archive/ Vikos.pdf

LYRINTZIS, G., PAPANASTASIS, V.P. & ISPIKOUDIS, I. 1998: Role of livestock husbandry in social and landscape changes in White Mountains and Psilorities of Crete. In: PAPANASTASIS, V.P. & PETER, D. (eds.): Ecological basis of livestock grazing in Mediterranean ecosystems: 322-327. European Commission.

MAGURRAN, A.E. 1995: Ecological diversity and its measurement. Chapman & Hall, London.

MAKRIS, E. 1996: Zagorochoria (in Greek). Ioannina.

MALAMAS, M. & MARSELOS, M. 1992: The tradition of medicinal plants in Zagori, Epirus (NW Greece). Journal of Ethnopharmacology 37: 197-203.

MARAGOU, P. 2003: Protected areas in the 21st Century (in Greek). In: KARAVELLAS, D, KATSADORAKIS, G., MARAGOU, P. & SVORONOU, E. (eds.): Protected Areas Management. Ministry of Environment - WWF. Athens.

MARAGOU, P. 2004: Evaluation of the National protected areas system in Greece (in Greek). WWF. Athens.

MARGULES, C.R. 1994. Erfassen und Bewerten von Lebensräumen in der Praxis. In: USHER, M. B. & ERZ, W. (eds): Erfassen und Bewerten im Naturschutz: 258-273. Quelle & Meyer. Heidelberg – Wiesbaden.

MARGULES, C. R. & USHER, M.B. 1981: Criteria used in assessing wildlife conservation potential: a review. Biological Conservation 21: 153-168.

MARKGRAF, F. 1932: Pflanzengeographie von Albanien. Ihre Bedeutung für Vegetation und Flora der Mittelmeerländer. Bibliotheca Botanica 105: 1-130.

MAUROMATIS, G. 1980: Le bioclimat de la Grece. Relations entre le climat et la vegetation naturelle. Cartes bioclimatiques. Institut de Recherches Forestieres d'Athenes.

MCNEILL, J.R. 1992: The mountains of the Mediterranean world. An environmental history. Studies in Environmental History 8. Cambridge.

MEEUS, J. H. A. 1995: Pan-European Landscapes. Landscape and Urban Planning 31: 57-79.

MERTZ, P. 2000: Pflanzengesellschaften Mitteleuropas und der Alpen: Erkennen, Bestimmen, Bewerten. Ein Handbuch für die vegetationskundliche Praxis. ecomed. Landesberg am Lech.

MICEVSKI, K. 1957: Typologische Gliederung der Niederungswiesen- und Sumfvegetation Mazedoniens. Folia balcanica 6: 29-33.

MINISTRY OF AGRICULTURE (ed) 2003: Code of Good Farming Practice (in Greek). Available at: http:www.minagric.gr/greek/data/apofasi091000.doc

MINISTRY OF AGRICULTURE (ed) 2004a: The new Common Agricultural Policy and its application (in Greek). Athens.

MINISTRY OF AGRICULTURE (ed) 2004b: Common ministerial decision about the application of the cross-compliance and the other measures of the agri-enrionmental Council Regulation 1782/2003 (in Greek). Athens.

MITCHLEY, J. & ISPIKOUDIS, J. 1999: Grassland and shrubland in Europe: biodiversity and conservation. In: PAPANASTASIS, V., FRAME, J. & NASTIS, A.S. (eds.): Grasslands and Woody Plants in Europe: 239-251. Proceedings of the International Occasional Symposium of the European Grassland Federation Thessaloniki.

MUCINA, L. 1997: Conspectus of classes of European vegetation. Folia Geobot.Phytotax. 32: 117-172.

MUELLER-DOMBOIS, D. & ELLENBERG, H. 1974: Aims and methods of vegetation ecology. J-Wiley & Sons. New York.

NAIR, P.K.R. 1993: An introduction to Agroforestry. Kluwer.

NAVEH, Z. 1993: Red Books for threatened Mediterranean landscapes as an innovative tool for holistic landscape conservation. Introduction to the western Crete Red Book case study. Landscape and Urban Planning 24: 241-248.

NAVEH, Z. 1998: From biodiversity to ecodiversity: Holistic conservation of the biological and cultural diversity of Mediterranean landscapes. In: RUNDER, PW., MONTENEGRO, G. & JAKSIC, F.M (eds): Landscape disturbance and biodiversity in Mediterranean-type ecosystems. Ecological studies 136: 23-53.

NAVEH, Z. & LIEBERMAN A.S. 1993: Landscape ecology: Theory and application. 2nd ed. Springer. New York.

NAVEH, Z. & WHITTAKER, R. H. 1979: Measurements and relationships of plant species diversity in Mediterranean shrublands and woodlands. In: GRASSLE, J.F., PATIL, G.P, SMITH, W. & TAILLIE, C. (eds.): Ecological diversity in theory and practice: 219-239. International Co-operative Publishing House. Fairland - Maryland.

NAVEH, Z. & WHITTAKER, R. H. 1979b: Structural and floristic diversity of shrublands and woodlands in Northern Israel and other Mediterranean areas. Vegetatio 41: 171-190.

NCESD (ed.) 2002: A contribution of NCESD to COP6 on Biodiversity. Research Paper 18.

NOSS, F. R. 1983: A regional landscape approach to maintain diversity. BioScience 33 (1): 700-706.

NOSS, F. R. 1990: Indicators for monitoring biodiversity: A hierarchical approach.- Conservation Biology 4 (4): 355-364.

NOY-MEIR, I. & ORON, T. 2001: Effects of grazing on geophytes in Mediterranean vegetation. Journal of Vegetation Science 12: 749-760.

NTIA, G. & STAMATOPOULOU, CH. 1983: Zagorochoria (in Greek). AUTH.

OBERDORFER, E. 1947: Gliederung und Umgrenzung der Mittelmeervegetation auf der Balkanhalbinsel. Ber. Geobot. Inst. Rübel: 84-111.

OBERDORFER, E. 1954: Über Unkrautgesellschaften der Balkanhalbinsel. Vegetatio 4: 379-411.

OBERDORFER, E. 2001: Pflanzensoziologische Exkursionsflora für Deutschland und angrenzende Gebiete. 8. Aufl. Ulmer. Stuttgart.

OECD (ed) 2001: Environmental indicators for Agriculture: Methods and results. Paris. Organisation for Economic Co-operation and Development.

PANAGIOTOPOULOU, M. 1994: The avifauna of Voidomatis basin in Vikos-Aoos National Park (in Greek). Diplome thesis. AUTH.

PAPAGEORGIOU, K. & BROTHERTON, I. 1999: A management planning framework based on ecological, perceptual and economic carrying capacity: The case study of Vikos-Aoos National Park, Greece. Journal of Environmental Management 56: 271-284.

PAPAIOANNOU, CH. 1999: The Herpetofauna of Zagori. In: Working Group of Arctos Programm. Special Environmental Study of Pindos – Zagori area. Bd.I.

PAPAMICHOS, N. 1985: Forest Soils (in Greek). AUTH. Thessaloniki.

PAPANASTASIS, V. P. 1993: Legal status of land tenure and use and its implication for open landscapes of western Crete. Landscape and Urban Planning 24: 273-277.

PAPANASTASIS, V. P. 1996: Silvopastoral systems and range management in the Mediterranean region. In: ETIENNE, M. (ed.): Western European Silvopastoral Systems:143-156. INRA. Paris.

PAPASTERGIADOU, E., DAFIS, S., DIMOPOULOS, P., & LAZARIDOU, TH. 1997: Syntaxonomic typology of Greek habitats. Folia Geobot. Phytotax. 32: 335-341.

PERRIER, R., KOUKOUZA, K., BIZON, G. & BIZON, J. J. 1970: Geological map of Greece: "Doliana" Sheet 1:50.000. IGME.

PHILLIPS, A. 1995: Cultural Landscapes: an IUCN Perspective. In: VON DROSTE, B., PLACHTER, H. & RÖSSLER, M. (eds.): Cultural landscapes of universal value: Components of a Global Strategy: 380-392. G-Fischer. Jena.

PHILLIPS, A. 2002: Management guidelines for IUCN category V protected areas. Protected landscapes/seascapes. Best practice protected area guidelines series No 9. WCPA - IUCN.

PHITOS, D., STRID, A., SNOGERUP, S. & GREUTER, W. 1995: The Red Data Book of rare and threatened plants of Greece. WWF.

PIGNATTI, G. & PIGNATTI, S. 1999: Biodiversity in Mediterranean ecosystems. In: KRATOCHWIL (ed.). Biodiversity in ecosystems: 59-73. Tasks for vegetation science 34. Kluwer. Dortrecht.

PIGNATTI, S. 1998: Iboschi d'Italia. Sinecologia e Biodiversita. Scienze Forestali e Abmientali.

PINEDA, F.D. & MONTALVO, J. 1995: Biological diversity in traditional land use systems. In: HALLADAY, P. (ed): Conserving biodiversity outside protected areas: 107-122. IUCN.

PLACHTER, H. 1991: Naturschutz. G-Fischer. Stuttgart.

PLACHTER, H. 1995: Functional criteria for the assessement of cultural landscapes. In: VON DROSTE, B., PLACHTER, H. & RÖSSLER, M. (eds.): Cultural landscapes of universal value: components of a global strategy: 393-404.

POLDINI, L. 1988: Übersicht des Verbandes *Ostryo-Carpinion* Orientalis (*Quercetalia pubescentis*) in SO-Europa. Phytocoenologia 16 (1): 125-143.

POLUNIN, O. & WALTER, M. 1985: A guide to the vegetation of Britain and Europe. Oxford.

RACKHAM, O & MOODY, J. 1996: The making of Cretan landscape. Manchester.

RAUS, TH. 1979: Die Vegetation Ostthessaliens (Griechnland) I. Vegetationszonen und Höhenstufen. Bot. Jahrb. Syst. 100 (4): 564-601.

RAUS, TH. 1983: Wechselnasse Wiesen in Griechenland. Tuexenia 3: 259-270.

REIF, A., BAUMGARTL, TH. & BREITENBACH, I. 1989: Die Pflanzengesellschaften des Grünlandes zwischen Mauth und Finsterau (Hinterer Bayerischer Wald) und die Geschichte ihrer Entstehung. Hoppea, Denkschr. Regensb. Bot. Ges. 47: 149-256.

REIF, A., COCH, T., KNOERZER, D. & SUCHANT, R. 2001: Landschaftspflege in Wald. In: KONOLD, W., BÖCKER, R. & HAMPICKE, U. (Hrsg.): Handbuch Naturschutz und Landschaftspflege: Kompendium zu Schutz und Entwicklung von Lebensräumen und Landschaften. ecomed. Landsberg am Lech.

REIF, A. & LÖBLICH-ILLE, K. 1999: Sind die Rotbuchenwälder im Pieria-Gebirge (Nordgriechenland) höhenzonal oder extrazonal? Eine Studie zum Übergang zwischen temperaten und submediterranen Wälder in Nordgriechenland. Phytocoenologia 29 (1): 87-146.

ROCAMORA,G. 1997: Mediterranean forest, shrubland and rocky habitats. In: TUCKER, G.M. & EVANS, M.I. (eds.): Habitats for birds in Europe. A conservation strategy for the wider environment: 239-264.

ROYER, J.M. & RAMEAU J.C. 1979: Les associations des ourlets des forets du *Carpinion* (*Trifolion medii* et *Geranion sanguinei*) en Bourgogne et Champagne meridionale. Colloques phytosociologiques VIII: 84-113.

RUNDEL, P.W. 1998: Landscape disturbance in Mediterranean-type ecosystems: an overview. In: RUNDER, PW., MONTENEGRO, G. & JAKSIC, F.M (eds). Landscape disturbance and biodiversity in Mediterranean-type ecosystems. Ecological studies 136: 3-22.

RUNDER, PW., MONTENEGRO, G. & JAKSIC, F.M (eds). 1998: Landscape disturbance and biodiversity in Mediterranean-type ecosystems. Ecological studies 136. Springer. Berlin.

SAYER, U. 2000: Die Ökologie der Flaumeiche (*Quercus pubescens* Willd.) und ihrer Hybrider auf Kalkstandorten an ihrer nördlichen Arealgrenze. Untersuchungen zu Boden, Klima und Vegetation. Disserationes Botanicae Bd. 340.

SCHULTZ, AM., PAPANASTASIS, V., KATELMAN, T., TSIOUVARAS, C., KANDRELIS, S., & NASTIS, A. 1987: Agroforestry in Greece. Aristotle University. Thessaloniki.

SCHULTZE, ED, BECK, E. & MÜLLER-HOHENSTEIN, K. 2002: Pflanzenökologie. Spektrum.

SEIBERT, P. 1980: Ökologische Bewertung von homogenen Landschaftsteilen, Ökosystemen und Pflanzengesellschaften. Ber. ANL 4: 10-23.

SOKAL, R.R. & ROHLF, F.J. 1995: Biometry: the principles and practice of Statistics in biological research. 3rd ed. Freeman & Company. N.Y.

SOULIS, N. 1994: The climate of Epirus. Ioannina.

SPELLERBERG, F.I. 1992: Evaluation and assessment for conservation. Chapman & Hall. London.

SPELLERBERG, F.I. 1996: Conservation Biology. Longman. Edinburgh.

STOHLGREN, T., COUGHENOUR, M. B., CHONG, G.W., BINKLEY, D., KALKHAN, M.A., SCHELL, L.D., BUCKLEY, D.J. & BERRY, J.K. 1997: Landscape analysis of plant diversity. Landscape Ecology 12: 155-170.

STRID, A. (ed) 1986: Mountain Flora of Greece Vol. 1. Cambridge.

STRID, A. & TAN, K. (eds) 1991: Mountain Flora of Greece. Vol. 2. Edinburgh.

STRID, A. & TAN, K. (eds) 1997: Flora Hellenica Vol.1. Koeltz. Königstein.

STRID, A. & TAN, K.. 2000: Flora and Phytogeography of NW Greece (Epirus and W. Macedonia). University of Copenhagen.

TER BRAAK, C.J.F. 1988: A theory of gradient analysis. Advances in ecological research 18: 271-317.

TER BRAAK, C.J.F. & ŠMILAUER, P. 1998: CANOCO Reference manual and user’s guide to Canoco for windows: Software for Canonical Community Ordination (Vers.4). Microcomputer Power. Ithaca - NY.

TERKENLI, TH.S. 2001: Towards a theory of the landscape: the Aegean landscape as a cultural image. Landscape and Urban Planning 57: 197-208.

TERKENLI, TH.S. 2005: New landscape spatialities: the changing scales of function and symbolism. Landscape and Urban Planning 70 (1-2): 165-176.

THEODOROPOULOS, K.G. 1991: Bestimmung und Klassifizierung der pflanzensoziologischen Vegetationseinheiten im Universitatswald Taxiarchis Chalkidiki. Scientific Annals LB/18. AUTH.

THEODOROPOULOS, K.G. 1996: The vegetation of a small downy oak (*Quercus pubescens* Willd.) forest in the Thessalian Plain (C.Greece) (in Greek). In: Proceedings of the 6th Botanical Scientific Conference: 89-98.

THEODOROPOULOS, K., ATHANASIADIS, N., ELEFTERIADOU, E., GERASIMIDIS, A., TSIRIPIDIS, J., & KORAKIS, G. 1998: Vegetation units along the path of Prodromos Skete of St. Anna in the Holly Mountain. In: Proceedings of 7th Panhellenic Scientific Conference: 80-95.

TSIAKIRIS, R. 1999: The bird fauna of Zagori area. In: Working Group of Arctos Programm: Special environmental study of Pindos – Zagori area. Bd.I: 157-201.

TUCKER, G.M. & DIXON, J. 1997: Agricultural and grassland habitats. In: TUCKER, G.M. & EVANS, M.I. (eds.): Habitats for Birds in Europe: A Conservation strategy for the wider Environment. BirdLife Conservation Series 6: 267-325.

TUCKER, G.M. & EVANS, M.I. (eds.) 1997: Habitats for birds in Europe. A conservation strategy for the wider environment. BirdLife Conservation 6.

TUTIN, T. G., HEYWOOD, V. H., BURGES, N. A., VALENTINE, D. H., WALTERS, S. M., & WEBB, D. A. (eds). 1964-1980: Flora Europaea. Vol.1-5. Cambridge University.

UNCED (ed.) 1992: United Nations Conference of Environment and Development. Convention on Biological Diversity. United Nations Environment Programme.

USHER, M. B. 1994: Erfassen und Bewerten von Lebensräumen: Merkmale, Kriterien, Werte. In: USHER, M. B. & ERZ, W. (Hrsg.): Erfassen und Bewerten im Naturschutz: 17-47. Quelle & Meyer. Heidelberg – Wiesbaden.

VAN DER MAAREL, E. 1979: Transformation of cover-abundance values in Phytosociology and its effects on community similarity. Veg. 39 (2): 97-114.

VAN DER PLOEG, S.W.F. 1994: Erfassen und Bewerten von Lebensräumen in den Nederlanden: Ein kontroverses Thema in einem kleinen Land. In: USHER, M. B. & ERZ, W. (Hrsg.). Erfassen und Bewerten im Naturschutz: 102-116. Quelle & Meyer. Heidelberg – Wiesbaden.

VAN DIJK, G. 1991: The status of semi-natural grasslands in Europe. In: GORIUP, P.D., L.A. BATTEN & J.A. NORTON (eds): Conservation of lowland dry grassland birds in Europe. Proceedings of an international seminar held at the University of Reading 20-22 March 1991. Joint Nature Conservation Committee. Peterborough.

VOKOU, D., KATRADI, K. & KOKKINI, S. 1993: Ethnobotanical survey of Zagori (Epirus, Greece), a renowned centre of folk medicine in the past. Journal of Ethnopharmacology 39: 187-196.

VOLIOTIS, D. 1985: Über die Verbreitung, Ökologie und Synökologie von *Ostrya Carpinifolia* in Griechenland. Acta Botanica Hungarica 31 (1-4): 339-347.

VON DROSTE, B., PLACHTER, H. & RÖSSLER, M. (eds.) 1995: Cultural landscapes of universal value: components of a global strategy. G-Fischer. Jena.

VOS, W. & STORTELDER, A. 1992: Vanishing Tuscan landscapes: landscape ecology of a submediterranean montane area (Solano Basin, Tuscany, Italy). Pudoc. Wageningen.

WAGNER, H. H., WILDI, O. & EWALD, C. K. 2000: Additive partitioning of plant species diversity in an agricultural mosaic landscape. Landscape Ecology 15: 219-227.

WEBER, H.E., MORAVEC, J. & THEURILLAT, J.P. 2000: International Code of Phytosociological Nomenclature (ICPN). 3rd edition. J. Veg. Sci. 11: 739-768.

WHITTAKER, R. H. 1977: Evolution of species diversity in land communities. Evolutionary Biology 10: 1-67.

WHITTAKER, R. H. 1977b: Animal effects on plant species diversity. In : Tüxen, R. (ed.): Vegetation und Fauna: 409-425. Ber. Symp. Int. Ver. Vegetskunde, Rinteln 1976. Cramer. Vaduz.

WILDI, O. 1989: A new numerical solution to traditional phytosociological tabular Classification. Vegetatio 81: 95-106.

WILDI, O. & ORLOCI, L. 1996: Numerical exploration of community patterns: a guide to the use of MULVA 5. SPB. New York.

WILLIS, K. J. 1992: The late quaternary vegetational history of Northwest Greece. III. A comparative study of two contrasting sites. New Phytol. 121: 139-155.

WILLMANS, O. 1998: Ökologische Pflanzensoziologie. Eine Einführung in die Vegetation Mitteleuropas. Quelle und Meyer. Wiesbaden.

WITSCHEL, M. 1980: Xerothermvegetation und dealpine Vegetationskomplexe in Südbaden. Vegetationskundliche Untersuchungen und die Entwicklung eines

Wertungsmodells für den Naturschutz. Beih. Veröff. Naturschutz Lanschaftspflege Bad.-Württ. 17: 1-212.

WORKING GROUP OF ARCTOS PROGRAMM 1999: Special environmental study of Pindos, Zagori area. Bd I.

WORLD CONSERVATION MONITORING CENTRE (WCMC) (ed.) 1993: Conservation status listing of plants in Greece. Cambridge.

YPEXODE (ed.) 2002: National strategy for sustainable development. Greece. Ministry for the Environment, Physical Planning and Public Works. Athens.

YPEXODE (ed.) 2005: Press statement of the Ministry of Environment, Physical Planning and Public Works on the appointment of new presidents in the management boards of the protected areas. Athens.

ZAFEIRATOS, K. (ed.) 1995: On the fauna and flora of Zagori. LIFE project. Report.

ZIOGANAS, C., ANEPHALOS, E. & PAPANASTASIS, V.P. 1998: Livestock farming systems and economics in the Psilorites mountain of Crete, Greece. In: PAPANASTASIS, V.P. & PETER, D. (eds.): Ecological basis of livestock grazing in Mediterranean ecosystems: 328-331. European Commission.

ZOLLER, H., GEISSLER, P. & ATHANASIADIS, N. 1977: Beiträge zur Kenntnis der Wälder, Moos- und Flechtenassoziationen in den Gebirgen Nordgriechenlands. Bauhinia 6 (1): 215-255.

