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Environmental systems, vegetation belts and potential vegetation of the Monti Sibillini (Central Italy)

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Abstract. A synthesis map (scale of 1: 300,000) of the Monti Sibillini group (Central Italy), which represents contemporaneously the principal environmental and vegetation characteristics of the territory studied, is presented. This map of the potential vegetation also contains phytosociological (vegetation typology), ecological (environmental system and altitudinal belt) and phytogeographic information (chorology of the associations), and so constitutes an objective foundation for dividing the territory in ecological-environmental terms and for identifying environmental units necessary for landscape planning.

Key words: environmental systems, vegetation belts, potential vegetation, vegetation mapping, Monti Sibillini

Introduction

The present work presents a synthesis map (scale of 1:300,000) of the Monti Sibillini group (Central Italy) that represents contemporaneously the principal environmental and vegetation characteristics of the zone in question. This phytosociological map of the potential vegetation compiled according to classic methods (Tüxen 1956; Braun-Blanquet 1964; Falinski 1990-91) also indicates environmental systems and altitudinal belts; the resulting work is a geobotanical map enriched with ecological information, as suggested by Falinski (1993). Such a map constitutes the foundation for ecological-environmental subdivision of the territory and identification of its environmental units.

The Monti Sibillini group

The Monti Sibillini group (Central Apennines) extends from north to south for about 40 km, its crest line marking the watershed between the Adriatic side (Marches Region) and the Tyrrhenian one (Umbria Region); the highest peak is Monte Vettore, at 2,476 meters. The group is characterized by a quite varied morphology with abrupt or widely rounded peaks, glacial cirques, narrow, sharply incised valleys and karst basins with dolines and small lakes. The climate is suboceanic with annual precipitation between 600 and 1,000 mm in the hilly belt and between 1,000 and 1,600 mm in the montane belt (Pedrotti 1982a; Biondi *et al.* 1991; Orsomando *et al.* 1999).

Man's influence on the environment has been very strong due to deforestation and transformation of the original forest vegetation into grazing lands, woodcutting, livestock husbandry, above all of sheep, carbon production and agricultural activity even at very high altitudes, for example on the slopes of Monte Colle la Croce as far as 1,700 m. Thus the current vegetation of the Monti Sibillini is to a great degree formed of secondary grasslands; there are, however, also forest areas, sometimes quite vast. The real vegetation, or the current natural vegetation, and the potential vegetation of the Monti Sibillini are represented on different maps for the Marches, Umbria, individual parts of the group or all of Italy (Pedrotti *et al.* 1970, 1981, 1982d, 1989, 1992a and 1992b; Cortini - Pedrotti *et al.* 1973; Pedrotti and Orsomando 1982; Orsomando *et al.* 1998).

Finally, several works done by the Department of Botany and Ecology of the University of Camerino and to date in manuscript form should be noted, for example a map of the real vegetation of the Monti Sibillini National Park on a scale of 1:50,000.

Environmental systems

The Monti Sibillini group is formed exclusively of calcareous rocks and is surrounded by hilly areas formed of marly-arenaceous rocks (Fig. 1). For this reason, it can be attributed to the following two large environmental systems, or landscape systems, each of which possesses clearly differentiated physical and biological characteristics (Pedrotti 1999; Bisci 1990; Orsomando *et al.* 2000):

- Environmental system of the calcareous mountain chains of the Apennines in the Marches and Umbria, characterized by *Ostrya carpinifolia* and *Fraxinus ornus* forests as far as 1,000 m altitude and by neutral-basophyle forests of *Fagus sylvatica* between 1,000 and 1,800 m, slightly developed agricultural areas and very vast secondary grasslands with different associations of the *Phleo ambigui-Bromion erecti* alliance (environmental system n. 1)
- Environmental system with marly-arenaceous hills of the syncline of Camerino and the southern Marches, characterized by forests of *Quercus pubescens, Quercus cerris* and *Castanea sativa*, acidophyle forests of *Fagus sylvatica* in the montane belt, vast

agricultural areas and secondary grasslands of limited extension of the *Bromion erecti* alliance (environmental system n. 2).

Phytogeographical regions

The territory of the Monti Sibillini is in the Eurosiberian region (Fig. 2); only a narrow strip on the Adriatic coast is in the mediterranean region (some mediterranean species such as *Quercus ilex* and *Phillirea media* present in the central parts of the Sibillini are extrazonal). The delimitation between the mediterranean and the eurosiberian regions in the central Apennines is confirmed in the Vegetation Map of Europe (Bohn *et al.* 2000).