ANNEX I

Table 1: Soil characteristics of the plant communities

Soil sample no	Plant community	Altitude (m)	Geology	Soil depth	Soil colour	Soil texture	Sand content	pH
5	Di_vis2	950	Flysch	deep	light brown	CL-SiCL	slighly heavy	6,8
6	Mar_pe4	800		deep	light brown	CL-SiCL	slighly heavy	6,8
8	Qpub12	710		deep	light brown	SCL	medium	6,7
9	Qpub12	620		deep	light brown	CL	medium	6,6
12	Pte_aq19	630		deep	light brown	SCL	medium	6,7
13	Qpub12	720		deep	light brown	SL	medium	6,8
15	Tr_ni3	630		deep	light brown	SL	medium	6,8
1	Phl_fr8	670	Limestone	deep	red-brown	SCL-SC	medium	6,8
2	Car_or21	700		deep	dark brown	L	medium	7
3	Ac_Ost24	700		deep	dark brown	S-CL	medium	7
4	Qp_Car22	520		deep	dark brown	CL-SiL	medium	7,1
7	Ju_ox10	730		deep	red-brown	CL	medium	6,4
10	Jas_fr7	630		shallow	red-brown	C	slighly heavy	6,9
11	Q_coc11	690		shallow	dark brown	CL-SCL	medium	6,6
14	Q_coc11	640		shallow	brown	CL-SC	slighly heavy	6,6
16	Poa_bu5	710		deep	light brown	SL	light	7,2
17	Poa_bu5	710		deep	light brown	SL	medium	6,8
18	Poa_bul5	750		deep	light brown	SL	light	7,2
19	Ju_ox10	660		deep	light brown	L	medium	7,1
20	Qp_Car22	615		deep	red-brown	SCL	medium	6,8
21	Qp_Car23	600		deep	red-brown	SCL	medium	6,8
22	Ac_Ost24	600		deep	dark brown	SCL-C	medium	7
23	Sal_of9	590		deep	red-brown	CL	medium	7,3
24	Phl_fr8	650		shallow	dark brown	SCL	medium	7
25	Qp_Car22	650		deep	brown	C	heavy	7
26	Mar_pe4	740		deep	red-brown	SCL	medium	7,1
27	J_Aobt23	650		deep	dark brown	SCL	medium	7,4

Table 2: Characteristics of the annual livestock maintenance (*Alexandridis 1999*)		
Characteristic/ Phase	sheep	goats
Lactation period (in days)	200	180
Milk production (litres per animal during the lactation period)	91	117
Start of mating period	May/June	July/August
Duration of mating period	15-30 days	20-30 days
Lambing/ Kidding period	Oct. till Feb.	Dec.-Jan.
Duration of lambing/ kidding	30 days	17 days

Table 3: Histogram of nearest neighbor values			
Class no.	from	to	Frequency
1	0.06	0.139	1
2	0.139	0.218	1
3	0.218	0.297	11
4	0.297	0.376	22
5	0.376	0.455	54
6	0.455	0.534	95
7	0.534	0.613	107
8	0.613	0.693	85
9	0.693	0.772	25
10	0.772	0.851	9

Table 4 : Chasmophytic rock vegetation (Plot 206)	
Plant species	Cover (%)
Aubrietia scardica	4
Campanula versicolor	2
Asperula chlorantha	0,1
Frangula rupestris S	0,01
Quercus ilex S	0,01
Umbilicus erectus	0,1
Poa bulbosa	0,1
Cynosurus echinatus	0,1
Hordeum murinum	0,1

Table 5: Ecological characteristic and florist composition of *Quercus ilex* forest (Plot 381)			
Plot size (m2)	100	Herb cover (%)	10
Altitude (m)	460	Soil cover (%)	5
Aspect	W	Moss cover (%)	0
Inclination (%)	100	Rock cover (%)	85
Geology	Limestone	Richness	59
Tree cover (%)	40	Shannon	2.4
Shrub cover (%)	30	Evenness	59
Characteristic species of the *Quercus ilex* forest	Br-Bl sc.	Companion species (continuing)	Br-Bl sc.
Quercus ilex T	2b	*Micromeria cremnophila*	1
Quercus ilex S	2b	*Stipa bromoides*	1
Quercus ilex	1	*Alyssum alyssoides*	+
Phillyrea latifolia T	2a	*Calamintha nepeta*	+
Phillyrea latifolia S	1	*Carex halleriana*	+
Phillyrea latifolia	1	*Centaurea pawlowskii*	+
Character species of the *Quercetalia ilicis*		*Doronicum columnae*	+
Pistacia terebinthus T	r	*Ephedra campylopoda*	+
Pistacia terebinthus	r	*Euphorbia characias spp. wuffenii*	+
Ruscus aculeatus	+	*Leontodon hispidus ssp. hispidus*	+
Asparagus acutifolius	+	*Phlomis fruticosa*	+
Geranium robertianum ssp. purpureum	r	*Picris pauciflora*	+
Character species of the *Quercetalia pubescentis*		*Ramonda serbica*	+
Fraxinus ornus T	1	*Sedum dasyphyllum*	+
Fraxinus ornus	r	*Silene fabarioides*	+
Carpinus orientalis S	1	*Acanthus balcanicus*	r
Carpinus orientalis	r	*Aethionema saxatile ssp. oreophilum*	r
Acer monspessulanum S	r	*Arabis muralis*	r
Acer monspessulanum	r	*Bidens frondosa*	r
Coronilla emerus ssp. emeroides	+	*Carduus thoermeri*	r
Tamus communis	r	*Cirsium creticum*	r
Arabis turrita	1	*Crepis fraasii*	r
Brachypodium sylvaticum ssp. sylvaticum	r	*Echinops spinosissimus ssp. neumayeri*	r
Companion species		*Geum urbanum*	r
Platanus orientalis T	1	*Inula conyza*	r
Hedera helix S	1	*Polypodium vulgare*	r
Hedera helix	1	*Potentilla micrantha*	r
Asperula chlorantha	1	*Rhamnus saxatilis*	r
Asplenium trichomanes ssp. inexpectans	1	*Stachys menthifolia*	r
Ceterach officinarum	1	*Tilia platyphyllos*	r
Helictotrichon convolutum	1	*Vincetoxicum fuscatum*	R

Table 6: Codes and names of the plant communities		
Code	Plant community name	Short name refered in text
Bel_pe1	*Trifolium nigrescens* community, *Bellis perennis* form	*Bellis perennis* grassland
Di_vis2	*Trifolium nigrescens* community, *Dianthus viscidus* form	*Dianthus viscidus* grassland
Tri_ni3	*Trifolium nigrescens* community, typical form	*Trifolium nigrescens* meadows
Mar_pe4	*Marrubium peregrinum* community	*Marrubium peregrinum* community
Poa_bu5	*Alyssum alyssoides - Poa bulbosa* community	*Poa bulbosa* rocky grassland
Hel_nu6	*Helianthemum nummularium - Trifolium dalmaticum* community, typical form	*Trifolium dalmaticum* rocky grassland
Jas_fr7	*Helianthemum nummularium - Trifolium dalmaticum, Jasminum fruticans* form	*Jasminum fruticans* rocky grassland
Phl_fr8	*Phlomis fruticosa* community	*Phlomis fruticosa* phrygana
Sal_of9	*Salvia officinalis – Carpinus orientalis* community	*Salvia officinalis* garigue
Ju_ox10	*Quercus coccifera - Juniperus oxycedrus* community	*Juniperus oxycedrus* garigue
Q_coc11	Carpinus orientalis – Quercus coccifera community	*Quercus coccifera* woodland
Qpub12	Quercus pubescens community, Q.coccifera typical form	*Quercus pubescens* forest
Ju_Qpu13	Quercus pubescens community, Juniperus oxycedrus form	*Quercus pubescens* pasture
Co_Qpu14	*Quercus pubescens* community, *Cornus mas* form	*Quercus pubescens - Cornus mas* forest
Pla_or15	*Platanus orientalis* community	*Platanus orientalis* forest
Par_of16	*Parietaria officinalis* community	*Parietaria officinalis* community
Asp_ch17	*Asperula chlorantha - Centaurea pawlowskii* community	*Asperula chlorantha* community
Ru_Qpu18	*Rubus ulmifolius ssp. sanctus – Quercus pubescens* community	*Quercus pubescens* treehedges
Pte_aq19	*Brachypodium sylvaticum* community, *Pteridium aquilinum* form	*Pteridium aquilinum* forest fringe
Br_syl20	*Brachypodium sylvaticum* community, typical form	*Brachypodium sylvaticum* forest fring
Car_or21	*Carpinus orientalis* community	*Carpinus orientalis* woodland
Qp_Car22	*Quercus pubescens - Carpinus orientalis* community	*Quercus pubescens - Carpinus orientalis* forest
J_Aobt23	*Juglans regia – Acer obtusatum* community	*Juglans regia – Acer obtusatum* forest
Ac_Ost24	*Acer obtusatum – Ostrya carpinifolia* community	*Acer obtusatum – Ostrya carpinifolia* forest

Table 7: Pairwise comparisons of the diversity indices among the nine plant communities with the same inventoried area

Variable S10

Plant com.	2	3	8	10	11	12	21	22
3	**0,01**							
8	1,00	**0,00**						
10	1,00	0,12	1,00					
11	**0,00**	0,89	**0,00**	**0,02**				
12	0,05	1,00	**0,01**	0,19	0,96			
21	**0,00**	0,74	**0,00**	**0,02**	1,00	0,93		
22	**0,00**	1,00	**0,00**	0,06	1,00	1,00	1,00	
24	**0,00**	0,22	**0,00**	**0,02**	1,00	0,72	1,00	0,94

Variable S100

Plant com.	2	3	8	10	11	12	21	22
3	**0,01**							
8	1,00	**0,01**						
10	0,40	**0,00**	1,00					
11	0,67	1,00	0,25	**0,01**				
12	1,00	0,19	1,00	0,67	0,94			
21	**0,01**	1,00	**0,01**	**0,00**	1,00	0,15		
22	**0,02**	1,00	**0,01**	**0,00**	1,00	0,23	1,00	
24	**0,00**	0,88	**0,00**	**0,00**	0,72	**0,03**	1,00	0,99

H10

Plant com.	2	3	8	10	11	12	21	22
3	**0,00**							
8	1,00	**0,03**						
10	0,50	1,00	0,96					
11	**0,00**	**0,00**	**0,00**	**0,01**				
12	**0,00**	0,13	**0,00**	0,09	1,00			
21	**0,00**	**0,00**	**0,00**	**0,00**	0,96	0,39		
22	**0,00**	**0,10**	**0,00**	0,05	1,00	1,00	0,96	
24	**0,00**	**0,00**	**0,00**	**0,00**	0,81	0,23	1,00	0,85

H100

Plant com.	2	3	8	10	11	12	21	22
3	**0,00**							
8	1,00	**0,00**						
10	1,00	**0,01**	1,00					
11	**0,00**	1,00	**0,00**	**0,01**				
12	0,24	1,00	0,19	0,38	1,00			
21	**0,00**	**0,01**	**0,00**	**0,00**	**0,00**	**0,01**		
22	**0,00**	0,65	**0,00**	**0,00**	0,64	0,50	0,72	
24	**0,00**	**0,01**	**0,00**	**0,00**	**0,01**	0,05	1,00	1,00

E10

Plant com.	2	3	8	10	11	12	21	22
3	**0,02**							
8	0,64	0,81						
10	0,08	1,00	0,75					
11	**0,00**	**0,00**	**0,00**	0,09				
12	**0,00**	**0,01**	**0,00**	0,28	1,00			
21	**0,00**	**0,00**	**0,00**	**0,00**	0,65	0,42		
22	**0,00**	0,08	**0,01**	0,37	1,00	1,00	0,99	
24	**0,00**	**0,00**	**0,00**	**0,00**	0,69	0,46	1,00	0,97

E100

Plant com.	2	3	8	10	11	12	21	22
3	**0,02**							
8	1,00	**0,04**						
10	1,00	0,95	1,00					
11	**0,00**	1,00	**0,00**	0,32				
12	**0,02**	1,00	**0,04**	0,59	1,00			
21	**0,00**	**0,00**	**0,00**	**0,00**	**0,00**	**0,01**		
22	**0,00**	0,12	**0,00**	**0,01**	0,41	0,93	0,23	
24	**0,00**	**0,02**	**0,00**	**0,00**	0,07	0,42	0,82	1,00

G10

Plant com.	2	3	8	10	11	12	21	22
3	**0,02**							
8	0,84	0,20						
10	0,39	1,00	0,99					
11	**0,00**	0,73	**0,01**	0,23				
12	**0,00**	0,99	**0,01**	0,56	1,00			
21	**0,00**	**0,02**	**0,00**	**0,01**	0,79	0,25		
22	**0,02**	0,90	**0,04**	0,45	1,00	1,00	0,96	
24	**0,00**	0,08	**0,01**	**0,03**	0,82	0,41	1,00	0,94

G100

Plant com.	2	3	8	10	11	12	21	22
3	**0,03**							
8	1,00	0,06						
10	1,00	0,31	1,00					
11	**0,00**	1,00	**0,00**	0,20				
12	0,11	1,00	0,24	0,91	1,00			
21	**0,00**	0,11	**0,01**	**0,00**	0,06	**0,03**		
22	**0,04**	1,00	0,06	0,12	0,98	0,87	0,70	
24	**0,01**	0,39	**0,01**	**0,01**	0,17	0,09	1,00	1,00

Each value of the matrix expresses the level of significance of the comparison between two groups for the specific variable.
Values <0,05 indicate significant difference among the two groups for the specific variable

Table 8a: Rare plant species of the study area

Plant species	Criterion					
	Greek endemic	Threatened taxa				Wide endemic
		PD 67/81	CITES	WCMC	European Red List	
Abies borisii-regis						+
Achillea holosericea						+
Aesculus hippocastanum		+				+
Aethionema saxatile ssp. oreophilum						+
Anacamptis pyramidalis		+	+			
Anthemis chia						+
Aubrietia scardica						+
Aurinia saxatilis ssp. orientalis						+
*Barbarea sicula**		+		+		
Biarum tenuifolium	+					
Bromus cappadocicus ssp. lacmonicus						+
Campanula spatulata ssp. spruneriana	+					
Centaurea affinis spp. pallidior	+					
Centaurea epirota						+
Centaurea pawlowskii		+		+		
Cephalanthera rubra		+				
Corylus colurna		+				+
Crepis viscidula ssp.geracioides						+
Crocus cartwrightianus	+					
Dactylorhiza saccifera		+				+
Dianthus viscidus						+
Digitalis laevigata ssp. graeca		+				+
Epipactis helleborine		+	+			
Epipactis microphylla		+	+			
Erysimum cephalonicum						+
Euphorbia deflexa	+					
Fritillaria thessala ssp. ionica	+					
Galanthus nivalis			+			
Galium laconicum						+
Galium monasterium	+					
Galium parisiense						+
Helleborus cyclophyllus						+
Hieracium cymosum ssp. heldreichianum						+
Himantoglossum caprinum		+				
Hypericum rumeliacum ssp. apollinis						+
Lilium candidum		+				+

Lilium chalcedonicum		+				+
<u>Limodorum abortivum</u>		+	+			
Malcolmia graeca ssp. bicolor						+
Nepeta spruneri						+
Onobrychis montana ssp. scardica						+
Onopordum bracteatum						+
Ophrys mammosa		+				
Ophrys scolopax ssp. cornuta		+				+
Orchis morio		+	+			
Orchis quantripunctata		+	+			
Orchis tridentata		+	+			
Orchis ustulata		+				+
Orlaya daucorlaya						+
Petrorhagia illyrica ssp. illyrica						+
Prunus prostata	+	+				
Pterocephalus perennis ssp. bellidifolius						+
Ramonda serbica		+		+	+	
Rosa arvensis				+		
Saxifraga chrysospleniifolia						+
Scabiosa tenuis				+		
Scutellaria rupestris ssp. adenotricha						+
Sedum atratum						+
Serapias vomeracea		+	+			
Silene cephallenia	+	+				
Silene fabarioides						+
Silene niederi	+	+				
Silene ungeri	+					
Teucrium flavum ssp. hellenicum						+
Thymus longicaulis ssp. chaubardii						+
Trifolium aurantiacum	+					
<u>Trifolium pignantii</u>						+
Trinia glauca ssp. pindica						+
Valantia aprica						+
Verbascum speciosum ssp. megaphlomos	+					
Veronica chamaedrys ssp. chamaedryoides	+					
Total of each category	14	25	9	5	1	40
		28				
Total rare plant taxa	72					
Inventoried rare plant taxa	13	25				38
Total of inventoried rare taxa	65					

* The underlined species in are met at the study area, but not in a plot.

Table 8: Rare species distribution and fidelity in the rarity groups

		Species distribution			Species fidelity			Communities of the high rarity group					Communities of the medium rarity group											Communities of the low rarity group								Total occurances (in plots)	Species type	Constancy (%)[c]
Rare taxon type	species name	HRG	MRG	LRG	HRG	MRG	LRG	12[a]	10	8	7	2	24	21	22	13	11	9	6	17	5	1	20	15	23	14	18	4	3	19	16			
Greek endemics	Biarum tenuifolium	0,6	0,5	0,0	38	63	0	1[b]	0	2	0	0	0	0	0	0	0	1	1	0	2	1	0	0	0	0	0	0	0	0	0	7	o	2
	Campanula spatulata ssp. spruneriana	14,0	7,7	2,3	40	49	10	33	11	11	0	15	10	11	14	8	14	8	0	1	1	12	6	1	1	7	4	0	2	2	1	173	ff	42
	Centaurea affinis spp pallidior	2,4	0,9	0,4	48	40	12	1	3	4	1	3	0	0	0	0	0	5	0	0	2	1	2	0	0	1	1	1	0	0	0	25	o	6
	Euphorbia deflexa	9,2	3,7	0,8	49	44	6	2	13	20	8	3	9	8	6	2	2	9	0	1	0	2	2	1	2	1	1	0	0	0	1	93	o	23
	Fritillaria thessala ssp. ionica	0,2	0,0	0,0	100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Galium monasterium	7,2	4,0	1,0	41	50	9	20	8	0	4	4	3	2	7	6	18	1	4	1	0	1	1	1	0	4	2	0	0	1	0	88	ff	22
	Prunus prostrata	0,4	0,0	0,0	100	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Silene cephallenia	0,2	0,4	0,0	20	80	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Silene niederi	0,2	0,0	0,0	100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Silene ungeri	7,2	1,5	0,4	65	29	5	3	4	13	8	8	0	0	0	1	0	4	3	0	5	1	2	0	0	0	0	1	2	0	0	55	o	13
	Trifolium aurantiacum	3,6	1,0	0,1	60	37	3	1	6	6	2	3	2	1	1	1	1	2	0	0	0	1	2	0	0	0	0	0	1	0	0	30	o	7
	Verbascum speciosum ssp. megaphlomos	1,4	0,5	1,3	32	23	45	2	0	5	0	0	0	0	0	0	0	0	1	0	4	0	0	0	0	0	2	3	5	0	0	22	o	5
	Veronica chamaedrys ssp. chamaedryoides	9,2	7,7	2,3	31	57	12	29	8	6	1	2	11	11	22	8	20	4	1	0	0	3	5	0	1	9	4	0	0	3	1	149	ff	37
	Sum	**56**	**28**	**8**																														
Wide endemics	Abies borisii-regis	0,0	0,1	0,1	0	50	50	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	f	0
	Achillea holosericea	0,8	0,1	0,0	80	20	0	0	4	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Aesculus hippocastanum	0,0	0,4	0,0	0	100	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	f	1
	Aethionema saxatile ssp. oreophilum	5,6	1,2	0,1	67	31	2	0	9	10	9	0	0	0	0	1	0	8	0	4	0	0	0	0	0	1	0	0	0	0	0	42	o	10
	Anthemis chia	0,0	0,2	0,0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	o	0
	Aubrietia scardica	0,2	0,1	0,0	50	50	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Aurinia saxatilis ssp. orientalis	2,0	0,7	0,3	50	40	10	0	0	9	1	0	0	0	0	0	1	0	0	4	3	0	0	1	0	0	1	0	0	0	0	20	o	5
	Bromus cappadocicus ssp. lacmonicus	0,0	0,1	0,0	0	100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	o	0
	Centaurea epirota	0,2	0,1	0,1	33	33	33	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	o	1
	Corylus colurna	0,0	0,7	0,1	0	89	11	0	0	0	0	0	6	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9	f	2
	Dactylorhiza saccifera	0,0	0,1	0,0	0	100	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	f	0
	Dianthus viscidus	2,8	0,7	0,0	64	36	0	2	1	0	0	11	0	0	0	2	1	0	0	0	0	3	2	0	0	0	0	0	0	0	0	22	o	5
	Digitalis laevigata ssp. graeca	1,4	2,1	1,4	17	56	27	6	0	0	0	1	8	1	9	4	0	0	0	0	0	0	1	1	2	6	0	0	0	1	1	41	f	10
	Erysimum cephalonicum	4,4	0,4	0,3	79	14	7	1	12	5	4	0	0	0	0	1	0	2	0	0	0	0	1	0	0	0	1	0	0	0	1	28	o	7
	Galium laconicum	2,2	3,0	1,9	19	56	25	11	0	0	0	0	11	2	15	0	0	0	0	0	0	1	4	1	3	8	1	0	0	1	1	59	f	14
	Galium parisiense	8,6	2,8	0,9	53	38	9	2	4	22	11	4	0	0	0	3	6	7	9	0	4	1	1	1	0	0	3	0	2	0	1	81	o	20
	Helleborus cyclophyllus	6,6	7,3	1,3	27	65	8	15	8	6	1	3	13	11	21	5	17	7	0	0	0	0	6	0	3	4	0	0	0	0	3	123	f	30
	Hieracium cymosum ssp. heldreichianum	0,2	0,0	0,0	100	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Hypericum rumeliacum ssp. apollinis	1,0	0,4	0,0	56	44	0	0	0	2	3	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	9	o	2
	Lilium canditum	1,4	0,3	0,0	70	30	0	0	0	1	6	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	10	o	2
	Lilium chalcedonicum	0,0	0,5	0,0	0	100	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Malcolmia graeca ssp. bicolor	0,0	0,5	0,1	0	83	17	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	6	ff	1
	Nepeta spruneri	0,2	0,0	0,0	100	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Onobrychis montana ssp. scardica	0,4	0,6	0,0	22	78	0	0	0	0	2	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	9	o	2
	Onopordum bracteatum	1,4	0,3	0,6	47	20	33	1	0	5	0	1	0	0	0	0	0	1	0	0	2	0	0	0	0	0	1	2	2	0	0	15	o	4
	Ophrys scolopax ssp. cornuta	1,0	0,5	0,0	50	50	0	0	0	0	2	3	0	0	0	0	1	0	2	0	1	1	0	0	0	0	0	0	0	0	0	10	o	2
	Orchis ustulata	0,4	0,0	0,0	100	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Orlaya daucorlaya	13,0	4,6	1,4	51	40	9	6	10	20	18	11	1	2	4	4	5	8	13	0	7	3	4	0	0	0	2	5	3	1	0	127	o	31
	Petrorhagia illyrica ssp. illyrica	0,0	0,1	0,0	0	100	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Pterocephalus perennis ssp. bellidifolius	1,2	0,4	0,0	60	40	0	0	3	0	2	1	0	0	0	0	0	0	0	3	1	0	0	0	0	0	0	0	0	0	0	10	o	2
	Saxifraga chrysospleniifolia	0,2	0,9	0,0	9	91	0	1	0	0	0	0	6	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	f	3
	Scutellaria rupestris ssp. adenotricha	0,0	0,1	0,0	0	100	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Sedum atratum	1,0	0,2	0,4	50	20	30	0	0	2	1	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	3	0	0	10	o	2
	Silene fabarioides	0,0	0,3	0,3	0	60	40	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	1	0	0	0	5	o	1
	Teucrium flavum ssp. hellenicum	0,6	0,4	0,0	43	57	0	0	0	1	2	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	7	o	2
	Thymus longicaulis ssp. chaubardii	8,2	4,3	0,3	46	52	2	13	5	7	4	12	0	2	2	7	18	4	11	0	0	1	2	0	0	0	0	0	0	2	0	90	o	22
	Trinia glauca ssp. pindica	2,4	1,1	0,0	50	50	0	0	3	3	5	1	0	0	0	0	0	3	8	0	1	0	0	0	0	0	0	0	0	0	0	24	o	6
	Valantia aprica	0,4	0,0	0,0	100	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Sum	**68**	**35**	**9**																														
Threatened taxa	Aesculus hippocastanum	0,0	0,4	0,0	0	100	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	f	1
	Anacamptis pyramidalis	1,2	1,5	0,0	26	74	0	2	0	1	3	0	0	2	3	0	0	1	7	0	3	0	1	0	0	0	0	0	0	0	0	23	o	6
	Centaurea pawlowskii	0,8	0,5	0,0	40	60	0	0	0	2	2	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	10	o	2
	Corylus colurna	0,0	0,7	0,1	0	89	11	0	0	0	0	0	6	0	2	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	9	f	2
	Dactylorhiza saccifera	0,0	0,1	0,0	0	100	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	f	0
	Digitalis laevigata ssp. graeca	1,4	2,1	1,4	17	56	27	6	0	0	0	1	8	1	9	4	0	0	0	0	0	0	1	1	2	6	0	0	0	1	1	41	f	10
	Epipactis helleborine	0,6	1,9	0,5	11	75	14	3	0	0	0	0	9	4	4	1	2	1	0	0	0	0	0	0	2	1	0	0	0	1	0	28	f	7
	Epipactis microphylla	0,4	0,5	0,0	25	75	0	2	0	0	0	0	0	2	3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	f	2
	Galanthus nivalis	0,2	0,3	0,0	25	75	0	1	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	f	1
	Himantoglossum caprinum	2,2	0,7	0,1	55	40	5	1	0	6	0	4	0	0	1	0	1	1	3	0	0	1	1	0	0	0	1	0	0	0	0	20	o	5
	Lilium canditum	1,4	0,3	0,0	70	30	0	0	0	1	6	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	10	o	2
	Lilium chalcedonicum	0,0	0,5	0,0	0	100	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Ophrys mammosa	0,0	0,2	0,0	0	100	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Ophrys scolopax ssp. cornuta	1,0	0,5	0,0	50	50	0	0	0	0	2	3	0	0	0	0	1	0	2	0	1	1	0	0	0	0	0	0	0	0	0	10	o	2
	Orchis morio	1,2	0,4	0,0	60	40	0	1	0	0	2	3	0	1	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	10	o	2
	Orchis quantripunctata	1,6	0,5	0,0	62	38	0	1	3	0	4	0	0	0	0	0	1	0	2	0	0	2	0	0	0	0	0	0	0	0	0	13	o	3
	Orchis tridentata	0,8	0,1	0,0	80	20	0	0	0	1	2	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Orchis ustulata	0,4	0,0	0,0	100	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Prunus prostrata	0,4	0,0	0,0	100	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	o	0
	Ramonda serbica	0,8	0,5	0,0	40	60	0	0	3	1	0	0	0	0	0	0	2	0	0	4	0	0	0	0	0	0	0	0	0	0	0	10	o	2
	Rosa arvensis	0,4	0,2	0,0	50	50	0	2	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	ff	1
	Scabiosa tenuis	8,2	2,9	0,5	53	42	5	1	8	17	11	4	1	0	0	1	2	3	11	1	13	0	0	0	0	0	0	1	3	0	0	77	o	19
	Serapias vomeracea	0,6	0,1	0,0	75	25	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	4	o	1
	Silene cephallenia	0,2	0,4	0,0	20	80	0	0	0	1	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	5	o	1
	Silene niederi	0,2	0,0	0,0	100	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	o	0
	Sum	**24**	**15**	**3**																														

HRG: High rarity group; MRG: Medium rarity group; LRG: Low rarity group

a: refers to the number of the community in the Vegetation Table; b: the number of the community plots containing the respective taxon; c: refered to the total inventoried plots

f: forest species, ff: forest fringe species, o: open vegetation species

Table 9: Principal Component Analysis of the four nature conservation indices. Total Variance Explained						
	Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2,311	57,787	57,787	1,961	49,036	49,036
2	1,142	28,560	86,348	1,492	37,312	86,348

Table 10: Rotated Component Matrix		
Evaluation criteria	Component 1	Component 2
Diversity value	-,569	,727
Rarity value	5,050E-02	,951
Naturalness value	,897	-,239
Restorability value	,912	4,912E-02

Table 11: Sampling intensity (plot number and size) and mean plot diversity of the plant communities

		Plots numbers per plot size				Mean richness per plot size				Mean Shannon diversity per plot				Mean Evenness per plot			Mean Gini index per		
Com. no	Code of Plant community	10	20	100	200	S10	S20	S100	S200	H10	H20	H100	H200	E10	E20	E100	G10	G20	G100
1	Bel_pe1	14	14	4	0	42	51	65		2,7	3,1	3,5		74	79	83	0,88	0,9	0,94
2	Di_vis2	32	30	11	0	53	63	86		3,2	3,5	3,9		80	84	87	0,93	0,9	0,97
3	Tri_ni3	29	28	20	0	36	42	56		2,4	2,7	3,1		68	74	78	0,83	0,8	0,91
4	Mar_pe4	19	19	5	0	35	43	54		2,4	2,7	3,2		67	73	80	0,82	0,8	0,92
5	Poa_bu5	22	19	7	0	48	55	76		2,9	3,2	3,7		76	80	85	0,90	0,9	0,96
6	Hel_nu6	25	11	3	0	51	59	72		3,1	3,4	3,8		80	83	88	0,92	0,9	0,97
7	Jas_fr7	25	7	4	0	56	60	99		3,2	3,4	4,0		79	82	88	0,93	0,9	0,97
8	Phl_fr8	24	0	23	0	58		96		2,9		3,9		71		86	0,89		0,96
9	Sal_of9	9	0	9	0	54		98		2,1		3,4		52		74	0,75		0,91
10	Ju_ox10	13	0	13	0	57		103		2,4		3,5		60		76	0,81		0,91
11	Q_coc11	20	0	26	0	29		66		1,7		2,9		51		70	0,72		0,89
12	Qpub12	34	0	37	3	36		77	81	1,7		3,1	3,1	48		72	0,72		0,91
13	Ju_Qpu13	6	0	9	0	43		75		2,2		3,1		58			0,82		0,92
14	Co_Qpu14	9	0	9	3	30		67	84	1,7		2,9	3,5	50		69	0,75		0,90
15	Pla_or15	0	0	6	0			49				1,5				39			0,59
16	Par_of16	9	7	3	0	24	24	60		1,6	1,9	2,8		50	61	70	0,65	0,7	0,89
17	Asp_ch17	7	0	0	0	29				2,2				66			0,85		
18	Ru_Qpu18	6	0	7	0	27		88		1,6		3,4		51		*78*	0,67		*0,94*
19	Pte_aq19	6	6	2	0	30	39	74		1,8	2,3	2,8		55	63	65	0,70	0,8	0,88
20	Br_syl20	14	12	0	0	39	46			2,5	2,8			68	74		0,84	0,8	
21	Car_or21	13	0	14	7	26		55	57	1,2		2,3	2,5	37		57	0,52		0,78
22	Qp_Car22	21	0	24	7	31		60	66	1,6		2,9	3,1	46		71	0,68		0,90
23	J_Aobt23	4	0	5	3	19		41	37	1,0		1,8	2,1	34		48	0,47		0,64
24	Ac_Ost24	15	0	18	17	25		47	55	1,3		2,5	2,9	40		65	0,58		0,83
Total / Mean		37	15	25	40	41	50	72		2,3	3,0	3,1		63	77	73	0,80	0,9	0,89

Annex II: Vegetation Table

Plot number
Plot group number
Plot size
Altitude
Azimuth
Aspect
Inclination(%)
Tree cover (%)
Shrub cover(%)
Herb cover(%)
Soil-Litter cover(%)
Moss cover(%)
Rock cover(%)
Plot Richness
Plot Shannon index
Plot Evenness

No.	Species	Group
	***Platanus orientalis* species group: Diagnostic (D) of *Platanus orientalis* community 15**	
521	*Platanus orientalis T*	28
520	*Platanus orientalis S*	28
519	*Platanus orientalis*	28
806	*Viola riviniana*	28
628	*Salix eleagnos ssp. eleagnos*	28
	***Juglans regia* species group: D of *Juglans regia-Acer obtusatum* community 23**	
359	*Juglans regia T*	32
358	*Juglans regia S*	32
357	*Juglans regia*	32
202	*Cornus sanguinea ssp. australis S*	32
201	*Cornus sanguinea ssp. australis*	32
638	*Sambucus nigra S*	32
	***Acer obtusatum* species group: D of *Acer obtusatum – Ostrya carpinifolia* community 24**	
11	*Acer obtusatum T*	24
10	*Acer obtusatum S*	24
9	*Acer obtusatum*	24
482	*Ostrya carpinifolia S*	24
481	*Ostrya carpinifolia*	24
133	*Cardamine graeca*	24
70	*Arabis turrita*	24
130	*Campanula trachelium ssp. athoa*	24
305	*Galium laconicum*	24
684	*Silene italica*	24
124	*Calamintha grandiflora*	24
251	*Digitalis laevigata ssp. graeca*	24
264	*Epipactis helleborine*	24
86	*Asplenium trichomanes ssp. inexpectans*	24
441	*Melittis melissophyllum ssp. albida*	24
526	*Poa nemoralis*	24
665	*Sedum cepaea*	24
204	*Coronilla emerus ssp. emeroides*	24
220	*Crepis fraasii*	24
386	*Lathyrus venetus*	24
750	*Trifolium medium ssp. balcanicum*	24
	***Ostrya carpinifolia* species group: D of *Acer obtusatum – Ostrya carpinifolia* community 24**	
483	*Ostrya carpinifolia T*	25
29	*Aesculus hippocastanum T*	25
27	*Aesculus hippocastanum*	25
12	*Acer platanoides*	25
456	*Mycelis muralis*	25
659	*Scutellaria columnae ssp. columnae*	25
241	*Daphne laureola ssp. laureola*	25
542	*Primula vulgaris*	25
770	*Ulmus glabra*	25
805	*Viola reichenbachiana*	25
631	*Salvia glutinosa*	25
641	*Sanicula europaea*	25
694	*Smyrnium perfoliatum ssp. perfoliatum*	25
	***Umbilicus erectus* species group: D of *Acer obtusatum – Ostrya carpinifolia* community 24**	
215	*Corylus colurna T*	26
214	*Corylus colurna S*	26
213	*Corylus colurna*	26
725	*Tilia cordata T*	26
412	*Lunaria annua*	26
774	*Umbilicus erectus*	26
708	*Symphytum ottomanum*	26
374	*Lamiastrum galeobdolon*	26
444	*Mercurialis perennis*	26
377	*Lamium garganicum ssp. laevigatum*	26
645	*Saxifraga chrysospleniifolia*	26
793	*Veronica hederifolia*	26
418	*Malcolmia graeca ssp. bicolor*	26
533	*Polygonatum odoratum*	26
535	*Polystichum setiferum*	26
126	*Calystegia silvatica*	26
252	*Doronicum columnae*	26
	***Hedera helix* species group: D of *Quercus pubescens – Carpinus orientalis* community 22**	
148	*Carpinus orientalis T*	23
147	*Carpinus orientalis S*	23
146	*Carpinus orientalis*	23
573	*Quercus cerris T*	23
572	*Quercus cerris S*	23
571	*Quercus cerris*	23
199	*Cornus mas S*	23
198	*Cornus mas*	23
294	*Fraxinus ornus*	23
6	*Acer monspessulanum ssp. monspessulanum*	23
539	*Potentilla micrantha*	23
791	*Veronica chamaedrys ssp. chamaedryoides*	23
319	*Hedera helix*	23
326	*Helleborus cyclophyllus*	23
670	*Selinum silaifolium*	23
74	*Aremonia agrimonioides*	23
438	*Melica uniflora*	23
804	*Viola odorata*	23
255	*Dryopteris villarii ssp. pallida*	23
108	*Brachypodium sylvaticum ssp. sylvaticum*	23
317	*Geum urbanum*	23
	***Lathyrus laxiflorus* species group: D of *Quercus pubescens – Carpinus orientalis* community 22**	
382	*Lathyrus laxiflorus*	16
696	*Sorbus domestica*	16
283	*Festuca heterophylla*	16
366	*Jurinea mollis*	16
753	*Trifolium patulum*	16
174	*Chamaecytisus polytrichus*	16
392	*Leontodon cichoriaceus*	16
398	*Lilium chalcedonicum*	16
	***Rosa canina* species group: D of *Rosa canina - Quercus pubescens* community 18**	
553	*Prunus mahaleb T*	27
552	*Prunus mahaleb S*	27
551	*Prunus mahaleb*	27
550	*Prunus cocomilia T*	27
549	*Prunus cocomilia S*	27
170	*Cercis siliquastrum T*	27
169	*Cercis siliquastrum S*	27
168	*Cercis siliquastrum*	27
288	*Ficus carica T*	27
189	*Clematis vitalba T*	27
188	*Clematis vitalba S*	27
187	*Clematis vitalba*	27
186	*Clematis flammula S*	27
234	*Cydonia oblonga S*	27
556	*Prunus spinosa S*	27
555	*Prunus spinosa*	27
619	*Rubus ulmifolius S*	27
618	*Rubus ulmifolius*	27
606	*Rosa canina S*	27
434	*Medicago polymorpha*	27
	***Quercus pubescens* species group: D of *Quercus pubescens* community with *Q.coccifera* typical community form 12**	
585	*Quercus pubescens T*	22
584	*Quercus pubescens S*	22
583	*Quercus pubescens*	22
296	*Fraxinus ornus T*	22
295	*Fraxinus ornus S*	22
8	*Acer monspessulanum ssp. monspessulanum T*	22
7	*Acer monspessulanum ssp. monspessulanum S*	22
570	*Quercus coccifera T*	22
569	*Quercus coccifera S*	22
568	*Quercus coccifera*	22
364	*Juniperus oxycedrus ssp. oxycedrus S*	22
363	*Juniperus oxycedrus ssp. oxycedrus*	22
500	*Phillyrea latifolia S*	22
499	*Phillyrea latifolia*	22
194	*Colutea arborescens ssp. arborescens S*	22
193	*Colutea arborescens ssp. arborescens*	22
605	*Rosa canina*	22
185	*Clematis flammula*	22
599	*Rhamnus saxatilis*	22
409	*Lonicera etrusca*	22
129	*Campanula spatulata ssp. spruneriana*	22
709	*Tamus communis*	22
79	*Asparagus acutifolius*	22
239	*Dactylis glomerata ssp. glomerata*	22
182	*Cirsium creticum*	22
624	*Ruscus aculeatus*	22
306	*Galium monasterium*	22
406	*Lithospermum purpurocaeruleum*	22
414	*Luzula forsteri*	22
143	*Carex guestphalica*	22
347	*Hypericum spruneri*	22
107	*Brachypodium pinnatum*	22
85	*Asplenium adiantum-nigrum*	22
	***Pyrus amygdaliformis* species group: D of *Quercus pubescens* community with *Juniperus oxycedrus* community form 13**	
563	*Pyrus amygdaliformis* S	21
562	*Pyrus amygdaliformis*	21
253	*Dorycnium herbaceum*	21
466	*Ononis spinosa*	21
244	*Daucus carota*	21
	***Pteridium aquilinum* species group: D of *Quercus pubescens* community with *Cornus mas* community form 14**	
547	*Prunus avium T*	30
545	*Prunus avium*	30
200	*Cornus mas T*	30
321	*Hedera helix T*	30
320	*Hedera helix S*	30
577	*Quercus frainetto*	30
726	*Tilia platyphyllos*	30
637	*Sambucus nigra*	30
603	*Rosa arvensis*	30
616	*Rubus caesius*	30
272	*Euonymus europaeus*	30
559	*Pteridium aquilinum*	30
78	*Arum italicum*	30
378	*Lapsana communis*	30
290	*Fragaria vesca*	30
459	*Myrrhoides nodosa*	30
125	*Calamintha nepeta*	30
163	*Centaurium erythraea ssp. erythraea*	30
534	*Polypodium vulgare*	30
544	*Prunella vulgaris*	30
580	*Quercus ilex*	30
416	*Lysimachia punctata*	30
15	*Acer pseudoplatanus*	30
38	*Ajuga reptans*	30
	***Corylus avellana* species group: D of *Quercus pubescens* community with *Cornus mas* community form 14**	
212	*Corylus avellana T*	29
211	*Corylus avellana S*	29
210	*Corylus avellana*	29
538	*Populus tremula T*	29

Species	Group	Relevé values
536 *Populus tremula*	29	[illegible]
***Pistacia terebinthus* species group: D of *Carpinus orientalis* – *Quercus coccifera* community 11**		
512 *Pistacia terebinthus* S	15	[illegible]
511 *Pistacia terebinthus*	15	[illegible]
558 *Psoralea bituminosa*	15	[illegible]
719 *Thesium linophylon ssp. linophylon*	15	[illegible]
***Athamanta macedonica* species group: D of *Asperula chlorantha* – *Centaurea pawlowskii* community 17**		
93 *Athamanta macedonica ssp. macedonica*	9	[illegible]
81 *Asperula chlorantha*	9	[illegible]
644 *Satureja montana ssp. montana*	9	[illegible]
445 *Micromeria cremnophila*	9	[illegible]
561 *Pterocephalus perennis ssp. bellidifolius*	9	[illegible]
632 *Salvia officinalis*	9	[illegible]
666 *Sedum dasyphyllum*	9	[illegible]
***Centaurea pawlowskii* species group: D of *Asperula chlorantha* – *Centaurea pawlowskii* community 17**		
158 *Centaurea pawlowskii*	10	[illegible]
225 *Crepis turcica*	10	[illegible]
346 *Hypericum rumeliacum ssp. apollinis*	10	[illegible]
678 *Silene cephallenia*	10	[illegible]
716 *Teucrium flavum ssp. hellenicum*	10	[illegible]
275 *Euphorbia characias spp. wuffenii*	10	[illegible]
681 *Silene fabarioides*	10	[illegible]
48 *Alyssoides utriculata*	10	[illegible]
***Erysimum cephalonicum* species group: D of *Quercus coccifera* – *Juniperus oxycedrus* community 10**		
271 *Erysimum cephalonicum*	8	[illegible]
353 *Inula oculus-christi*	8	[illegible]
162 *Centaurea zucchariniana*	8	[illegible]
242 *Daphne oleoides*	8	[illegible]
304 *Galium divaricatum*	8	[illegible]
360 *Juniperus foetidissima*	8	[illegible]
668 *Sedum ochroleucum*	8	[illegible]
329 *Hieracium cymosum ssp. cymosum*	8	[illegible]
22 *Acinos alpinus ssp. majoranifolius*	8	[illegible]
612 *Rosa pulverulenta*	8	[illegible]
700 *Sorbus umbellata*	8	[illegible]
20 *Achillea holosericea*	8	[illegible]
68 *Arabis muralis*	8	[illegible]
332 *Hieracium pannosum cf.*	8	[illegible]
405 *Lithospermum incrassatum*	8	[illegible]
18 *Achillea clypeolata*	8	[illegible]
76 *Armeria canescens*	8	[illegible]
589 *Ramonda serbica*	8	[illegible]
803 *Viola kitaibeliana*	8	[illegible]
447 *Minuartia attica*	8	[illegible]
***Galium aparine* species group: D of *Quercus coccifera* – *Juniperus oxycedrus* community 10**		
759 *Trifolium speciosum*	19	[illegible]
369 *Koeleria nitidula*	19	[illegible]
389 *Legousia speculum-veneris*	19	[illegible]
476 *Orlaya daucoides*	19	[illegible]
741 *Trifolium arvense*	19	[illegible]
43 *Allium guttatum ssp. sardoum*	19	[illegible]
311 *Geranium lucidum*	19	[illegible]
437 *Melica ciliata*	19	[illegible]
742 *Trifolium aurantiacum*	19	[illegible]
458 *Myosotis sylvatica ssp. cyanea*	19	[illegible]
720 *Thlaspi perfoliatum*	19	[illegible]
250 *Dictamnus albus*	19	[illegible]
303 *Galium aparine*	19	[illegible]
478 *Ornithogalum montanum*	19	[illegible]
781 *Valerianella dentata*	19	[illegible]
455 *Muscari neglectum*	19	[illegible]
597 *Rhagadiolus stellatus*	19	[illegible]
151 *Celtis australis*	19	[illegible]
285 *Fibigia clypeata*	19	[illegible]
267 *Erodium cicutarium*	19	[illegible]
***Acinos suaveolens* species group: D of *Salvia officinalis* – *Carpinus orientalis* community 9**		
485 *Paliurus spina-christi* S	7	[illegible]
484 *Paliurus spina-christi*	7	[illegible]
506 *Phlomis fruticosa*	7	[illegible]
276 *Euphorbia deflexa*	7	[illegible]
284 *Festuca jeanpertii*	7	[illegible]
475 *Origanum vulgare*	7	[illegible]
23 *Acinos suaveolens*	7	[illegible]
30 *Aethionema saxatile ssp. oreophilum*	7	[illegible]
69 *Arabis sagittata*	7	[illegible]
171 *Ceterach officinarum*	7	[illegible]
314 *Geranium robertianum ssp. purpureum*	7	[illegible]
393 *Leontodon crispus ssp. asper*	7	[illegible]
71 *Arabis verna*	7	[illegible]
431 *Medicago lupulina*	7	[illegible]
449 *Minuartia hybrida*	7	[illegible]
109 *Briza humilis*	7	[illegible]
279 *Euphorbia myrsinites*	7	[illegible]
780 *Valerianella coronata*	7	[illegible]
128 *Campanula ramosissima*	7	[illegible]
154 *Centaurea affinis spp pallidior*	7	[illegible]
446 *Micromeria juliana*	7	[illegible]
479 *Orobanche alba*	7	[illegible]
714 *Taraxacum gracilens cf.*	7	[illegible]
738 *Tragopogon crocifolius ssp. samaritani*	7	[illegible]
652 *Scandix australis ssp. grandiflora*	7	[illegible]
219 *Crepis dioscoridis*	7	[illegible]
648 *Saxifraga tridactylites*	7	[illegible]
268 *Erophila verna*	7	[illegible]
661 *Sedum acre*	7	[illegible]
814 *Xeranthemum inapertum*	7	[illegible]
***Helianthemum nummularium* species group: D of *Salvia officinalis* – *Carpinus orientalis* community 6**		
706 *Stipa bromoides*	6	[illegible]
323 *Helianthemum nummularium ssp. nummularium*	6	[illegible]
309 *Geranium columbinum*	6	[illegible]
144 *Carex halleriana*	6	[illegible]
477 *Orlaya daucorlaya*	6	[illegible]
715 *Teucrium chamaedrys ssp. chamaedrys.*	6	[illegible]
206 *Coronilla scorpioides*	6	[illegible]
307 *Galium parisiense*	6	[illegible]
717 *Teucrium polium*	6	[illegible]
246 *Desmazeria rigida*	6	[illegible]
50 *Alyssum repens*	6	[illegible]
226 *Crucianella angustifolia*	6	[illegible]
229 *Crupina vulgaris*	6	[illegible]
223 *Crepis sancta*	6	[illegible]
667 *Sedum hispanicum*	6	[illegible]
702 *Stachys germanica ssp. heldreichii*	6	[illegible]
722 *Thymus longicaulis ssp. chaubardii*	6	[illegible]
689 *Silene ungeri*	6	[illegible]
650 *Scabiosa tenuis*	6	[illegible]
462 *Nigella damascena*	6	[illegible]
64 *Anthyllis vulneraria ssp. pulchella*	6	[illegible]
503 *Phleum montanum*	6	[illegible]
195 *Consolida regalis ssp. paniculata*	6	[illegible]
683 *Silene graeca*	6	[illegible]
197 *Convolvulus cantabrica*	6	[illegible]
***Lonicera etrusca* species group: C of *Salvia officinalis* – *Carpinus orientalis* community 9**		
782 *Valerianella rimosa*	14	[illegible]
675 *Seseli peucedanoides*	14	[illegible]
410 *Lonicera etrusca* S	14	[illegible]
***Malabaila aurea* species group: D of *Phlomis fruticosa* community 8**		
417 *Malabaila aurea*	12	[illegible]
653 *Scandix pecten - veneris*	12	[illegible]
262 *Ephedra campylopoda*	12	[illegible]
695 *Sonchus asper*	12	[illegible]
95 *Aurinia saxatilis ssp. orientalis*	12	[illegible]
384 *Lathyrus setifolius*	12	[illegible]
299 *Fumaria officinalis*	12	[illegible]
315 *Geranium rotundifolium*	12	[illegible]
110 *Briza maxima*	12	[illegible]
488 *Papaver dubium*	12	[illegible]
443 *Mercurialis annua*	12	[illegible]
480 *Orobanche caryophyllacea*	12	[illegible]
256 *Echinops spinosissimus ssp. neumayeri*	12	[illegible]
522 *Plumbago europaea*	12	[illegible]
776 *Urospermum picroides*	12	[illegible]
***Picris pauciflora* species group: D of *Phlomis fruticosa* community 8**		
508 *Picris pauciflora*	11	[illegible]
439 *Melilotus neapolitanus*	11	[illegible]
635 *Salvia viridis*	11	[illegible]
***Minuartia mediterranea* species group: D of *Helianthemum nummularium* – *Trifolium dalmaticum* with *Jasminum fruticans* community form 7**		
49 *Alyssum alyssoides*	18	[illegible]
625 *Ruta graveolens*	18	[illegible]
36 *Ajuga chamaepitys ssp. chamaepitys*	18	[illegible]
159 *Centaurea salonitana*	18	[illegible]
450 *Minuartia mediterranea*	18	[illegible]
115 *Bromus squarrosus*	18	[illegible]
498 *Petrorhagia saxifraga*	18	[illegible]
404 *Linum tenuifolium*	18	[illegible]
767 *Trinia glauca ssp. pindica*	18	[illegible]
41 *Allium cupani ssp. cupani*	18	[illegible]
701 *Stachys annua ssp. annua*	18	[illegible]
***Jasminum fruticans* species group: D of Helianthemum nummularium – *Trifolium dalmaticum* with Jasminum fruticans community form 7**		
356 *Jasminum fruticans*	17	[illegible]
324 *Helictotrichon convolutum*	17	[illegible]
766 *Trigonella monspeliaca*	17	[illegible]
397 *Lilium canditum*	17	[illegible]
413 *Lupinus albus spp. graecus*	17	[illegible]
705 *Steptorhamphus tuberosus*	17	[illegible]
***Aegilops neglecta* species group: D of Helianthemum nummularium – Trifolium dalmaticum typical community form 6**		
25 *Aegilops neglecta*	13	[illegible]
122 *Bupleurum glumaceum*	13	[illegible]
557 *Psilurus incurvus*	13	[illegible]
740 *Trifolium angustifolium*	13	[illegible]
277 *Euphorbia flavicoma*	13	[illegible]
270 *Eryngium campestre*	13	[illegible]
289 *Fillago vulgaris*	13	[illegible]
813 *Xeranthemum cylindraceum*	13	[illegible]
145 *Carlina corymbosa*	13	[illegible]
403 *Linum strictum*	13	[illegible]
463 *Onobrychis caput-galli*	13	[illegible]
336 *Hippocrepis unisiliqua*	13	[illegible]
464 *Onobrychis montana ssp. scardica*	13	[illegible]
596 *Reichardia picroides*	13	[illegible]
721 *Thymelaea passerina*	13	[illegible]
784 *Velezia rigida*	13	[illegible]
***Hordeum murinum* species group: D of the *Marrubium peregrinum* community 4**		
340 *Hordeum murinum*	2	[illegible]
623 *Rumex pulcher*	2	[illegible]
132 *Capsella bursa-pastoris*	2	[illegible]
737 *Torilis nodosa*	2	[illegible]
137 *Carduus pycnocephalus*	2	[illegible]
692 *Sisymbrium officinale*	2	[illegible]
426 *Marrubium peregrinum*	2	[illegible]
112 *Bromus hordaceous*	2	[illegible]
429 *Medicago arabica*	2	[illegible]
442 *Mentha longifolia*	2	[illegible]
139 *Carduus tmoleus*	2	[illegible]
278 *Euphorbia helioscopia*	2	[illegible]
433 *Medicago orbicularis*	2	[illegible]
489 *Papaver rhoeas*	2	[illegible]
425 *Malva sylvestris*	2	[illegible]
119 *Bunias erucago var. macropetala*	2	[illegible]
196 *Convolvulus arvensis*	2	[illegible]
257 *Echium italicum*	2	[illegible]
655 *Scolymus maculatus*	2	[illegible]
787 *Verbascum pulverulentum*	2	[illegible]
***Sambucus ebulus* species group: D of *Marrubium peregrinum* community 4**		
704 *Stellaria media*	1	[illegible]
636 *Sambucus ebulus*	1	[illegible]
541 *Potentilla reptans*	1	[illegible]
424 *Malva neglecta*	1	[illegible]
428 *Marrubium vulgare*	1	[illegible]
494 *Persicaria salicifolia*	1	[illegible]
80 *Asperugo procumbens*	1	[illegible]
***Chondrilla juncea* species group: D of *Trifolium nigrescens* typical community 3**		
178 *Chondrilla juncea*	3	[illegible]
732 *Tordylium apulum*	3	[illegible]
656 *Scorzonera laciniata*	3	[illegible]
96 *Avena barbata*	3	[illegible]
435 *Medicago rigidula*	3	[illegible]
222 *Crepis rubra*	3	[illegible]
57 *Anchusa cretica*	3	[illegible]
166 *Cerastium glomeratum*	3	[illegible]
65 *Aphanes arvensis*	3	[illegible]
101 *Berteroa obliqua*	3	[illegible]
58 *Anchusa hybrida*	3	[illegible]
368 *Knautia integrifolia*	3	[illegible]
243 *Dasypyrum villosum*	3	[illegible]
734 *Tordylium officinale*	3	[illegible]
388 *Legousia hybrida*	3	[illegible]
99 *Bellardia trixago*	3	[illegible]
***Medicago minima* species group: D of *Trifolium nigrescens* with *Dianthus viscidus* community form 2**		
348 *Hypochoeris cretensis*	5	[illegible]
525 *Poa bulbosa ssp. pseudoconcinna*	5	[illegible]
540 *Potentilla recta*	5	[illegible]
640 *Sanguisorba minor ssp. muricata*	5	[illegible]
238 *Cynosurus echinatus*	5	[illegible]
432 *Medicago minima*	5	[illegible]
517 *Plantago lanceolata*	5	[illegible]
677 *Sherardia arvensis*	5	[illegible]
165 *Cerastium brachypetalum ssp. roeseri*	5	[illegible]
745 *Trifolium dalmaticum*	5	[illegible]
751 *Trifolium nigrescens*	5	[illegible]
35 *Aira elegantissima*	5	[illegible]
490 *Parentucellia latifolia*	5	[illegible]
743 *Trifolium campestre*	5	[illegible]
221 *Crepis neglecta ssp. neglecta*	5	[illegible]
179 *Cichorium intybus*	5	[illegible]

No.	Species	Group	Relevé data
60	*Anthemis arvensis*	5	[illegible]
795	*Veronica verna*	5	[illegible]
497	*Petrorhagia prolifera*	5	[illegible]
345	*Hypericum perforatum*	5	[illegible]
451	*Moenchia mantica*	5	[illegible]
760	*Trifolium stellatum ssp. xanthinum*	5	[illegible]
761	*Trifolium striatum*	5	[illegible]
810	*Vulpia myuros*	5	[illegible]
75	*Arenaria serpyllifolia*	5	[illegible]
744	*Trifolium cherleri*	5	[illegible]
762	*Trifolium subterraneum*	5	[illegible]
116	*Bromus sterilis*	5	[illegible]
735	*Torilis arvensis*	5	[illegible]
457	*Myosotis stricta*	5	[illegible]
809	*Vulpia ciliata*	5	[illegible]
254	*Draba muralis*	5	[illegible]
313	*Geranium molle ssp. molle*	5	[illegible]
454	*Muscari comosum*	5	[illegible]
799	*Vicia peregrina*	5	[illegible]
	Dianthus viscidus **species group: D of** ***Trifolium nigrescens*** **with** ***Dianthus viscidus*** **community form 2**		
248	*Dianthus viscidus*	20	[illegible]
758	*Trifolium resupinatum*	20	[illegible]
232	*Cyclamen hederifolium*	20	[illegible]
	Lotus corniculatus **species group: D of** ***Trifolium nigrescens*** **with** ***Bellis perennis*** **community form 1**		
100	*Bellis perennis*	4	[illegible]
411	*Lotus corniculatus*	4	[illegible]
593	*Ranunculus neapolitanus*	4	[illegible]
752	*Trifolium ochroleucum*	4	[illegible]
754	*Trifolium physodes*	4	[illegible]
543	*Prunella laciniata*	4	[illegible]
328	*Hieracium bauhini*	4	[illegible]
190	*Clinopodium vulgare*	4	[illegible]
528	*Poa trivialis ssp. sylvicola*	4	[illegible]
207	*Coronilla varia*	4	[illegible]
228	*Cruciata laevipes*	4	[illegible]
31	*Agrimonia eupatoria ssp. eupatoria*	4	[illegible]
380	*Lathyrus aphaca*	4	[illegible]
408	*Lolium perenne*	4	[illegible]
436	*Medicago sativa ssp. falcata*	4	[illegible]
757	*Trifolium repens*	4	[illegible]
756	*Trifolium pratense*	4	[illegible]
	Parietaria officinalis **species group: D of** ***Parietaria officinalis*** **community 16**		
492	*Parietaria officinalis*	31	[illegible]
733	*Tordylium maximum*	31	[illegible]
777	*Urtica dioica*	31	[illegible]
231	*Cuscuta europaea*	31	[illegible]
173	*Chaerophyllum temulentum*	31	[illegible]
281	*Fallopia dumetorum*	31	[illegible]
	Companion species		
801	*Vicia tenuifolia*	999	[illegible]
736	*Torilis leptophylla*	999	[illegible]
141	*Carex distachya*	999	[illegible]
470	*Opopanax chironium*	999	[illegible]
797	*Vicia grandiflora*	999	[illegible]
134	*Cardamine hirsuta*	999	[illegible]
594	*Ranunculus psilostachys*	999	[illegible]
527	*Poa pratensis*	999	[illegible]
385	*Lathyrus sphaericus*	999	[illegible]
261	*Elytrigia intermedia*	999	[illegible]
59	*Anemone pavonina*	999	[illegible]
37	*Ajuga orientalis*	999	[illegible]
502	*Phleum echinatum*	999	[illegible]
55	*Anacamptis pyramidalis*	999	[illegible]
113	*Bromus intermedius*	999	[illegible]
390	*Lens ervoides*	999	[illegible]
224	*Crepis setosa*	999	[illegible]
327	*Herniaria incana*	999	[illegible]
788	*Verbascum speciosum ssp. megaphlomos*	999	[illegible]
217	*Crataegus monogyna*	999	[illegible]
351	*Inula conyza*	999	[illegible]
663	*Sedum amplexicaule ssp. tenuifolium*	999	[illegible]
150	*Carum multiflorum*	999	[illegible]
334	*Himantoglossum caprinum*	999	[illegible]
504	*Phleum pratense ssp. bertolonii*	999	[illegible]
614	*Rosa spec.*	999	[illegible]
2	*Acanthus balcanicus*	999	[illegible]
440	*Melissa officinalis*	999	[illegible]
783	*Valerianella turgida*	999	[illegible]
291	*Frangula rupestris*	999	[illegible]
310	*Geranium dissectum*	999	[illegible]
739	*Tragopogon dubius*	999	[illegible]
800	*Vicia sativa*	999	[illegible]
786	*Verbascum densiflorum*	999	[illegible]
796	*Vicia disperma*	999	[illegible]
40	*Allium amethystinum*	999	[illegible]
56	*Anagalis arvensis*	999	[illegible]
245	*Delphinium peregrinum*	999	[illegible]
381	*Lathyrus cicera*	999	[illegible]
591	*Ranunculus millefoliatus*	999	[illegible]
615	*Rostraria cristata*	999	[illegible]
19	*Achillea grandifolia*	999	[illegible]
467	*Onopordum bracteatum*	999	[illegible]
712	*Tanacetum parthenium*	999	[illegible]
674	*Seseli montanum ssp. tommasinii*	999	[illegible]
763	*Trigonela corniculata*	999	[illegible]
218	*Crataegus monogyna S*	999	[illegible]
230	*Cuscuta epithymum ssp. kotschyi*	999	[illegible]
237	*Cynoglossum columnae*	999	[illegible]
331	*Hieracium murorum cf.*	999	[illegible]
472	*Orchis quantripunctata*	999	[illegible]
685	*Silene latifolia ssp. alba*	999	[illegible]
775	*Umbilicus rupestris*	999	[illegible]
3	*Acer campestre*	999	[illegible]
106	*Brachypodium distachyon*	999	[illegible]
657	*Scrophularia canina spp. bicolor*	999	[illegible]
322	*Hedypnois cretica*	999	[illegible]
343	*Huetia cynapioides ssp. cynapioides*	999	[illegible]
349	*Hypochoeris radicata*	999	[illegible]
391	*Lens nigricans*	999	[illegible]
394	*Leontodon hispidus ssp. hispidus*	999	[illegible]
487	*Papaver apulum*	999	[illegible]
493	*Pastinaca sativa ssp. urens*	999	[illegible]
651	*Scaliregia napiformis*	999	[illegible]
707	*Stipa pennata ssp. pulcherrima*	999	[illegible]
748	*Trifolium hirtum*	999	[illegible]
779	*Valeriana italica*	999	[illegible]
34	*Agrostis stolonifera*	999	[illegible]
365	*Juniperus oxycedrus ssp. oxycedrus T*	999	[illegible]
469	*Ophrys scolopax ssp. cornuta*	999	[illegible]
471	*Orchis morio*	999	[illegible]
509	*Pimpinella tragium ssp. polyclada*	999	[illegible]
633	*Salvia scarlea*	999	[illegible]
662	*Sedum album*	999	[illegible]
664	*Sedum atratum*	999	[illegible]
713	*Taraxacum*	999	[illegible]
47	*Althaea hirsuta*	999	[illegible]
181	*Cirsium arvense*	999	[illegible]
205	*Coronilla emerus ssp. emeroides S*	999	[illegible]
486	*Pallenis spinosa*	999	[illegible]
654	*Scleranthus annuus ssp. annuus*	999	[illegible]
26	*Aegilops triuncialis*	999	[illegible]
33	*Agrostis gigantea*	999	[illegible]
102	*Biarum tenuifolium*	999	[illegible]
265	*Epipactis microphylla*	999	[illegible]
300	*Gagea pusilla*	999	[illegible]
507	*Picnomon acarna*	999	[illegible]
523	*Poa angustifolia*	999	[illegible]
548	*Prunus cocomilia*	999	[illegible]
688	*Silene remotiflora*	999	[illegible]
812	*Xeranthemum annuum*	999	[illegible]
62	*Anthoxanthum odoratum*	999	[illegible]
82	*Asphodelina lutea*	999	[illegible]
103	*Bidens frondosa*	999	[illegible]
142	*Carex flacca*	999	[illegible]
191	*Clypeola jonthlaspi*	999	[illegible]
227	*Crucianella latifolia*	999	[illegible]
339	*Hordeum bulbosum*	999	[illegible]
373	*Lactuca viminea*	999	[illegible]
375	*Lamium amplexicaulis*	999	[illegible]
402	*Linum nodiflorum*	999	[illegible]
501	*Phillyrea latifolia T*	999	[illegible]
529	*Podocitysus caramanicus*	999	[illegible]
595	*Raphanus raphanistrum*	999	[illegible]
646	*Saxifraga graeca*	999	[illegible]
728	*Tilia platyphyllos T*	999	[illegible]
792	*Veronica cymbalaria*	999	[illegible]
90	*Astragalus glycyphyllos*	999	[illegible]
117	*Bromus tectorum*	999	[illegible]
138	*Carduus thoermeri*	999	[illegible]
160	*Centaurea solstitialis ssp. solstitialis*	999	[illegible]
183	*Cirsium eriophorum*	999	[illegible]
192	*Colchicum autumnale*	999	[illegible]
280	*Euphorbia seguieriana ssp. niciciana*	999	[illegible]
372	*Lactuca serriola*	999	[illegible]
379	*Lathyrus annuus*	999	[illegible]
387	*Lavatera thuringiaca ssp. ambigua*	999	[illegible]
422	*Malus sylvestris*	999	[illegible]
564	*Pyrus amygdaliformis T*	999	[illegible]
607	*Rosa canina x R.pulverulenta*	999	[illegible]
698	*Sorbus domestica T*	999	[illegible]
802	*Vincetoxicum fuscatum*	999	[illegible]
815	*Ziziphora capitata*	999	[illegible]
45	*Allium sphaerocephalon*	999	[illegible]
84	*Asphodelus fistulosus*	999	[illegible]
104	*Bifora testiculata*	999	[illegible]
361	*Juniperus foetidissima S*	999	[illegible]
461	*Nigella arvensis*	999	[illegible]
465	*Ononis spec.*	999	[illegible]
473	*Orchis tridentata*	999	[illegible]
586	*Quercus trojana*	999	[illegible]
587	*Quercus trojana S*	999	[illegible]
588	*Quercus trojana T*	999	[illegible]
617	*Rubus caesius S*	999	[illegible]
622	*Rumex cristatus*	999	[illegible]
627	*Salix amplexicaulis*	999	[illegible]
669	*Sedum rubens*	999	[illegible]
671	*Senecio squalidus*	999	[illegible]
697	*Sorbus domestica S*	999	[illegible]
746	*Trifolium glomeratum*	999	[illegible]
749	*Trifolium incarnatum*	999	[illegible]
764	*Trigonella gladiata*	999	[illegible]
67	*Arabis caucasica*	999	[illegible]
114	*Bromus scoparius*	999	[illegible]
155	*Centaurea calsitrapa*	999	[illegible]
184	*Cistus creticus*	999	[illegible]
236	*Cynodon dactylon*	999	[illegible]
282	*Ferulago nodosa*	999	[illegible]
301	*Galanthus nivalis*	999	[illegible]
312	*Geranium macrorrhizum*	999	[illegible]
316	*Geranium versicolor*	999	[illegible]
383	*Lathyrus niger*	999	[illegible]
395	*Leontodon tuberosus*	999	[illegible]
400	*Linaria peloponnesiaca var. parnassica*	999	[illegible]
401	*Linaria simplex*	999	[illegible]
419	*Malus domestica*	999	[illegible]
430	*Medicago coronata*	999	[illegible]
491	*Parietaria lusitanica*	999	[illegible]
505	*Phleum subulatum*	999	[illegible]
590	*Ranunculus ficaria*	999	[illegible]
604	*Rosa arvensis S*	999	[illegible]
672	*Serapias vomeracea*	999	[illegible]
691	*Silybum marianum*	999	[illegible]
693	*Sisymbrium orientale*	999	[illegible]
718	*Thalictrum minus ssp. olympicum*	999	[illegible]
723	*Tilia cordata*	999	[illegible]
581	*Quercus ilex S*	999	[illegible]

ANNEX III : Constancy table

Plant community number	15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
Plots number	6	6	18	14	24	7	37	9	9	26	7	13	9	26	25	25	19	22	29	33	14	14	6	10
Syntaxonomic class	Sp	Qp	Qp	Qp	Qp	R-P	Qp	Qp	Qp	Qp	At	R-P	R-P	C-M	T-B	T-B	Av	T-B	T-B	T-B	T-B	T-G	T-G	G-U
Landscape element (Habitat type)	F	F	F	W	F	TH	F	F/W	F	W	R	S	S	S	G	G	G	G	G	G	G	G	G	G
Mean inclination	33	60	64	63	64	54	51	48	61	70	99	63	49	61	28	26	18	22	16	28	40	13	10	18
Mean trees cover	69	71	64	63	48	40	45	32	57	5	0	0	0	0	0	0	0	0	0	0	0	0	2	20
Mean shrubs cover	14	13	10	30	52	71	58	46	49	68	0	33	16	1	0	0	0	0	0	1	1	7	3	11
Mean herbs cover	8	9	21	23	28	47	31	39	30	36	11	55	63	64	39	50	77	65	81	71	75	68	58	78
Mean soil cover	1	47	53	70	65	51	66	49	67	48	0	22	20	24	17	26	23	22	15	15	15	20	41	20
Mean moss cover	0	0	3	2	1	0	1	3	2	12	5	13	1	7	21	28	0	26	15	43	40	20	2	8
Mean rock cover	92	44	24	7	8	1	3	9	1	11	87	19	17	11	38	10	0	4	0	2	0	6	1	2
Community Richness	148	119	199	227	270	242	437	246	219	318	93	333	251	386	351	252	209	258	205	327	208	243	140	162
Community Shannon	1,4	1,9	3,1	2,4	3,3	3,6	3,2	3,5	3,6	3,0	2,8	4,0	3,8	4,1	4,2	3,7	3,5	3,6	2,8	4,0	3,6	3,7	2,2	2,4
Community Evenness	28	40	59	45	59	66	52	63	67	52	62	68	68	68	71	66	65	64	53	69	68	68	44	48

D: diagrnostic species group; Bold black numbers indicate species of the diagnostic group of a plant community; Bold black numbers in a box indicate diagnostic species of the specific plant community

Sp: *Salicetea purpureae*; Qp: *Quercetea pubescentis*; R-P: *Rhamno-Prunetea*; At: *Asplenietea trichomanis*; T-B: *Thero-Brachypodietea*; T-G: *Trifolio-Geranietea*; G-U: *Galio-Urticetea*

F: Forest; W: Woodland; TH: Treehedge; R: Rock; S: Shrubland; G: Grassland

No.	Species	Species group number	15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
	***Platanus orientalis* species group : Diagnostic (D) of *Platanus orientalis* community 15**																									
521	*Platanus orientalis T*	28	**100**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
520	*Platanus orientalis S*	28	**83**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
519	*Platanus orientalis*	28	**83**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
628	*Salix eleagnos ssp. eleagnos*	28	**67**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
806	*Viola riviniana*	28	**67**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	***Juglans regia* species group : D of *Juglans regia - Acer obtusatum* community 23**																									
359	*Juglans regia T*	32	.	**50**	.	.	4	29	11	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	50
358	*Juglans regia S*	32	.	**33**	.	.	.	14	8	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
357	*Juglans regia*	32	.	**50**	.	.	.	.	5	.	22	4	.	.	.	.	.	.	.	.	.	.	.	.	17	10
202	*Cornus sanguinea ssp. australis S*	32	.	**17**	.	.	.	29	.	.	22	.	.	.	.	.	.	.	.	.	.	.	.	7	.	20
201	*Cornus sanguinea ssp. australis*	32	.	**17**	.	.	.	29	3	.	11	.	.	.	.	.	.	.	.	.	.	.	.	14	.	20
638	*Sambucus nigra S*	32	.	**17**	.	.	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
	***Acer obtusatum* species group : D of *Acer obtusatum - Ostrya carpinifolia* community 24**																									
11	*Acer obtusatum T*	24	.	100	**61**	7	29	29	30	56	89	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
10	*Acer obtusatum S*	24	.	83	**22**	.	17	.	19	22	56	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
9	*Acer obtusatum*	24	33	100	**61**	14	50	29	24	44	100	4	.	8	22	.	.	.	5	.	.	.	.	7	50	30
482	*Ostrya carpinifolia S*	24	17	33	**61**	14	29	.	14	.	33	19	.	15	22	.	.	.	.	.	.	.	.	.	.	10
481	*Ostrya carpinifolia*	24	83	33	**67**	36	33	14	19	33	33	27	14	54	67	19	.	.	.	.	.	.	.	.	.	10
133	*Cardamine graeca*	24	17	83	**83**	64	46	.	16	11	11	38	14	.	11	4	8	.	.	.	.	.	7	7	.	10
70	*Arabis turrita*	24	.	50	**22**	14	38	.	11	.	11	23	14	8	.	19	8	.	.	.	.	.	7	7	.	.
130	*Campanula trachelium ssp. athoa*	24	50	50	**44**	29	50	43	19	.	89	.	.	8	.	.	4	.	.	.	.	.	.	.	33	30
305	*Galium laconicum*	24	17	50	**61**	14	63	14	30	.	89	.	.	.	.	.	.	.	.	.	.	.	7	29	17	10
684	*Silene italica*	24	17	50	**44**	79	63	.	16	11	44	58	29	8	33	.	4	4	.	.	.	.	.	14	.	10
124	*Calamintha grandiflora*	24	.	33	**50**	29	25	14	11	.	11	15	.	.	.	.	.	.	.	.	.	.	.	7	.	30
251	*Digitalis laevigata ssp. graeca*	24	17	33	**44**	7	38	.	16	44	67	.	.	.	.	.	.	.	.	.	.	3	.	7	17	10
264	*Epipactis helleborine*	24	.	33	**50**	29	17	.	8	11	11	8	.	.	11	.	.	.	.	.	.	.	.	.	17	.
86	*Asplenium trichomanes ssp. inexpectans*	24	17	17	**56**	86	67	.	24	22	44	69	43	46	78	4	4	.	.	.	.	.	.	.	.	10
441	*Melittis melissophyllum ssp. albida*	24	.	17	**72**	43	63	14	5	11	22	38	.	.	.	4	.	.	.	.	.	.	.	.	.	.
526	*Poa nemoralis*	24	17	17	**17**	36	21	.	3	.	44	12	.	.	.	.	.	.	.	.	.	.	.	.	.	10
665	*Sedum cepaea*	24	.	17	**56**	50	33	14	11	11	22	42	.	.	.	4	4	.	.	.	.	.	.	.	.	20
204	*Coronilla emerus ssp. emeroides*	24	83	.	**39**	36	46	.	41	56	67	85	71	69	56	19	16	12	.	.	.	3	.	7	.	10
220	*Crepis fraasii*	24	.	.	**44**	71	67	.	16	11	44	54	57	62	22	4	4	4	.	.	3	.	.	.	.	.
386	*Lathyrus venetus*	24	.	.	**50**	57	58	.	3	.	11	12	.	.	.	.	.	.	.	.	.	.	.	.	.	.
750	*Trifolium medium ssp. balcanicum*	24	67	.	**11**	36	42	.	19	.	11	54	.	31	44	.	.	.	.	.	.	6	.	7	17	.
	***Ostrya carpinifolia* species group : D of *Acer obtusatum - Ostrya carpinifolia* community 24**																									
483	*Ostrya carpinifolia T*	25	17	33	**94**	21	17	.	3	.	11	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
29	*Aesculus hippocastanum T*	25	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
27	*Aesculus hippocastanum*	25	.	.	**39**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
12	*Acer platanoides*	25	.	.	**50**	14	13	.	3	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
456	*Mycelis muralis*	25	50	50	**67**	7	17	.	.	.	.	4	.	.	.	4	.	.	5	.	.	.	.	.	.	.
659	*Scutellaria columnae ssp. columnae*	25	17	17	**61**	43	8	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
241	*Daphne laureola ssp. laureola*	25	17	33	**56**	36	13	.	.	.	.	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.
542	*Primula vulgaris*	25	33	50	**50**	29	8	.	.	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
770	*Ulmus glabra*	25	17	17	**50**	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	.
805	*Viola reichenbachiana*	25	17	.	**39**	.	.	.	3	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
631	*Salvia glutinosa*	25	33	17	**33**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
641	*Sanicula europaea*	25	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
694	*Smyrnium perfoliatum ssp. perfoliatum*	25	.	.	**22**	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	***Umbilicus erectus* species group: D of *Acer obtusatum - Ostrya carpinifolia* community 24**																									
215	*Corylus colurna T*	26	.	17	**28**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
214	*Corylus colurna S*	26	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
213	*Corylus colurna*	26	.	17	**33**	.	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
725	*Tilia cordata T*	26	.	**33**	**11**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
412	*Lunaria annua*	26	.	33	**67**	21	.	43	3	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	10
774	*Umbilicus erectus*	26	.	67	**67**	14	4	.	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
708	*Symphytum ottomanum*	26	17	50	**56**	21	13	14	19	.	.	15	.	.	.	.	.	.	11	.	.	.	.	29	.	30
374	*Lamiastrum galeobdolon*	26	.	33	**44**	14	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
444	*Mercurialis perennis*	26	.	50	**44**	21	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
377	*Lamium garganicum ssp. laevigatum*	26	.	50	**33**	21	.	.	5	.	.	8	.	.	.	4	.	.	.	.	.	3	.	.	.	40
645	*Saxifraga chrysospleniifolia*	26	.	.	**33**	21	.	.	3	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
793	*Veronica hederifolia*	26	.	17	**33**	21	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
418	*Malcolmia graeca ssp. bicolor*	26	17	.	**28**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
533	*Polygonatum odoratum*	26	.	.	**28**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
535	*Polystichum setiferum*	26	.	.	**28**	7	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
126	*Calystegia silvatica*	26	.	17	**17**	.	.	14	.	22	.	.	.	.	.	.	.	.	.	.	.	.	.	7	.	20
252	*Doronicum columnae*	26	.	17	**11**	7	17	.	3	.	.	4	43	.	.	4	.	.	.	.	.	.	.	.	.	10

Plant community Number		15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
***Hedera helix* species group : D of *Quercus pubescens - Carpinus orientalis* community 22**																									
148 *Carpinus orientalis T*	23	67	.	56	100	**100**	.	41	22	33	38	.	.	11	.	.	.	.	.	.	.	.	.	.	.
147 *Carpinus orientalis S*	23	50	.	50	100	**100**	.	78	44	78	77	.	54	56	12	.	.	.	.	.	3	.	14	17	10
146 *Carpinus orientalis*	23	100	17	67	86	**100**	.	84	100	89	77	14	85	100	50	12	.	.	5	.	15	14	36	50	.
573 *Quercus cerris T*	23	.	.	11	43	**54**	.	30	44	56	15	.	.	.	.	.	.	.	.	.	.	.	.	33	.
572 *Quercus cerris S*	23	.	.	.	7	**50**	.	32	33	44	15	.	.	11	4	.	.	.	.	.	3	7	7	33	.
571 *Quercus cerris*	23	.	.	28	71	**67**	.	30	44	44	12	.	8	22	15	.	.	.	.	.	3	21	14	.	.
199 *Cornus mas S*	23	.	67	61	50	**83**	86	68	.	89	15	.	8	.	.	.	.	.	.	.	3	.	7	17	20
198 *Cornus mas*	23	83	67	56	71	**92**	86	73	67	100	35	.	46	78	23	.	.	.	.	.	6	7	21	67	30
294 *Fraxinus ornus*	23	100	100	89	93	**100**	43	89	78	89	96	57	100	100	62	32	4	.	.	.	3	7	14	33	20
6 *Acer monspessulanum*	23	83	17	56	93	**96**	71	89	89	67	77	.	92	100	73	20	.	.	.	.	12	.	36	50	10
539 *Potentilla micrantha*	23	33	33	56	79	**92**	14	38	67	56	50	.	15	22	.	4	.	.	.	.	.	7	21	.	10
791 *Veronica chamaedrys ssp. chamaedryoides*	23	.	17	61	79	**92**	57	78	89	100	77	.	62	44	23	4	4	.	.	.	6	21	36	50	10
319 *Hedera helix*	23	100	67	83	100	**88**	100	97	78	100	50	.	23	11	4	4	.	.	.	.	.	.	29	33	60
326 *Helleborus cyclophyllus*	23	.	50	72	79	**88**	.	41	56	44	65	.	62	78	23	4	.	.	.	.	9	.	43	.	30
670 *Selinum silaifolium*	23	83	50	17	36	**79**	14	19	11	67	38	.	.	22	4	.	.	.	.	.	.	.	7	17	30
74 *Aremonia agrimonioides*	23	33	50	78	71	**71**	.	59	67	89	31	.	15	11	4	.	.	.	.	.	9	14	14	83	10
438 *Melica uniflora*	23	17	83	94	64	**67**	14	24	22	67	42	.	.	.	.	.	.	.	.	.	3	.	14	.	30
804 *Viola odorata*	23	33	50	61	93	**67**	29	65	78	100	62	.	8	11	8	.	.	.	5	3	6	14	57	50	40
255 *Dryopteris villarii ssp. pallida*	23	33	83	67	86	**58**	43	43	44	44	27	14	69	67	31	12	.	.	.	.	3	.	.	.	20
108 *Brachypodium sylvaticum ssp. sylvaticum*	23	83	67	56	93	**46**	57	89	56	100	38	.	8	44	19	.	8	.	5	3	27	43	71	100	30
317 *Geum urbanum*	23	.	50	78	57	**46**	86	54	56	78	19	.	15	22	8	.	.	.	.	3	.	21	36	67	50
***Lathyrus laxiflorus* species group : D of *Quercus pubescens - Carpinus orientalis* community 22**																									
382 *Lathyrus laxiflorus*	16	.	.	.	.	**38**	.	24	11	33	8	.	.	.	.	.	.	.	.	.	.	.	29	17	.
283 *Festuca heterophylla*	16	.	17	6	7	**29**	.	14	.	22	8	.	.	.	4	4	.	.	.	.	.	.	.	.	.
696 *Sorbus domestica*	16	.	.	.	21	**25**	.	22	.	44	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.
366 *Jurinea mollis*	16	17	.	.	7	**21**	.	30	22	11	19	.	.	.	.	.	.	.	.	.	.	.	21	.	.
753 *Trifolium patulum*	16	17	.	.	.	**13**	.	5	.	.	27	.	.	.	.	.	4	.	.	.	3	.	21	.	.
174 *Chamaecytisus polytrichus*	16	.	.	.	.	.	.	5	22	11	19	.	.	.	.	.	4	.	.	.	.	.	.	.	.
392 *Leontodon cichoriaceus*	16	.	.	.	14	.	.	19	11	.	23	.	8	.	.	12	.	.	.	7	9	29	50	17	.
398 *Lilium chalcedonicum*	16	.	.	.	.	.	.	.	.	.	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Rosa canina* species group : D of *Rubus ulmifolius ssp. sanctus - Quercus pubescens* community 18**																									
553 *Prunus mahaleb T*	27	.	.	.	7	.	**71**	11	.	33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
552 *Prunus mahaleb S*	27	.	17	.	.	.	**43**	11	.	11	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.
551 *Prunus mahaleb*	27	.	33	17	21	13	**57**	24	.	33	4	.	15	.	4	.	.	5	.	.	3	.	.	.	.
550 *Prunus cocomilia T*	27	.	.	.	.	.	**43**	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
549 *Prunus cocomilia S*	27	.	.	.	.	.	**43**	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
170 *Cercis siliquastrum T*	27	17	17	6	.	8	**57**	19	.	22	.	.	.	.	4	.	.	.	.	.	.	.	.	.	10
169 *Cercis siliquastrum S*	27	.	.	6	.	.	**57**	41	11	.	.	.	.	.	4	.	.	.	.	.	.	7	.	.	10
168 *Cercis siliquastrum*	27	33	33	28	36	17	**57**	38	22	44	4	.	8	33	27	4	.	5	.	.	.	21	7	33	10
288 *Ficus carica T*	27	.	.	.	.	.	**29**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	20
189 *Clematis vitalba T*	27	.	.	11	7	.	**43**	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
188 *Clematis vitalba S*	27	.	.	.	.	4	**100**	38	.	.	8	.	8	.	.	.	.	.	.	.	.	.	.	.	10
187 *Clematis vitalba*	27	100	33	33	36	21	**86**	41	11	22	23	.	38	33	23	.	4	5	.	3	3	14	.	33	30
186 *Clematis flammula S*	27	.	.	.	.	.	**29**	14	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
234 *Cydonia oblonga S*	27	.	.	.	.	.	**43**	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
556 *Prunus spinosa S*	27	.	.	.	.	.	**71**	16	.	11	.	.	8	.	.	.	.	.	.	.	3	.	14	.	10
555 *Prunus spinosa*	27	.	17	.	.	8	**71**	30	22	.	12	.	.	.	8	4	.	11	5	10	15	7	14	17	10
619 *Rubus ulmifolius sanctus S*	27	17	.	6	.	.	**100**	14	11	11	.	.	.	.	.	.	.	.	.	.	.	7	.	.	20
618 *Rubus ulmifolius sanctus*	27	67	17	.	.	4	**100**	30	22	33	4	.	.	11	12	.	.	11	.	7	.	14	7	33	20
606 *Rosa canina S*	27	.	.	.	.	.	**100**	30	11	.	.	.	.	.	.	.	.	.	.	.	.	14	7	.	.
434 *Medicago polymorpha*	27	.	.	.	.	.	**57**	.	.	.	.	.	.	.	.	.	4	11	5	3	6	14	7	.	.
***Quercus pubescens* species group : D of *Quercus pubescens* with *Q. coccifera community* form 12**																									
585 *Quercus pubescens T*	22	.	.	.	14	79	100	**97**	78	89	27	.	.	.	.	.	.	.	.	.	.	.	.	33	.
584 *Quercus pubescens S*	22	.	.	.	.	75	100	**95**	67	100	31	.	.	22	.	.	.	.	.	.	9	14	14	17	.
583 *Quercus pubescens*	22	.	50	28	57	83	100	**97**	89	100	58	.	31	44	23	40	40	11	32	7	58	50	71	67	20
296 *Fraxinus ornus T*	22	33	50	28	14	79	14	**76**	33	33	35	.	.	.	.	.	.	.	.	.	.	.	.	.	.
295 *Fraxinus ornus S*	22	33	33	44	36	79	14	**92**	22	89	92	.	8	11	4	4	.	.	.	.	.	.	.	.	10
8 *Acer monspessulanum T*	22	.	.	22	50	63	57	**68**	44	22	62	.	.	.	.	.	.	.	.	.	.	.	.	.	.
7 *Acer monspessulanum S*	22	.	.	11	.	63	71	**76**	56	89	85	.	15	.	4	.	.	.	.	.	.	7	.	.	.
570 *Quercus coccifera T*	22	17	.	.	21	29	14	**46**	22	22	38	.	.	11	.	.	.	.	.	.	.	.	.	.	.
569 *Quercus coccifera S*	22	.	17	.	21	63	71	**100**	89	78	100	.	85	22	12	4	.	.	5	.	18	14	14	33	.
568 *Quercus coccifera*	22	.	33	.	57	83	100	**100**	89	89	100	.	100	56	50	56	72	5	18	.	48	50	50	67	10
364 *Juniperus oxycedrus S*	22	.	.	.	.	33	.	**62**	100	56	85	.	100	78	4	12	.	.	.	.	6	7	.	17	.
363 *Juniperus oxycedrus*	22	33	.	11	43	50	14	**70**	100	56	92	43	100	100	73	32	12	.	.	.	24	36	21	.	.
500 *Phillyrea latifolia S*	22	17	.	.	21	29	.	**65**	.	22	81	.	.	.	8	4	4	.	.	.	.	7	7	.	.
499 *Phillyrea latifolia*	22	17	.	.	29	50	29	**70**	22	33	92	.	23	11	23	36	4	.	.	.	3	7	29	17	.
194 *Colutea arborescens S*	22	.	.	.	.	38	14	**35**	44	78	46	.	8	.	.	4	.	.	.	.	.	.	7	17	10
193 *Colutea arborescens*	22	.	.	.	7	50	29	**38**	56	56	54	.	15	.	.	8	4	.	.	.	3	7	21	.	10
605 *Rosa canina*	22	.	.	.	21	25	100	**59**	56	56	46	.	23	.	4	8	.	.	.	3	9	14	21	17	20
185 *Clematis flammula*	22	.	.	6	36	63	43	**70**	44	33	65	.	15	33	4	20	16	.	14	.	15	7	21	33	10
599 *Rhamnus saxatilis*	22	.	.	6	.	17	.	**38**	33	22	50	14	23	33	15	12	4	.	.	.	3	.	7	.	.
409 *Lonicera etrusca*	22	.	17	11	21	67	14	**86**	44	78	54	.	8	.	.	.	.	.	.	.	3	.	14	.	10
129 *Campanula spatulata ssp. spruneriana*	22	17	17	56	79	58	57	**89**	89	78	54	14	85	89	42	.	.	.	5	7	45	86	43	33	10
709 *Tamus communis*	22	.	67	61	14	71	57	**81**	44	78	65	.	.	.	12	.	.	.	.	.	3	.	21	.	30
79 *Asparagus acutifolius*	22	.	.	.	29	17	86	**76**	22	11	54	.	15	22	35	16	8	5	.	.	3	.	7	.	.
239 *Dactylis glomerata ssp. glomerata*	22	67	33	72	93	54	29	**76**	100	67	73	.	100	100	100	52	88	16	41	24	73	50	64	33	.
182 *Cirsium creticum*	22	17	.	11	29	67	14	**62**	22	78	35	.	8	.	4	.	4	.	.	.	3	.	7	17	10
624 *Ruscus aculeatus*	22	.	33	22	64	50	57	**59**	22	67	46	.	.	.	.	.	.	.	.	.	.	.	.	.	.
306 *Galium monasterium*	22	17	.	17	14	29	29	**54**	67	44	69	14	62	11	.	16	16	.	.	.	12	7	7	17	.
406 *Lithospermum purpurocaeruleum*	22	33	17	.	14	54	29	**51**	11	89	50	.	.	11	.	.	.	.	.	.	.	.	57	33	.
414 *Luzula forsteri*	22	.	.	11	29	83	.	**46**	33	56	42	.	.	.	.	.	.	.	.	.	15	14	29	33	.
143 *Carex guestphalica*	22	17	17	11	21	42	57	**32**	22	56	54	.	46	11	12	4	.	5	.	17	33	71	57	50	.
347 *Hypericum spruneri*	22	.	.	17	43	46	57	**32**	67	11	65	14	92	78	42	36	8	5	.	3	18	50	21	17	.
85 *Asplenium adiantum-nigrum*	22	.	.	11	50	46	14	**27**	11	22	58	.	8	.	.	.	.	.	.	.	.	.	7	.	.
107 *Brachypodium pinnatum*	22	.	.	.	.	21	.	**24**	56	.	35	.	46	56	19	.	.	.	.	.	9	.	14	.	.
***Pyrus amygdaliformis* species group : D of *Quercus pubescens* with *Juniperus oxycedrus* community form 13**																									
563 *Pyrus amygdaliformis S*	21	.	.	.	.	.	.	16	**44**	.	.	.	8	.	8	4	.	.	.	.	.	.	.	.	.
562 *Pyrus amygdaliformis*	21	.	.	.	.	.	29	22	**44**	.	.	.	31	11	12	8	24	.	9	10	9	.	7	.	.
253 *Dorycnium herbaceum*	21	17	.	.	.	.	.	8	**44**	11	12	.	8	.	.	8	24	.	.	.	15	.	.	.	.
466 *Ononis spinosa*	21	33	.	.	.	.	.	.	**22**	.	12	.	8	.	.	8	.	.	.	.	21	.	.	.	.
244 *Daucus carota*	21	.	.	.	.	4	.	5	.	.	.	.	.	.	.	.	.	.	36	.	.	.	.	.	.

Plant community Number		15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
***Pteridium aquilinum* species group : D of *Quercus pubescens* with *Cornus mas* community form 14**																									
547 *Prunus avium T*	30	.	17	.	.	4	29	5	.	**44**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
545 *Prunus avium*	30	.	17	.	.	4	14	24	22	**33**	.	.	8	.	.	4	4	.	.	.	3	7	7	33	.
200 *Cornus mas T*	30	.	33	28	29	29	14	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
321 *Hedera helix T*	30	.	.	28	21	4	57	38	.	**56**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
320 *Hedera helix S*	30	17	.	.	7	4	.	19	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
577 *Quercus frainetto*	30	.	.	.	.	.	.	5	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
726 *Tilia platyphyllos*	30	33	.	33	29	13	14	8	11	**11**	.	.	.	.	.	.	.	.	.	.	.	.	.	17	.
637 *Sambucus nigra*	30	.	50	.	14	25	29	30	11	**56**	4	.	.	.	.	.	.	.	.	.	3	.	7	.	60
603 *Rosa arvensis*	30	.	17	6	.	29	.	19	22	**22**	12	.	.	.	.	4	.	.	.	.	.	.	.	.	.
616 *Rubus caesius*	30	33	17	11	7	8	.	22	.	**22**	.	.	8	11	.	.	.	.	.	.	.	.	.	17	30
272 *Euonymus europaeus*	30	17	67	17	7	21	29	35	11	**56**	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
559 *Pteridium aquilinum*	30	.	17	.	.	13	.	.	11	**100**	.	.	.	.	.	.	.	.	.	.	3	.	14	100	20
78 *Arum italicum*	30	.	33	6	7	4	57	14	.	**44**	4	.	.	.	15	.	.	11	.	.	3	.	7	17	40
378 *Lapsana communis*	30	17	17	33	14	8	43	14	.	**44**	.	.	.	.	.	.	.	.	.	.	.	.	14	.	50
290 *Fragaria vesca*	30	.	17	.	7	4	.	3	.	**33**	8	.	.	.	.	.	.	.	.	.	.	7	.	33	.
459 *Myrrhoides nodosa*	30	17	17	50	36	17	100	43	11	**33**	.	.	.	.	4	4	.	.	.	.	.	21	14	17	80
125 *Calamintha nepeta*	30	**83**	33	11	29	4	29	3	.	**22**	4	.	8	11	12	.	.	5	5	.	.	14	21	.	.
163 *Centaurium erythraea ssp. erythraea*	30	.	.	.	.	4	.	.	11	**22**	4	.	.	.	.	4	.	.	.	.	.	.	.	33	.
534 *Polypodium vulgare*	30	17	.	22	**64**	8	.	5	.	**11**	8	14	8	.	.	.	.	.	.	.	.	.	.	.	.
544 *Prunella vulgaris*	30	**100**	.	6	21	8	.	.	.	**11**	.	.	.	.	.	.	.	.	.	.	3	7	21	17	10
580 *Quercus ilex*	30	17	.	17	29	.	.	3	.	.	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.
416 *Lysimachia punctata*	30	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	.	.	.	.	33	.
15 *Acer pseudoplatanus*	30	17	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7	33	20
38 *Ajuga reptans*	30	.	.	11	**36**	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Corylus avellana* species group : D of *Quercus pubescens* with *Cornus mas* community form 14**																									
212 *Corylus avellana T*	29	.	.	.	7	.	.	3	.	**33**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
211 *Corylus avellana S*	29	.	.	.	7	4	.	5	33	**33**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
210 *Corylus avellana*	29	33	.	.	7	8	.	5	22	**33**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
538 *Populus tremula T*	29	.	.	.	.	8	.	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
536 *Populus tremula*	29	.	.	.	.	8	.	.	.	**22**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Pistacia terebinthus* species group : D of *Carpinus orientalis - Quercus coccifera* community 11**																									
512 *Pistacia terebinthus S*	15	.	.	.	.	4	.	16	.	.	**38**	.	8	.	.	.	.	.	.	.	.	.	.	.	.
511 *Pistacia terebinthus*	15	.	.	.	7	8	.	14	.	.	**46**	29	15	.	12	4	.	.	.	.	.	.	.	.	.
558 *Psoralea bituminosa*	15	.	.	.	.	.	.	19	.	.	**27**	.	8	.	12	20	40	.	18	.	9	.	7	.	.
719 *Thesium linophylon ssp. linophylon*	15	.	.	.	.	.	.	.	.	.	**27**	.	.	.	.	4	12	.	.	.	.	.	.	.	.
Athamanta macedonica species group : D of Asperula chlorantha - Centaurea pawlowskii community 17																									
93 *Athamanta macedonica*	9	67	.	.	.	.	.	.	.	.	4	**100**	23	.	12	20	.	.	.	.	3	.	7	.	.
81 *Asperula chlorantha*	9	50	.	.	.	.	.	.	.	.	19	**86**	77	44	31	16	.	.	.	.	3	.	.	.	.
644 *Satureja montana ssp. montana*	9	17	.	.	.	.	.	.	.	.	4	**86**	69	22	19	12	.	.	.	.	3	.	.	.	.
445 *Micromeria cremnophila*	9	33	.	.	.	.	.	.	.	.	4	**43**	15	.	12	8	.	.	.	.	3	.	.	.	.
561 *Pterocephalus perennis ssp. bellidifolius*	9	.	.	.	.	.	.	.	.	.	.	**43**	23	.	.	8	.	.	5	.	3	.	.	.	.
632 *Salvia officinalis*	9	33	.	.	.	4	.	.	.	.	.	**29**	46	78	35	8	.	.	.	.	3	.	.	.	.
666 *Sedum dasyphyllum*	9	.	.	.	.	.	.	.	.	.	.	**29**	8	.	.	4	.	.	.	.	3	.	.	.	.
Centaurea pawlowskii species group : D of Asperula chlorantha - Centaurea pawlowskii community 17																									
158 *Centaurea pawlowskii*	10	.	.	.	.	.	.	.	.	.	.	**86**	.	.	8	8	.	.	.	.	.	.	.	.	.
225 *Crepis turcica*	10	.	.	.	.	.	.	.	.	.	.	**57**	.	.	4	.	.	.	.	.	.	.	.	.	.
346 *Hypericum rumeliacum ssp. apollinis*	10	.	.	.	.	.	.	.	.	.	.	**57**	.	.	8	12	.	.	.	.	.	.	.	.	.
678 *Silene cephallenia*	10	.	.	.	.	.	.	.	.	.	.	**57**	.	.	4	.	.	.	.	.	.	.	.	.	.
716 *Teucrium flavum ssp. hellenicum*	10	.	.	.	.	.	.	.	.	.	.	**57**	.	.	4	8	.	.	.	.	.	.	.	.	.
275 *Euphorbia characias spp. wuffenii*	10	.	.	6	.	.	.	.	.	.	.	**43**	.	.	4	.	.	.	.	.	.	.	.	.	.
681 *Silene fabarioides*	10	17	.	.	.	.	.	.	.	.	.	**43**	.	.	.	.	.	5	.	.	.	.	.	.	.
48 *Alyssoides utriculata*	10	.	.	.	.	.	.	.	.	.	.	**29**	.	.	.	8	.	.	.	.	.	.	.	.	.
Erysimum cephalonicum species group : D of Quercus coccifera - Juniperus oxycedrus community 10																									
271 *Erysimum cephalonicum*	8	.	.	.	.	.	14	3	11	.	.	.	**92**	22	19	16	.	.	.	.	.	.	7	.	10
353 *Inula oculus-christi*	8	.	.	.	.	.	.	3	.	.	.	.	**69**	22	4	12	.	.	5	.	9	.	.	.	.
162 *Centaurea zucchariniana*	8	.	.	.	.	4	.	5	22	.	4	.	**62**	.	.	16	28	.	14	3	9	.	.	.	.
242 *Daphne oleoides*	8	.	.	6	.	4	.	.	.	.	4	.	**62**	.	8	4	.	.	.	.	.	.	.	.	.
304 *Galium divaricatum*	8	17	.	.	7	8	.	11	22	.	15	29	**62**	.	8	32	24	.	18	.	24	7	7	.	.
360 *Juniperus foetidissima*	8	.	.	.	7	4	.	3	11	.	.	.	**62**	33	15	.	.	.	.	.	.	.	.	.	.
668 *Sedum ochroleucum*	8	.	.	.	.	.	.	5	11	.	15	14	**62**	22	4	28	.	.	.	3	3	.	.	.	.
329 *Hieracium cymosum ssp. cymosum*	8	.	.	.	.	.	.	3	11	.	12	.	**54**	.	.	12	4	.	.	.	.	.	.	.	.
22 *Acinos alpinus ssp. majoranifolius*	8	.	.	.	.	.	.	.	11	.	4	.	**46**	.	.	16	.	.	.	.	3	.	.	.	.
612 *Rosa pulverulenta*	8	.	.	.	7	4	.	.	11	.	4	.	**46**	11	8	.	.	.	.	.	.	.	.	.	.
700 *Sorbus umbellata*	8	.	.	.	.	.	.	.	.	.	.	.	**38**	.	.	.	.	.	.	.	.	.	.	.	.
20 *Achillea holosericea*	8	.	.	.	.	.	.	.	.	.	.	.	**31**	11	.	.	.	.	.	.	.	.	.	.	.
68 *Arabis muralis*	8	.	.	.	.	.	.	.	.	.	4	29	**31**	.	.	8	4	.	.	.	.	.	.	.	.
332 *Hieracium pannosum cf.*	8	.	.	.	.	.	.	.	.	.	.	.	**31**	.	4	4	.	.	.	3	3	.	.	.	.
405 *Lithospermum incrassatum*	8	.	.	.	.	.	.	.	.	.	4	.	**31**	.	15	12	4	.	.	.	3	.	7	.	.
18 *Achillea clypeolata*	8	.	.	.	.	.	.	.	.	.	.	14	**23**	.	.	.	.	.	.	.	.	.	.	.	.
76 *Armeria canescens*	8	.	.	.	.	.	.	.	.	.	.	.	**23**	.	.	4	.	.	.	.	.	.	.	.	.
589 *Ramonda serbica*	8	.	.	.	.	.	.	.	.	.	8	**57**	**23**	.	4	.	.	.	.	.	.	.	.	.	.
803 *Viola kitaibeliana*	8	.	.	.	.	4	.	.	.	.	.	.	**23**	.	4	.	.	.	.	.	.	.	.	.	.
447 *Minuartia attica*	8	.	.	.	.	.	.	.	.	.	.	29	**15**	.	4	.	.	.	.	.	.	.	.	.	.
Galium aparine species group : D of Quercus coccifera - Juniperus oxycedrus community 10																									
759 *Trifolium speciosum*	19	.	.	6	7	13	14	16	33	.	8	.	**77**	33	46	12	.	.	5	10	18	.	.	.	.
369 *Koeleria nitidula*	19	.	.	.	.	.	.	.	33	.	19	71	**54**	11	8	52	28	.	.	.	9	.	7	.	.
389 *Legousia speculum-veneris*	19	.	.	6	7	8	29	16	11	11	.	.	**54**	22	35	12	.	32	18	34	15	.	.	17	10
476 *Orlaya daucoides*	19	.	.	6	.	.	.	5	.	.	.	.	**54**	.	8	8	16	11	9	.	15	7	21	.	.
741 *Trifolium arvense*	19	.	.	.	.	.	.	14	44	.	35	.	**54**	22	23	48	12	.	.	28	33	14	7	.	.
43 *Allium guttatum ssp. sardoum*	19	.	.	.	.	.	.	11	11	.	4	.	**46**	22	19	52	12	5	18	.	3	7	.	.	.
311 *Geranium lucidum*	19	33	17	39	57	21	29	38	22	22	15	.	**46**	44	62	8	.	.	18	3	15	14	.	17	30
437 *Melica ciliata*	19	.	.	6	.	.	57	19	11	.	8	29	**46**	22	54	20	4	.	.	7	.	14	.	.	10
742 *Trifolium aurantiacum*	19	.	.	11	7	4	.	3	11	.	4	.	**46**	22	23	8	.	.	.	3	9	7	14	.	.
458 *Myosotis sylvatica ssp. cyanea*	19	.	.	39	50	21	.	16	11	11	15	.	**38**	.	8	.	.	11	5	3	3	.	21	17	30
720 *Thlaspi perfoliatum*	19	.	.	33	29	17	14	8	22	22	4	.	**38**	33	35	24	4	5	5	.	9	.	.	.	10
250 *Dictamnus albus*	19	.	.	.	.	.	.	.	.	.	.	.	**23**	.	.	.	.	.	.	3	.	.	.	.	.
303 *Galium aparine*	19	50	50	61	93	29	86	49	11	33	31	.	**23**	44	65	8	.	26	5	.	6	7	29	17	90
478 *Ornithogalum montanum*	19	.	17	.	.	4	.	5	11	.	12	29	**23**	33	31	56	44	11	45	.	18	.	7	.	.
781 *Valerianella dentata*	19	.	.	.	.	.	.	.	.	.	8	.	**23**	22	.	32	12	.	.	3	3	.	.	.	.
455 *Muscari neglectum*	19	.	.	.	7	4	.	3	.	.	4	.	**15**	.	8	48	16	.	5	3	9	.	7	17	.
597 *Rhagadiolus stellatus*	19	.	.	11	14	4	86	30	.	11	4	.	**15**	11	46	4	4	5	27	.	9	29	7	.	10
151 *Celtis australis*	19	50	17	11	21	.	14	14	.	.	12	.	**8**	22	31	4	.	.	.	3	.	.	.	.	.
285 *Fibigia clypeata*	19	.	.	.	.	.	.	.	.	.	.	.	**8**	22	4	.	.	.	.	.	.	.	.	.	.
Erodium cicutarium	19	.	.	.	.	.	.	.	11	.	.	.	.	.	4	16	.	5	41	21	6	7	.	.	.

Plant community number		15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
***Acinos suaveolens species* group : D of *Salvia officinalis - Carpinus orientalis* community 9**																									
485 *Paliurus spina-christi S*	7	.	.	.	.	.	.	8	.	.	4	.	8	**33**	4	.	.	.	.	.	.	.	.	.	.
484 *Paliurus spina-christi*	7	.	.	.	.	.	.	3	.	.	4	.	15	**56**	12	.	.	.	.	.	.	.	.	.	.
506 *Phlomis fruticosa*	7	17	.	.	29	8	.	14	22	.	15	43	54	**56**	92	28	16	11	27	3	9	7	.	.	.
276 *Euphorbia deflexa*	7	17	33	50	57	25	14	5	22	11	8	14	100	**100**	77	32	.	.	.	.	9	14	14	.	10
284 *Festuca jeanpertii*	7	17	.	.	7	8	.	11	67	11	23	29	100	**100**	38	48	8	.	.	.	12	.	7	.	.
475 *Origanum vulgare*	7	50	17	6	21	13	43	24	22	56	4	.	54	**100**	54	4	8	.	9	3	3	14	14	33	10
23 *Acinos suaveolens*	7	.	.	.	7	4	.	3	11	.	.	.	46	**89**	69	.	4	.	.	3	.	.	.	.	.
30 *Aethionema saxatile ssp. oreophilum*	7	.	.	.	.	.	.	.	11	11	.	57	69	**89**	38	36	.	.	.	.	.	.	.	.	.
69 *Arabis sagittata*	7	.	.	.	7	4	14	14	33	22	19	14	92	**89**	35	24	4	.	5	.	30	7	21	17	.
171 *Ceterach officinarum*	7	.	17	28	93	58	.	19	33	22	42	57	92	**89**	85	32	4	.	5	3	.	.	7	.	.
314 *Geranium robertianum ssp. purpureum*	7	33	17	39	21	21	14	41	33	.	31	57	77	**89**	73	44	4	5	9	.	9	.	21	.	20
393 *Leontodon crispus ssp. asper*	7	.	.	.	.	4	.	3	11	.	35	71	100	**89**	58	44	12	.	9	3	.	7	14	.	.
71 *Arabis verna*	7	.	.	.	14	8	.	.	.	.	15	14	62	**78**	54	24	.	.	5	.	3	.	.	.	10
431 *Medicago lupulina*	7	50	.	.	7	8	14	8	22	.	15	.	69	**78**	19	8	8	5	.	7	27	7	21	.	10
449 *Minuartia hybrida*	7	.	.	.	7	.	.	.	11	.	12	.	46	**78**	77	48	40	5	45	3	30	7	7	.	.
109 *Briza humilis*	7	.	.	.	.	8	.	.	.	.	.	.	15	**67**	19	16	.	.	.	.	.	.	7	.	.
279 *Euphorbia myrsinites*	7	.	.	.	.	.	.	8	33	.	12	.	85	**67**	65	48	24	.	32	3	24	.	7	.	.
780 *Valerianella coronata*	7	.	.	.	.	.	.	.	.	.	4	.	31	**67**	15	8	16	.	14	.	3	.	.	.	.
128 *Campanula ramosissima*	7	.	.	11	.	4	.	.	.	.	4	.	31	**56**	85	8	.	16	18	.	3	7	.	.	10
154 *Centaurea affinis spp pallidior*	7	.	.	.	.	.	14	3	.	11	.	.	23	**56**	15	4	.	5	9	.	9	7	14	.	.
446 *Micromeria juliana*	7	.	.	.	.	.	.	5	.	.	8	57	38	**56**	65	24	8	.	9	.	.	.	.	.	.
479 *Orobanche alba*	7	.	.	11	.	4	.	3	.	.	.	.	31	**56**	27	8	4	.	5	3	.	.	.	.	.
714 *Taraxacum gracilens cf.*	7	17	.	.	14	.	.	.	.	.	.	.	8	**56**	15	.	4	5	18	3	9	14	.	.	.
738 *Tragopogon crocifolius ssp. samaritani*	7	.	.	.	.	.	.	5	.	.	.	.	62	**56**	15	16	4	16	.	10	21	29	7	.	.
652 *Scandix australis ssp. grandiflora*	7	.	.	.	.	4	.	3	.	.	8	.	77	**44**	65	40	12	5	5	.	9	.	.	.	.
219 *Crepis dioscoridis*	7	.	.	.	.	8	29	5	.	.	4	14	31	**33**	**81**	8	8	5	.	7	3	.	.	.	.
648 *Saxifraga tridactylites*	7	.	.	.	.	.	.	.	22	.	8	14	38	**33**	35	44	12	.	27	7	9	7	.	.	.
268 *Erophila verna*	7	.	.	.	7	.	.	.	.	11	4	.	46	**22**	35	36	16	.	41	14	21	29	7	.	.
661 *Sedum acre*	7	.	.	.	.	.	.	3	11	.	.	.	46	**22**	38	32	4	.	18	.	3	.	7	.	.
814 *Xeranthemum inapertum*	7	.	.	.	.	.	.	.	.	.	4	.	23	**22**	4	.	.	.	.	.	.	.	.	.	.
Helianthemum nummularium* species group : D of *Salvia officinalis - Carpinus orientalis community 9																									
706 *Stipa bromoides*	6	17	17	17	29	29	.	43	44	22	35	14	38	**100**	62	32	56	.	9	.	21	7	36	.	.
323 *Helianthemum nummularium*	6	.	.	.	.	4	.	27	44	11	35	.	92	**89**	27	92	88	.	55	3	61	7	29	.	.
309 *Geranium columbinum*	6	.	.	.	7	8	.	19	33	.	12	.	85	**89**	35	64	68	5	9	.	55	7	29	33	.
144 *Carex halleriana*	6	.	.	.	.	8	.	27	33	11	58	.	77	**89**	27	56	60	.	14	7	15	7	36	33	.
477 *Orlaya daucorlaya*	6	.	.	6	14	17	29	16	44	.	19	.	77	**89**	77	72	52	26	32	10	33	21	29	17	.
715 *Teucrium chamaedrys ssp. chamaedrys.*	6	50	.	.	36	21	29	46	89	22	62	.	100	**89**	38	48	52	5	14	3	30	14	36	.	.
206 *Coronilla scorpioides*	6	.	.	.	.	.	.	3	.	.	23	.	46	**89**	35	68	48	5	5	.	6	7	14	.	.
307 *Galium parisiense*	6	17	.	.	.	.	43	5	33	.	23	.	31	**78**	85	44	36	.	18	7	12	7	7	.	10
717 *Teucrium polium*	6	.	.	.	.	.	.	14	22	.	15	.	92	**67**	31	52	76	.	41	7	30	.	7	.	.
246 *Desmazeria rigida*	6	.	.	.	7	8	14	22	44	.	35	.	38	**67**	69	44	72	16	55	.	12	7	7	.	.
50 *Alyssum repens*	6	.	.	.	.	.	14	22	22	11	15	.	100	**67**	85	72	56	.	59	.	36	7	21	17	.
226 *Crucianella angustifolia*	6	.	.	.	7	17	.	8	67	.	46	.	92	**67**	19	48	52	.	.	.	30	.	21	.	.
229 *Crupina vulgaris*	6	.	.	.	.	8	.	3	.	.	23	.	54	**67**	35	52	44	.	5	.	3	.	.	.	.
223 *Crepis sancta*	6	.	.	.	.	.	14	5	.	.	.	.	23	**56**	81	20	12	42	50	24	12	.	.	.	.
667 *Sedum hispanicum*	6	.	.	11	.	4	.	5	.	.	15	14	77	**44**	81	52	52	.	73	10	12	7	14	.	.
702 *Stachys germanica ssp. heldreichii*	6	.	.	.	.	.	.	11	11	.	.	.	46	**44**	58	28	48	5	45	7	36	.	7	.	.
722 *Thymus longicaulis ssp. chaubardii*	6	.	.	.	14	8	.	35	78	.	69	.	38	**44**	27	16	44	.	.	.	36	7	14	33	.
689 *Silene ungeri*	6	.	.	.	.	.	.	8	11	.	.	.	31	**44**	50	32	12	5	23	7	24	7	14	.	.
650 *Scabiosa tenuis*	6	.	.	6	.	.	.	3	11	.	8	14	62	**33**	65	44	44	5	59	10	12	.	.	.	.
462 *Nigella damascena*	6	.	.	.	.	.	57	16	11	.	4	.	23	**33**	58	28	32	5	32	7	15	.	7	17	.
64 *Anthyllis vulneraria ssp. pulchella*	6	.	.	.	.	.	.	.	11	.	4	14	69	**33**	12	44	24	.	9	.	9	7	.	.	.
503 *Phleum montanum*	6	.	.	.	.	.	.	5	33	22	12	.	54	**33**	15	36	4	.	5	.	.	.	.	.	.
195 *Consolida regalis ssp. paniculata*	6	.	.	.	.	4	.	5	.	.	4	.	.	**22**	15	36	52	.	55	3	9	.	.	.	.
683 *Silene graeca*	6	.	.	.	.	.	.	3	.	.	.	.	15	**22**	15	28	24	.	23	3	6	.	.	.	.
197 *Convolvulus cantabrica*	6	.	.	.	.	.	.	3	.	.	4	.	15	.	38	72	48	5	36	.	3	.	.	.	.
***Lonicera etrusca* species group : D of *Salvia officinalis - Carpinus orientalis* community 9**																									
782 *Valerianella rimosa*	14	.	.	.	.	.	.	.	11	.	4	.	.	**33**	4	4	.	.	.	.	.	.	.	.	.
675 *Seseli peucedanoides*	14	.	.	.	.	.	.	22	11	.	.	.	.	**22**	.	.	.	5	.	7	3	29	.	.	.
410 *Lonicera etrusca S*	14	.	.	.	.	.	.	24	.	.	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
***Malabaila aurea* species group : D of *Phlomis fruticosa* community 8**																									
417 *Malabaila aurea*	12	.	.	.	.	.	71	3	.	.	.	.	.	.	**58**	4	.	.	5	.	.	.	.	.	.
653 *Scandix pecten - veneris*	12	.	.	.	.	.	14	5	.	.	4	.	23	11	**54**	12	.	21	9	7	.	.	.	.	.
262 *Ephedra campylopoda*	12	.	.	.	.	4	.	.	.	.	8	43	38	11	**42**	28	.	.	.	.	.	.	.	.	.
695 *Sonchus asper*	12	.	.	.	14	.	43	22	22	11	.	14	15	.	**42**	.	4	42	9	10	3	7	.	.	.
95 *Aurinia saxatilis ssp. orientalis*	12	17	.	.	.	.	14	.	.	.	4	57	.	.	**35**	4	.	.	14	.	.	.	.	.	.
384 *Lathyrus setifolius*	12	.	.	.	.	.	.	5	.	.	.	.	23	33	**35**	16	4	.	.	3	.	7	.	17	.
299 *Fumaria officinalis*	12	.	.	.	.	.	14	.	.	.	.	14	.	.	**31**	8	.	11	.	.	.	.	.	.	.
315 *Geranium rotundifolium*	12	.	.	.	.	.	.	3	.	.	4	.	8	.	**31**	12	.	.	.	.	.	.	.	.	.
110 *Briza maxima*	12	.	.	.	.	.	.	5	.	.	4	.	15	22	**27**	16	4	.	.	.	.	.	.	.	.
488 *Papaver dubium*	12	.	.	.	.	.	.	.	.	.	.	.	8	11	**27**	.	.	.	.	.	3	.	.	.	.
443 *Mercurialis annua*	12	.	.	.	.	.	.	.	.	.	.	.	.	.	**23**	4	.	.	5	.	.	.	.	.	.
480 *Orobanche caryophyllacea*	12	.	.	28	.	.	.	3	.	.	.	14	.	.	**23**	4	4	11	.	10	.	.	.	.	.
256 *Echinops spinosissimus ssp. neumayeri*	12	.	.	.	.	.	.	.	.	.	.	.	.	.	**19**	4	.	.	.	.	.	.	.	.	.
522 *Plumbago europaea*	12	.	.	6	.	.	43	14	.	.	.	.	.	.	**15**	4	.	32	9	10	6	7	.	.	.
776 *Urospermum picroides*	12	.	.	.	.	.	.	.	.	.	.	.	.	.	**15**	.	.	.	.	.	.	.	.	.	.
***Picris pauciflora* species group : D of *Phlomis fruticosa* community 8**																									
508 *Picris pauciflora*	11	.	.	.	.	.	.	3	.	.	4	14	15	22	**35**	44	16	.	14	7	3	.	.	.	10
439 *Melilotus neapolitanus*	11	.	.	.	.	.	.	3	.	.	.	.	15	44	**19**	16	24	.	9	.	9	.	.	.	.
635 *Salvia viridis*	11	.	.	.	.	.	.	.	.	.	.	.	.	.	**4**	8	20	.	.	.	.	.	.	.	.
***Minuartia mediterranea* species group : D of *Helianthemum nummularium - Trifolium dalmaticum* with *Jasminum fruticans* community form 7**																									
49 *Alyssum alyssoides*	18	.	.	.	.	.	.	.	11	.	.	.	8	11	15	**40**	12	11	55	14	.	.	.	.	.
625 *Ruta graveolens*	18	.	.	.	.	.	.	3	.	.	.	.	.	44	.	**32**	4	.	9	.	.	.	.	.	.
36 *Ajuga chamaepitys*	18	.	.	.	.	.	.	3	.	.	.	.	.	.	4	**28**	16	.	18	.	.	.	7	.	.
159 *Centaurea salonitana*	18	.	.	.	.	.	.	8	11	.	.	.	8	11	8	**28**	12	11	45	10	24	7	7	.	.
450 *Minuartia mediterranea*	18	.	.	.	.	.	.	.	.	.	.	.	8	**67**	27	**28**	4	.	27	3	3	.	.	.	.
115 *Bromus squarrosus*	18	.	.	.	.	4	.	3	.	.	4	.	38	11	27	**24**	.	11	18	.	.	.	7	.	.
498 *Petrorhagia saxifraga*	18	.	.	.	.	.	.	3	.	.	.	.	.	.	.	**24**	24	.	.	.	3	.	.	.	.
404 *Linum tenuifolium*	18	.	.	.	.	.	.	.	.	.	4	.	38	.	.	**20**	.	.	5	.	6	.	7	.	.
767 *Trinia glauca ssp. pindica*	18	.	.	.	.	.	.	.	.	.	.	.	23	33	12	**20**	32	.	5	.	3	.	.	.	.
41 *Allium cupani ssp. cupani*	18	.	.	.	.	.	.	.	.	.	.	.	.	**33**	12	**16**	4	.	.	.	6	.	.	.	.
701 *Stachys annua ssp. annua*	18	33	.	.	.	.	.	.	.	.	.	.	.	.	.	**8**	.	.	.	.	.	.	.	.	.
***Jasminum fruticans* species group : D of *Helianthemum nummularium - Trifolium dalmaticum* with *Jasminum fruticans* community form 7**																									
356 *Jasminum fruticans*	17	.	.	.	7	.	29	35	.	.	31	29	8	.	23	**44**	8	.	5	.	.	.	.	.	.
324 *Helictotrichon convolutum*	17	33	.	.	7	4	.	.	11	.	23	43	23	.	12	**28**	.	.	.	.	.	.	.	.	.
766 *Trigonella monspeliaca*	17	.	.	.	.	.	.	3	.	.	.	.	15	11	19	**28**	12	.	.	.	3	.	.	.	.
397 *Lilium canditum*	17	.	.	.	.	.	.	.	.	.	4	.	.	.	4	**24**	4	.	.	.	.	.	7	.	.
413 *Lupinus albus spp. graecus*	17	.	.	.	.	.	.	.	.	.	12	.	.	.	.	**24**	.	.	.	.	.	.	.	.	.
705 *Steptorhamphus tuberosus*	17	.	.	.	.	.	.	.	.	.	4	.	.	.	4	**24**	4	.	.	.	.	.	.	.	.

Plant community Number		**15**	**23**	**24**	**21**	**22**	**18**	**12**	**13**	**14**	**11**	**17**	**10**	**9**	**8**	**7**	**6**	**4**	**5**	**3**	**2**	**1**	**20**	**19**	**16**
***Aegilops neglecta* species group : D of *Helianthemum nummularium - Trifolium dalmaticum* typical community form 6**																									
25 *Aegilops neglecta*	13	.	.	.	.	.	.	8	11	.	4	.	.	.	4	48	**76**	16	50	.	73	.	7	17	.
122 *Bupleurum glumaceum*	13	.	.	.	.	.	.	8	11	.	12	.	46	.	12	32	**76**	.	9	.	24	7	14	.	.
557 *Psilurus incurvus*	13	.	.	.	.	.	.	.	11	.	.	.	.	.	.	24	**68**	.	27	3	33	7	7	.	.
740 *Trifolium angustifolium*	13	.	.	.	7	.	.	24	.	.	8	.	.	22	15	12	**64**	5	9	3	42	.	36	.	.
277 *Euphorbia flavicoma*	13	.	.	.	.	.	.	.	.	.	.	.	8	.	.	20	**60**	5	18	21	33	.	7	.	.
270 *Eryngium campestre*	13	.	.	.	.	.	43	43	67	11	15	.	69	33	19	40	**56**	16	41	31	85	14	36	50	.
289 *Fillago vulgaris*	13	.	.	.	.	.	.	5	11	.	4	.	.	.	12	20	**48**	5	9	14	30	.	.	.	.
813 *Xeranthemum cylindraceum*	13	.	.	.	.	.	.	5	.	.	15	.	.	.	.	36	**44**	.	5	.	15	.	.	.	.
145 *Carlina corymbosa*	13	.	.	.	.	.	.	30	33	.	12	.	.	.	8	4	**40**	.	27	.	24	.	.	17	.
403 *Linum strictum*	13	.	.	.	.	.	.	.	.	.	8	.	8	22	4	20	**40**	.	9	.	18	.	.	.	.
463 *Onobrychis caput-galli*	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**32**	.	14	.	.	.	.	.	.
336 *Hippocrepis unisiliqua*	13	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	**28**	.	5	.	.	.	.	.	.
464 *Onobrychis montana ssp. scardica*	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	**28**	.	.	.	.	.	.	.	.
596 *Reichardia picroides*	13	.	.	.	.	.	.	3	.	.	.	.	.	.	.	4	**28**	.	5	.	9	.	.	.	.
721 *Thymelaea passerina*	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8	**28**	.	.	.	6	.	.	.	.
784 *Velezia rigida*	13	.	.	.	.	.	.	3	.	.	.	.	.	.	.	12	**24**	.	14	.	.	.	.	.	.
***Hordeum murinum* species group : D of *Marrubium peregrinum* community 4**																									
340 *Hordeum murinum*	2	17	.	.	.	.	43	3	.	.	4	.	.	.	4	4	.	**89**	14	41	6	.	.	.	30
623 *Rumex pulcher*	2	.	.	.	.	.	86	14	.	.	.	.	8	.	23	.	.	**89**	23	52	9	29	7	.	30
132 *Capsella bursa-pastoris*	2	.	.	.	.	8	29	5	.	.	.	.	8	.	35	4	.	**79**	32	38	6	14	7	.	40
737 *Torilis nodosa*	2	.	.	.	.	.	43	5	.	.	.	.	15	.	27	4	.	**79**	23	21	9	.	14	.	20
137 *Carduus pycnocephalus*	2	.	.	.	.	.	29	14	.	.	.	.	.	.	73	12	8	**74**	27	17	3	.	7	.	.
692 *Sisymbrium officinale*	2	.	.	.	.	.	29	.	.	.	.	.	.	.	8	.	.	**74**	27	28	6	.	.	.	20
426 *Marrubium peregrinum*	2	.	.	.	.	.	14	3	.	.	.	.	.	.	.	.	.	**68**	36	10	6	.	.	.	10
112 *Bromus hordaceous*	2	.	.	.	.	.	29	3	11	11	4	.	31	.	27	16	8	**63**	14	45	33	57	7	.	.
429 *Medicago arabica*	2	.	.	.	7	.	14	.	.	.	.	.	8	.	4	.	.	**63**	14	41	9	57	14	.	30
442 *Mentha longifolia*	2	33	.	.	.	.	43	.	.	.	.	.	.	.	4	.	.	**53**	.	10	12	14	.	.	.
139 *Carduus tmoleus*	2	.	.	.	.	.	57	3	11	.	.	.	.	11	12	4	8	**47**	14	14	12	7	.	.	.
278 *Euphorbia helioscopia*	2	.	.	.	.	.	.	3	.	.	.	.	.	.	4	8	.	**42**	41	10	3	7	.	.	.
433 *Medicago orbicularis*	2	.	.	.	.	.	57	.	.	.	.	.	15	33	42	8	44	**42**	41	52	33	14	21	.	.
489 *Papaver rhoeas*	2	.	.	.	.	.	43	5	.	.	.	.	.	.	42	4	.	**42**	23	14	.	.	.	.	20
425 *Malva sylvestris*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	**26**	18	21	9	.	.	.	10
119 *Bunias erucago var. macropetala*	2	.	.	.	.	.	.	.	.	.	.	.	8	.	31	4	.	**21**	36	28	3	7	.	.	.
196 *Convolvulus arvensis*	2	.	.	.	.	4	.	3	.	.	.	.	.	.	.	.	.	**21**	14	24	3	7	7	17	30
257 *Echium italicum*	2	.	.	.	.	.	14	.	.	.	4	.	.	.	4	.	.	**21**	23	31	12	7	.	.	.
655 *Scolymus maculatus*	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**21**	.	.	.	.	.	.	.
787 *Verbascum pulverulentum*	2	17	.	.	.	.	14	.	11	.	4	.	.	22	8	4	.	**16**	32	7	.	.	7	.	.
***Sambucus ebulus* species group : D of *Marrubium peregrinum* community 4**																									
704 *Stellaria media*	1	.	.	33	43	.	.	5	.	.	4	.	8	.	15	.	.	**47**	9	.	.	7	14	.	30
636 *Sambucus ebulus*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**37**	.	.	.	.	.	.	.
541 *Potentilla reptans*	1	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.	.	**32**	5	.	.	.	14	.	10
424 *Malva neglecta*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**21**	9	.	.	.	.	.	.
428 *Marrubium vulgare*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**21**	.	.	.	.	.	.	.
494 *Persicaria salicifolia*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**21**	5	.	.	.	.	.	10
80 *Asperugo procumbens*	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**11**	.	.	.	.	.	.	**30**
***Chondrilla juncea* species group : D of *Trifolium nigrescens* typical community 3**																									
178 *Chondrilla juncea*	3	.	.	.	.	.	.	.	.	.	.	.	.	.	8	8	.	21	41	**76**	15	36	.	.	.
732 *Tordylium apulum*	3	.	.	.	.	.	57	3	.	.	.	.	8	.	50	20	32	68	59	**76**	36	36	.	17	.
656 *Scorzonera laciniata*	3	.	.	.	.	.	.	14	11	.	.	.	23	.	15	24	48	47	73	**72**	45	.	.	.	.
96 *Avena barbata*	3	.	.	.	.	.	43	8	.	.	.	.	.	11	58	36	52	42	50	**59**	21	7	.	.	.
435 *Medicago rigidula*	3	17	.	.	.	.	.	.	.	.	.	.	8	.	27	8	32	26	82	**59**	55	21	.	17	.
222 *Crepis rubra*	3	.	.	.	.	.	.	.	.	.	.	.	8	.	23	16	12	47	32	**55**	12	14	.	.	.
57 *Anchusa cretica*	3	.	.	.	.	.	.	8	.	.	.	.	.	.	35	24	8	16	41	**52**	24	7	.	.	.
166 *Cerastium glomeratum*	3	.	.	.	.	4	.	.	.	.	4	.	8	33	15	4	8	53	32	**38**	39	.	14	.	.
65 *Aphanes arvensis*	3	.	.	.	.	.	.	3	.	.	.	.	.	22	46	12	8	16	41	**34**	30	21	7	.	.
101 *Berteroa obliqua*	3	.	.	.	7	.	14	3	.	.	.	.	.	.	35	.	.	32	32	**34**	.	7	.	.	.
58 *Anchusa hybrida*	3	.	.	.	.	.	14	.	.	.	.	.	.	.	8	8	12	11	27	**28**	15	7	.	.	.
368 *Knautia integrifolia*	3	.	.	6	.	.	.	8	22	.	4	.	54	11	62	8	4	16	41	**14**	42	29	.	33	.
243 *Dasypyrum villosum*	3	.	.	.	.	.	.	.	.	.	.	.	8	.	**42**	8	.	11	9	**10**	12	.	.	.	10
734 *Tordylium officinale*	3	.	.	.	.	.	29	3	.	.	.	.	15	11	50	12	4	11	55	**10**	9	.	.	.	.
388 *Legousia hybrida*	3	.	.	.	.	.	.	.	.	.	4	.	23	33	35	8	4	5	.	**3**	3	.	.	.	10
99 *Bellardia trixago*	3	.	.	.	.	.	.	.	.	.	.	.	.	.	19	.	.	.	.	.	.	.	.	.	.
***Medicago minima* species group : D of *Trifolium nigrescens* with *Dianthus viscidus* community form 2**																									
348 *Hypochoeris cretensis*	5	.	.	.	7	.	57	27	22	11	4	.	15	33	50	24	68	74	77	83	**100**	79	29	17	.
525 *Poa bulbosa ssp. pseudoconcinna*	5	50	.	11	7	17	71	43	56	33	46	43	100	78	85	96	92	37	95	83	**97**	86	57	17	10
540 *Potentilla recta*	5	.	.	.	21	.	29	38	67	33	46	.	69	78	31	76	92	11	23	45	**97**	79	50	83	10
640 *Sanguisorba minor ssp. muricata*	5	17	.	11	29	13	71	41	78	22	23	14	100	100	81	60	56	16	73	79	**97**	86	43	50	.
238 *Cynosurus echinatus*	5	.	.	.	21	13	71	49	67	22	23	.	38	22	46	24	60	21	50	21	**94**	57	64	.	.
432 *Medicago minima*	5	.	.	.	7	.	29	16	33	.	12	.	77	78	92	80	84	32	95	83	**91**	43	14	17	.
517 *Plantago lanceolata*	5	.	.	.	.	.	14	3	33	.	.	.	31	22	27	32	72	47	59	90	**91**	64	14	17	.
677 *Sherardia arvensis*	5	17	.	.	7	.	86	14	44	11	12	.	38	33	88	76	84	68	86	93	**88**	86	29	17	.
165 *Cerastium brachypetalum ssp. roeseri*	5	.	.	6	7	38	71	32	89	11	54	14	85	100	96	80	68	63	64	48	**85**	93	64	17	10
745 *Trifolium dalmaticum*	5	.	.	.	7	8	29	22	22	.	23	.	69	89	92	72	100	42	68	59	**85**	43	36	.	.
751 *Trifolium nigrescens*	5	.	.	.	.	.	57	5	11	11	.	.	23	44	50	4	12	79	55	100	**82**	71	36	.	.
35 *Aira elegantissima*	5	.	.	.	.	.	29	8	33	.	19	.	23	11	4	24	24	.	5	28	**79**	93	29	17	.
490 *Parentucellia latifolia*	5	.	.	.	.	.	14	.	22	.	.	.	8	11	8	12	32	5	59	69	**79**	36	.	.	.
743 *Trifolium campestre*	5	.	.	.	29	4	43	38	67	11	42	.	77	100	54	68	92	16	14	38	**79**	50	29	.	.
221 *Crepis neglecta*	5	.	.	.	.	.	57	14	22	.	4	.	69	44	85	44	56	79	100	97	**76**	36	.	17	.
179 *Cichorium intybus*	5	.	.	.	7	.	57	19	11	.	4	.	23	33	38	.	24	47	64	76	**73**	71	36	17	20
60 *Anthemis arvensis*	5	.	.	.	.	21	14	.	44	11	15	.	77	89	73	52	48	68	77	72	**70**	29	14	.	.
795 *Veronica verna*	5	.	.	.	.	4	29	5	33	.	12	.	31	44	69	40	48	68	91	90	**70**	71	21	.	10
497 *Petrorhagia prolifera*	5	.	.	.	.	.	14	8	11	.	8	.	77	44	23	32	32	.	45	72	**67**	14	14	17	.
345 *Hypericum perforatum*	5	17	17	.	.	4	71	14	22	.	8	.	15	11	23	16	36	5	27	28	**64**	43	14	.	.
451 *Moenchia mantica*	5	.	.	.	.	.	14	5	11	.	.	.	8	.	.	.	.	11	5	41	**64**	71	14	17	.
760 *Trifolium stellatum ssp. xanthinum*	5	.	.	.	.	.	29	11	33	11	12	.	46	33	69	12	24	16	23	66	**61**	86	21	17	.
761 *Trifolium striatum*	5	.	.	.	.	.	.	5	22	.	15	.	23	.	8	28	4	16	27	24	**61**	36	14	.	.
810 *Vulpia myuros*	5	.	.	.	.	.	.	.	11	.	.	.	15	.	27	.	16	37	32	83	**61**	71	21	17	.
75 *Arenaria serpyllifolia*	5	.	.	.	.	.	.	11	.	.	12	.	69	78	77	76	64	53	95	72	**58**	7	.	17	.
744 *Trifolium cherleri*	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	12	28	5	5	31	**58**	7	.	.	.
762 *Trifolium subterraneum*	5	.	.	.	.	.	14	5	.	.	4	.	.	33	15	4	16	26	18	41	**48**	71	.	17	10
116 *Bromus sterilis*	5	67	.	6	14	29	86	30	33	11	31	29	62	56	85	52	4	89	41	48	**45**	86	43	17	80
735 *Torilis arvensis*	5	50	17	.	21	38	100	57	56	56	42	.	85	78	81	32	24	21	14	14	**45**	57	50	17	40
457 *Myosotis stricta*	5	.	.	.	.	.	.	11	22	11	4	.	23	78	38	24	16	26	32	28	**42**	57	14	.	10
809 *Vulpia ciliata*	5	.	.	.	.	.	29	8	11	.	.	.	15	11	27	40	56	42	77	52	**42**	21	.	.	.
254 *Draba muralis*	5	.	.	6	.	13	43	14	67	.	15	.	46	56	69	8	8	21	27	14	**39**	71	57	17	40
313 *Geranium molle*	5	50	.	.	.	.	29	19	.	22	4	.	23	22	73	4	4	79	77	86	**39**	79	7	17	40
454 *Muscari comosum*	5	17	.	.	7	.	.	24	.	.	35	29	8	11	27	56	36	11	23	38	**39**	43	50	50	.
799 *Vicia peregrina*	5	.	.	.	.	.	14	5	.	.	.	.	38	44	38	20	12	11	14	24	**18**	57	7	.	.

Plant community Number		15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
***Dianthus viscidus* species group : D of *Trifolium nigrescens* with *Dianthus viscidus* community form 2**																									
248 *Dianthus viscidus*	20	.	.	.	.	.	.	5	22	.	4	.	8	.	.	.	.	.	.	.	33	21	14	.	.
758 *Trifolium resupinatum*	20	.	.	.	.	.	.	.	.	.	.	.	8	.	4	.	.	26	.	7	9	.	.	.	.
232 *Cyclamen hederifolium*	20	.	.	.	.	13	.	14	.	.	.	.	8	.	27	8	.	.	.	.	3	.	.	.	.
***Lotus corniculatus* species group : D of *Trifolium nigrescens* with *Bellis perennis* community form 1**																									
100 *Bellis perennis*	4	33	.	.	36	17	43	35	67	33	19	.	23	44	23	.	4	21	18	34	85	93	57	17	20
411 *Lotus corniculatus*	4	.	.	.	.	.	14	14	67	22	8	.	46	33	15	.	52	5	27	14	94	71	43	33	.
593 *Ranunculus neapolitanus*	4	33	.	11	29	25	29	65	78	33	42	.	31	67	19	4	56	21	18	24	70	71	79	67	.
752 *Trifolium ochroleucum*	4	17	.	6	21	25	14	41	78	44	27	.	38	22	.	.	4	5	.	28	30	71	50	17	.
754 *Trifolium physodes*	4	.	.	.	21	21	29	46	78	.	42	.	54	89	15	12	24	32	14	48	67	71	43	17	.
543 *Prunella laciniata*	4	17	.	.	14	4	14	19	89	22	50	.	77	56	31	20	64	.	9	10	88	64	36	33	.
328 *Hieracium bauhini*	4	17	.	.	29	8	14	30	89	44	35	.	69	100	15	24	36	.	9	10	70	57	21	33	.
190 *Clinopodium vulgare*	4	33	17	28	29	42	86	57	78	78	27	.	23	33	4	4	4	.	5	.	27	43	50	50	.
528 *Poa trivialis ssp. sylvicola*	4	33	.	22	14	13	57	38	44	33	4	.	.	.	4	.	4	42	5	14	24	43	57	17	80
207 *Coronilla varia*	4	.	.	.	7	.	29	11	22	11	4	.	31	44	19	4	4	.	.	3	21	36	29	33	10
228 *Cruciata laevipes*	4	17	.	17	57	25	86	73	67	67	23	.	8	22	23	.	4	.	.	7	12	36	71	100	40
31 *Agrimonia eupatoria ssp. eupatoria*	4	.	.	.	7	.	43	27	.	22	12	.	8	22	15	.	.	5	.	3	12	29	36	33	.
380 *Lathyrus aphaca*	4	.	.	6	36	29	14	38	33	11	12	.	31	56	12	8	12	.	.	.	21	29	43	17	.
408 *Lolium perenne*	4	.	.	.	7	4	57	27	67	.	8	.	8	.	35	8	20	32	14	31	55	29	7	.	.
436 *Medicago sativa ssp. falcata*	4	.	.	.	7	.	43	27	44	11	27	.	46	33	15	12	20	16	14	7	64	29	29	.	.
757 *Trifolium repens*	4	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	11	5	10	18	21	14	.	40
756 *Trifolium pratense*	4	17	.	.	.	.	43	5	22	.	.	.	23	.	8	4	8	21	5	7	36	7	29	.	.
***Parietaria officinalis* species group : D of *Parietaria officinalis* community 16**																									
492 *Parietaria officinalis*	31	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	100
733 *Tordylium maximum*	31	.	.	.	.	4	43	.	11	11	.	.	.	.	8	.	.	11	.	.	.	.	21	33	90
777 *Urtica dioica*	31	.	17	11	.	.	43	3	.	.	.	.	.	.	.	.	.	21	.	.	.	.	14	17	90
231 *Cuscuta europaea*	31	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	60
173 *Chaerophyllum temulentum*	31	50	17	33	.	.	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	17	40
281 *Fallopia dumetorum*	31	17	.	.	7	.	14	.	.	.	.	14	.	.	.	.	.	.	.	3	.	21	21	33	30
Companion species																									
801 *Vicia tenuifolia*	999	17	.	11	.	21	57	24	44	22	8	.	15	22	50	16	16	.	18	10	18	14	21	17	.
736 *Torilis leptophylla*	999	17	.	6	43	13	.	30	33	.	27	.	15	22	19	12	16	5	5	3	18	7	14	.	10
141 *Carex distachya*	999	.	.	.	36	17	.	27	33	11	19	14	8	22	15	20	8	.	9	3	6	7	.	.	20
470 *Opopanax chironium*	999	.	.	.	14	13	14	19	.	33	27	.	8	.	8	16	4	5	5	10	12	7	36	17	30
797 *Vicia grandiflora*	999	.	.	22	21	17	57	24	.	22	.	.	.	.	8	4	4	5	.	3	15	14	29	17	10
134 *Cardamine hirsuta*	999	17	.	6	36	13	14	19	44	.	12	.	8	33	23	8	.	.	9	.	3	.	14	.	10
594 *Ranunculus psilostachys*	999	.	.	17	.	4	14	11	11	11	12	.	31	56	19	20	.	5	.	10	3	7	.	.	10
527 *Poa pratensis*	999	17	.	.	7	4	14	16	11	11	8	.	15	.	4	8	4	5	9	10	21	36	7	.	.
385 *Lathyrus sphaericus*	999	.	.	.	.	.	.	5	22	.	.	.	15	.	15	12	16	.	5	.	24	14	7	.	.
261 *Elytrigia intermedia*	999	.	.	.	.	.	29	11	11	.	12	.	23	.	4	12	24	.	.	.	6	.	14	.	.
59 *Anemone pavonina*	999	17	.	.	21	8	.	5	.	11	4	.	8	22	23	16	.	.	5	.	6	.	.	.	.
37 *Ajuga orientalis*	999	.	.	.	.	.	.	11	11	.	4	.	38	22	12	.	.	11	14	.	9	.	.	.	.
502 *Phleum echinatum*	999	.	.	.	.	.	.	5	22	.	.	.	8	33	23	16	4	.	14	.	6	.	.	.	.
55 *Anacamptis pyramidalis*	999	.	.	.	14	13	.	5	.	.	.	.	.	11	4	12	28	.	14	.	.	.	7	.	.
113 *Bromus intermedius*	999	.	.	.	.	.	14	5	11	.	12	.	15	.	8	28	4	.	.	3	9	.	.	.	.
390 *Lens ervoides*	999	.	.	.	29	13	.	5	.	.	15	.	.	11	15	4	.	.	5	.	.	21	.	.	.
224 *Crepis setosa*	999	.	.	.	.	.	14	5	11	.	4	.	8	.	8	.	4	16	18	17	3	.	.	.	.
327 *Herniaria incana*	999	.	.	.	.	.	.	.	.	.	.	.	31	11	23	4	8	5	14	7	6	.	.	.	.
788 *Verbascum speciosum ssp. megaphlomos*	999	.	.	.	.	.	29	5	.	.	.	.	.	.	19	.	4	16	18	17	.	.	.	.	.
217 *Crataegus monogyna*	999	.	.	.	36	17	14	8	11	.	8	.	8	11	.	4	.	.	.	3	3	.	.	.	.
351 *Inula conyza*	999	.	.	.	7	8	14	14	.	33	4	.	8	22	12	.	.	5	.	.	.	.	7	.	.
663 *Sedum amplexicaule ssp. tenuifolium*	999	.	.	.	7	.	14	8	33	.	12	.	8	11	8	4	.	.	.	.	6	21	.	.	.
150 *Carum multiflorum*	999	.	.	.	.	8	.	22	11	.	8	.	8	11	.	.	.	.	5	.	6	14	.	.	.
334 *Himantoglossum caprinum*	999	.	.	.	.	4	14	3	.	.	4	.	.	11	23	.	12	.	.	.	12	7	7	.	.
504 *Phleum pratense ssp. bertolonii*	999	.	.	.	.	.	.	5	11	.	12	.	15	33	12	.	.	.	.	.	15	.	7	.	.
614 *Rosa spec.*	999	33	.	22	21	4	.	5	11	11	4	.	.	11	12	.	.	.	.	.	.	.	7	.	.
2 *Acanthus balcanicus*	999	.	.	17	21	21	.	5	.	.	4	14	.	.	8	.	.	.	.	.	.	.	7	17	.
440 *Melissa officinalis*	999	17	.	.	.	8	43	14	.	11	.	.	8	.	.	.	.	5	.	.	3	14	7	17	.
783 *Valerianella turgida*	999	.	.	.	.	.	.	3	.	.	.	.	23	11	12	8	4	5	.	.	6	14	14	17	.
291 *Frangula rupestris*	999	17	33	6	7	4	.	8	.	33	8	.	15	11	4	.	.	.	.	.	.	.	.	.	.
310 *Geranium dissectum*	999	.	.	.	.	.	.	.	.	.	.	.	8	.	.	.	4	26	.	10	15	14	7	.	.
739 *Tragopogon dubius*	999	.	.	.	.	.	14	.	.	.	.	.	.	.	19	20	.	5	9	14	.	.	.	.	.
800 *Vicia sativa*	999	.	.	.	.	8	.	3	11	33	.	.	8	11	4	8	4	.	.	.	3	21	7	.	.
786 *Verbascum densiflorum*	999	.	.	.	.	.	.	3	11	.	.	.	31	.	12	8	.	.	14	3	3	.	.	17	.
796 *Vicia disperma*	999	.	.	.	.	4	.	5	.	.	12	.	8	22	.	12	20	.	.	.	.	.	.	.	.
40 *Allium amethystinum*	999	.	17	.	.	.	43	11	.	.	.	.	8	.	8	4	.	5	5	.	.	.	14	.	.
56 *Anagalis arvensis*	999	.	.	.	7	.	.	3	.	.	.	.	.	.	15	16	8	.	9	.	6	.	.	.	.
245 *Delphinium peregrinum*	999	.	.	6	7	.	.	14	.	.	.	.	.	.	4	12	8	.	5	.	6	.	.	.	.
381 *Lathyrus cicera*	999	.	.	.	.	.	.	.	.	.	.	.	.	33	8	4	8	5	.	7	12	7	.	.	.
591 *Ranunculus millefoliatus*	999	.	.	.	.	4	.	5	.	.	4	.	31	11	.	16	.	.	.	.	3	7	.	.	10
615 *Rostraria cristata*	999	.	.	.	.	.	.	.	.	.	.	.	.	.	15	.	8	16	14	10	3	.	.	.	.
19 *Achillea grandifolia*	999	.	17	22	7	8	.	3	.	11	4	14	8	.	.	.	.	.	.	.	.	.	.	17	10
467 *Onopordum bracteatum*	999	.	.	.	.	.	14	3	.	.	.	.	.	11	19	.	.	11	9	7	3	.	.	.	.
712 *Tanacetum parthenium*	999	.	17	17	7	17	.	.	.	22	12	.	.	.	.	4	.	.	.	.	.	.	.	.	.
674 *Seseli montanum ssp. tommasinii*	999	.	.	6	.	.	14	5	.	.	4	.	.	.	4	16	8	.	.	.	3	7	.	.	.
763 *Trigonela corniculata*	999	.	.	.	.	.	.	3	.	.	.	.	.	11	4	12	8	5	23	.	.	.	.	.	.
218 *Crataegus monogyna S*	999	17	.	.	14	13	14	11	.	.	4	.	.	11	.	.	.	.	.	.	.	.	.	.	.
230 *Cuscuta epithymum ssp. kotschyi*	999	.	.	.	.	.	.	.	.	.	.	.	23	11	12	4	4	.	.	.	9	.	7	.	.
237 *Cynoglossum columnae*	999	17	.	.	7	.	29	3	.	.	.	.	.	.	12	.	.	11	5	3	3	.	.	.	.
331 *Hieracium murorum cf.*	999	17	.	11	7	8	.	8	.	33	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
472 *Orchis quantripunctata*	999	.	.	.	.	.	.	3	.	.	4	.	23	.	.	16	8	.	.	.	.	14	.	.	.
685 *Silene latifolia ssp. alba*	999	.	.	6	7	.	.	8	.	11	.	.	.	11	4	.	.	11	.	.	.	.	.	17	20
775 *Umbilicus rupestris*	999	.	.	6	21	.	14	8	.	.	8	.	.	.	8	.	.	.	.	.	3	.	.	.	.
3 *Acer campestre*	999	.	.	6	21	4	.	5	.	22	.	.	8	.	4	.	.	.	.	.	.	7	.	.	.
106 *Brachypodium distachyon*	999	.	.	.	.	.	.	3	.	.	.	.	.	.	.	20	16	.	.	.	6	.	.	.	.
657 *Scrophularia canina spp. bicolor*	999	.	.	.	.	.	.	3	.	.	.	.	23	.	8	12	.	.	.	3	6	.	.	.	.
322 *Hedypnois cretica*	999	.	.	.	.	.	.	.	.	.	.	.	.	.	8	.	8	.	14	14	.	.	.	.	.
343 *Huetia cynapioides ssp. cynapioides*	999	.	.	11	14	4	.	5	.	11	4	.	.	.	.	4	.	.	.	.	.	.	.	17	.
349 *Hypochoeris radicata*	999	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5	17	12	7	.	.	.
391 *Lens nigricans*	999	.	.	.	.	.	.	3	.	.	8	.	.	33	4	4	4	.	.	.	3	.	7	.	.
394 *Leontodon hispidus ssp. hispidus*	999	.	.	.	7	4	.	3	.	.	.	.	.	.	.	.	.	.	5	.	6	14	21	.	.
487 *Papaver apulum*	999	.	.	.	.	.	.	.	.	.	.	.	15	.	19	.	.	5	.	10	.	.	.	.	.
493 *Pastinaca sativa ssp. urens*	999	.	.	.	.	.	.	.	.	.	.	.	8	.	12	.	8	5	5	3	3	7	.	.	.
651 *Scaliregia napiformis*	999	.	.	.	.	.	.	.	.	.	8	.	8	.	4	20	8	.	.	.	.	.	.	.	.
707 *Stipa pennata ssp. pulcherrima*	999	.	.	.	.	.	.	.	.	.	8	14	8	.	4	20	4	.	.	.	.	.	.	.	.
748 *Trifolium hirtum*	999	.	.	.	.	4	.	3	11	.	.	.	8	.	4	8	.	.	9	.	.	.	7	17	.
779 *Valeriana italica*	999	17	.	.	7	.	.	8	.	.	.	.	15	.	4	12	.	.	.	.	.	.	.	.	.
34 *Agrostis stolonifera*	999	.	.	6	.	4	.	5	.	.	4	.	.	.	.	.	.	5	.	3	3	7	.	17	.
365 *Juniperus oxycedrus ssp. oxycedrus T*	999	.	.	.	.	8	14	8	11	22	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.
469 *Ophrys scolopax ssp. cornuta*	999	.	.	.	.	.	.	.	.	.	4	.	.	.	.	8	8	.	5	.	9	7	.	.	.

Plant community Number		15	23	24	21	22	18	12	13	14	11	17	10	9	8	7	6	4	5	3	2	1	20	19	16
471 *Orchis morio*	999				7			3								8	4				9	7	7		
509 *Pimpinella tragium ssp. polyclada*	999							5					8				4		5	3	3		7	17	10
633 *Salvia scarlea*	999						14	3							12			5	18						
662 *Sedum album*	999			6					22			14			8	12								17	
664 *Sedum atratum*	999														8	4			9	10	6				
713 *Taraxacum*	999							3					8		4	8		5	5		6	7			
47 *Althaea hirsuta*	999														12	12	12								
181 *Cirsium arvense*	999					4		3	11				8		4		4	5					7		10
205 *Coronilla emerus ssp. emeroides S*	999					4		8	11		15														
486 *Pallenis spinosa*	999													11	12		12		9						
654 *Scleranthus annuus ssp. annuus*	999													11		20			5	7					
26 *Aegilops triuncialis*	999							3									12				9		7		
33 *Agrostis gigantea*	999				7		14	3		11	4										3			33	
102 *Biarum tenuifolium*	999							3						11	8		4		9			7			
265 *Epipactis microphylla*	999				14	13		5			4														
300 *Gagea pusilla*	999							3								8		5		3	6			17	
507 *Picnomon acarna*	999										4		8		19	4									
523 *Poa angustifolia*	999					4	14	5			4									3	3		7		
548 *Prunus cocomilia*	999			6			29	3					8					5	5	3					
688 *Silene remotiflora*	999							5					8		12	4			5						
812 *Xeranthemum annuum*	999												8		8	8	4		5				7		
62 *Anthoxanthum odoratum*	999					4			11												9	14			
82 *Asphodelina lutea*	999										8				12	8									
103 *Bidens frondosa*	999	17						3			4	14			12										
142 *Carex flacca*	999							3	11		4						8				3		7		
191 *Clypeola jonthlaspi*	999														8	12			9						
227 *Crucianella latifolia*	999							3							4	12	8								
339 *Hordeum bulbosum*	999						29				4		8					5		3					10
373 *Lactuca viminea*	999					4								11	8	4		11							
375 *Lamium amplexicaulis*	999												8		8			11	9						
402 *Linum nodiflorum*	999															4	16				6				
501 *Phillyrea latifolia T*	999				7	8		3			12														
529 *Podocytisus caramanicus*	999								11	11	15					4									
595 *Raphanus raphanistrum*	999		17	17		4																		17	10
646 *Saxifraga graeca*	999			6	14	4										8						7			
728 *Tilia platyphyllos T*	999		17	11		8	14	3																	
792 *Veronica cymbalaria*	999																4	21	5		3				
90 *Astragalus glycyphyllos*	999	17						5															14	17	
117 *Bromus tectorum*	999																	11	14	3					
138 *Carduus thoermeri*	999										4	14		22	8										
160 *Centaurea solstitialis ssp. solstitialis*	999												8			4		16			3				
183 *Cirsium eriophorum*	999								11		4				4			5			3	7			
192 *Colchicum autumnale*	999										8					4	8						7		
280 *Euphorbia seguieriana ssp. niciciana*	999							5	11							12									
372 *Lactuca serriola*	999							3							12					3					10
379 *Lathyrus annuus*	999						14	3					15				4					7			
387 *Lavatera thuringiaca ssp. ambigua*	999														12					3			14		
422 *Malus sylvestris*	999							5		22	4							5							
564 *Pyrus amygdaliformis T*	999							11	11						4										
607 *Rosa canina x R.pulverulenta*	999	17						3					8								3	7		17	
698 *Sorbus domestica T*	999					4		11		11															
802 *Vincetoxicum fuscatum*	999		17								4		8	22	4										
815 *Ziziphora capitata*	999															12	12								
45 *Allium sphaerocephalon*	999			6				5								8									
84 *Asphodelus fistulosus*	999					4									4	12									
104 *Bifora testiculata*	999										4		8						5	3		7			
361 *Juniperus foetidissima S*	999							5	11				15												
461 *Nigella arvensis*	999															8			5	3	3				
465 *Ononis spec.*	999	17																11			3		7		
473 *Orchis tridentata*	999													11	4	8					3				
586 *Quercus trojana*	999					4		5			4			11											
587 *Quercus trojana S*	999							8			4			11											
588 *Quercus trojana T*	999					4		8			4														
617 *Rubus caesius S*	999			6		4				11			8												10
622 *Rumex cristatus*	999												8					16		3					
627 *Salix amplexicaulis*	999															4	8			3			7		
669 *Sedum rubens*	999					4								11		8	4								
671 *Senecio squalidus*	999												8					5	14						
697 *Sorbus domestica S*	999					4		8		11															
746 *Trifolium glomeratum*	999							3						11	4					3	3				
749 *Trifolium incarnatum*	999												8							3	6	7			
764 *Trigonella gladiata*	999							3							4	8			5						
67 *Arabis caucasica*	999	17		6						11		14													
114 *Bromus scoparius*	999																	11	5		3				
155 *Centaurea calsitrapa*	999												8					11	5						
184 *Cistus creticus*	999							3								4	4		5						
236 *Cynodon dactylon*	999							3										5	9						
282 *Ferulago nodosa*	999							3							4	8									
301 *Galanthus nivalis*	999					13		3																	
312 *Geranium macrorrhizum*	999		17	6								14				4									
316 *Geranium versicolor*	999	17		11	7																				
383 *Lathyrus niger*	999					8		3		11															
395 *Leontodon tuberosus*	999																				9			17	
400 *Linaria peloponnesiaca var. parnassica*	999												15		8										
401 *Linaria simplex*	999															12			5						
419 *Malus domestica*	999						14	8																	
430 *Medicago coronata*	999						14								4		4				3				
491 *Parietaria lusitanica*	999														8	4			5						
505 *Phleum subulatum*	999														8		4				3				
590 *Ranunculus ficaria*	999		17	6																			7		10
604 *Rosa arvensis S*	999					4		5	11																
672 *Serapias vomeracea*	999																				9	7			
691 *Silybum marianum*	999														4			11			3				
693 *Sisymbrium orientale*	999							5											9						
718 *Thalictrum minus ssp. olympicum*	999		17	11							4														
723 *Tilia cordata*	999		17	11				3																	
581 *Quercus ilex S*	999							3				14													

Plant communities	
No	Name
1	*Trifolium nigrescens* community, *Bellis perennis* form
2	*Trifolium nigrescens* community, *Dianthus viscidus* form
3	*Trifolium nigrescens* community, typical form
4	*Marrubium peregrinum* community
5	*Alyssum alyssoides - Poa bulbosa* community
6	*Helianthemum nummularium - Trifolium dalmaticum* community, typical form
7	*Helianthemum nummularium - Trifolium dalmaticum, Jasminum fruticans* form
8	*Phlomis fruticosa* community
9	*Salvia officinalis – Carpinus orientalis* community
10	*Quercus coccifera - Juniperus oxycedrus* community
11	*Carpinus orientalis – Quercus coccifera* community
12	*Quercus pubescens* community, *Q.coccifera* typical form
13	*Quercus pubescens* community, *Juniperus oxycedrus* form
14	*Quercus pubescens* community, *Cornus mas* form
15	*Platanus orientalis* community
16	*Parietaria officinalis* community
17	*Asperula chlorantha - Centaurea pawlowskii* community
18	*Rubus ulmifolius* ssp. *sanctus – Quercus pubescens* community
19	*Brachypodium sylvaticum* community, *Pteridium aquilinum* form
20	*Brachypodium sylvaticum* community, typical form
21	*Carpinus orientalis* community
22	*Quercus pubescens - Carpinus orientalis* community
23	*Juglans regia – Acer obtusatum* community
24	*Acer obtusatum – Ostrya carpinifolia* community

PHOTO ANNEX

Photo 1.1: Vikos village

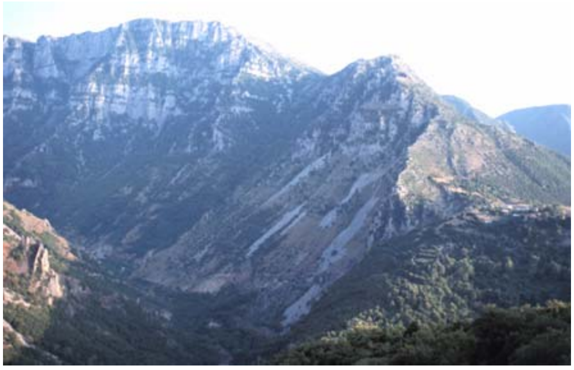

Photo 1.2: Study area

Photo 2.1: Southern slopes of Tymfi Mount and Vikos gorge

Photo 2.2: Main part of Vikos gorge "Oxia" site, Monodendri.

Photo 2.3: Slopes with mixed deciduous forest

Photo 2.4: Mixed forest of *Ostrya* stand with *Tilion-Acerion* species.

Photo 2.5: *Abies borisii-regis* stand

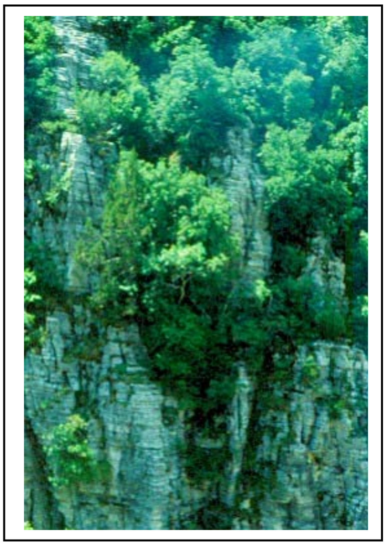

Photo 2.6: *Quercus ilex* forest fragment

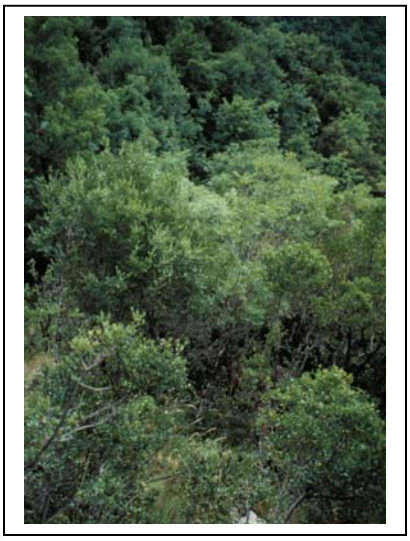

Photo 2.7: Pseudomachie woodland

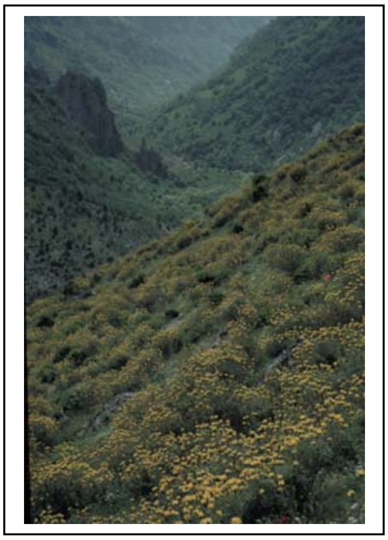

Photo 2.8: Phrygana of *Phlomis fruticosa*

Photo 2.9: Subalpine grasslands

Photo 2.10: *Platanus orientalis* riparian forest

Photo 2.11: Secondary grasslands on terraces

Photo 2.12: Rocky grasslands with *Orchis morio* stand

Photo 2.13: Chasmophytic vegetation

Photo 2.14: Vikos village – threashing floor

Photo 2.15: Terraces with tree hedges

Photo 2.16: Terraced watered garden

Photo 2.17: Grass-cutting in terraced meadow

Photo 2.18: Grazed area near Vikos village

Photo 2.19: Sheep grazing at fallow field

Photo 2.20: Shredded oaks

Photo 4.1: *Ostrya carpinifolia* stand

Photo 4.2: *Carpinus orientalis* woodland

Photo 4.3: *Quercus pubescens* forest

Photo 4.4: Grazed shrublands

Photo 4.5: Garigue with *Quercus coccifera*
Juniperus oxycedrus

Photo 4.6: Garigue of *Salvia officinalis* –
Carpinus orientalis

Photo 4.7: Rocky grassland with *Jasminum fruticans*

Photo 4.8: Rocky grassland with *Poa bulbosa*

Photo 4.9: Meadows with *Trifolium nigrescens*

Photo 4.10: Grassland with *Dianthus viscidus*

Photo 4.11: Grassland with *Bellis perennis*

Photo 4.12: Forest fringe vegetation

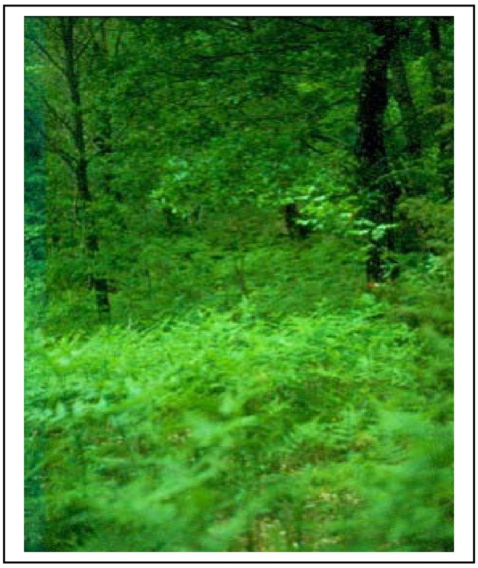

Photo 4.13: Forest fringe with *Pteridium aquilinum*

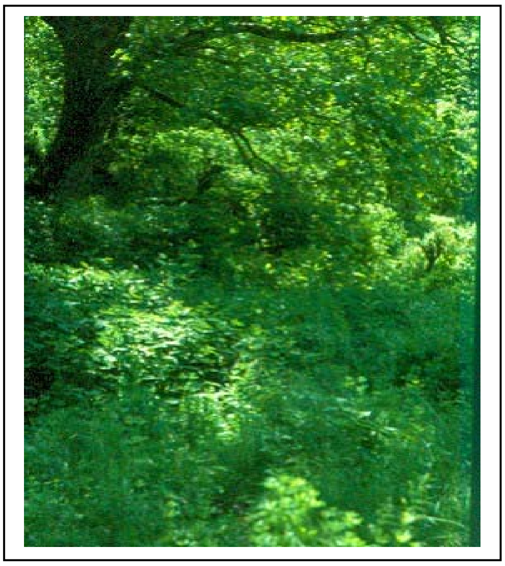

Photo 4.14: *Parietaria officinalis* forest fringe