Altitudinal vegetation belts

Due to the marked height differences in the Monti Sibillini group and surrounding zones it is possible to distinguish the hilly, montane, subalpine and alpine altitudinal vegetation belts; in the calcareous environmental system (environmental system n. 1) all four vegetation belts are present, while in the marly-arenaceous one (environmental system n. 2), due to lower altitude, only the hilly and montane belts are present (Fig. 3).

The hilly belt extends up to 950-1,000 m, according to exposure; in the marly-arenaceous sector it is characterized by thermophyle broadleaf forests of *Quercus pubescens* and *Quercus cerris* of the *Quercion pubescentis* alliance, *Quercetalia pubescentis* order; the secondary grasslands belong to the *Bromion erecti* alliance with *Centaureo bracteatae-Brometum erecti* and other associations; the shrub wood is formed of the *Spartio-Cytisetum sessilifolii* association. The most widespread association of infestant grasses is *Biforo testiculatae-Adonidetum cupanianae* (Kropac 1982). In the cooler and more moist localities, with slightly acidic substratum, there are also forests of *Castanea sativa* with the *Melampyro italici-Castanetum* association, of the *Quercion robori-petraeae* alliance and *Quercetalia robori-petraeae* order (Hruska 1980, 1982e, 1988); in this case the shrub wood is formed of the *Pteridio-Sarothamnetum* association.

The calcareous sector is characterized by forests of *Ostrya carpinifolia* and *Fraxinus ornus* with the *Scutellario-Ostryetum carpinifoliae* association of the *Ostryo-Carpinion orientalis* alliance, *Quercetalia pubescentis* order. In the deforested areas very extensive secondary grasslands have developed of the *Phleo ambigui-Bromion erecti* alliance with the *Asperulo purpureae-Brometum erecti, Seslerio nitidae-Brometum, Astragalo-Brometum* and *Saturejo montanae-Brometum* associations (Biondi *et al.* 1995). The shrub associations are the following: *Galio aparine-Prunetum mahaleb, Lonicero etruscae-Prunetum mahaleb, Cytiso sessilifolii-Prunetum mahaleb, Junipero oxycedri-Amelanchieretum ovalis* (Pedrotti 1982, 1994; Biondi *et al.* 1988). The association of crop-infesting grasses is *Bunio-Galietum tricornis*.

Ruderal, nitrophylous and border communities common to both environmental systems are *Hordeetum murini, Brometum sterilis, Cardario-Agropyretum, Sambucetum ebuli, Urtico-Aegopodietum, Anthriscetum sylvestris, Conietum maculati, Anthriscetum nemorosae, Chaerophylletum temuli, Symphyto bulbosi-Ranunculetum lanuginosi,* the latter also of the montane belt (Hruska 1981, 1982a, 1982b, 1982c, 1982d, 1984, 1985).

In certain microclimatic conditions (thermically favored slopes with southern exposure) in this vegetation belt one can even find forests of evergreen sclerophylous species of *Quercus ilex* with the *Cephalanthero-Quercetum ilicis* association of the *Quercion ilicis* alliance and the *Quercetalia ilicis* order, such as on the slopes of Monte Fiungo, in the Fiastrone Gola and the Valnerina Gola, etc. (Biondi and Venanzoni 1984). Some nuclei of *Quercus ilex* forests are also present in the marly-arenaceous environmental system, in the Tronto Valley between Ponte d'Arli and Acquasanta, also with the presence of other mediterranean species such as *Pinus halepensis* and *Ampelodemos mauritanicus*.

The montane belt is developed from 950-1,000 m up to 1,800 m; in the calcareous sector it is characterized by the presence of montane deciduous forests of *Fagus sylvatica* with the *Polysticho-Fagetum* association, *Geranio nodosi-Fagion* alliance, *Fagetalia sylvaticae* order; the secondary grasslands are represented by *Filipendulo vulgaris-Trifolietum montani* (Monte Ragnolo and Monte Meta) and by *Cynosuro-Trifolietum repentis,* only in the locality of the Pian Grande of Castelluccio di Norcia (Cortini Pedrotti *et al.* 1973; Francalancia *et al.* 1981). In the cultivation of lentils (*Lens culinaris*) of Castelluccio there is the *Sinapio arvensis-Anthemidetum arvensis* association (Allegrezza and Hruska 1992). The shrub associations are the following: *Milio-Aceretum campestris* and *Melico uniflorae-Populetum tremulae* (Pedrotti 1982b, 1994 and 1995).

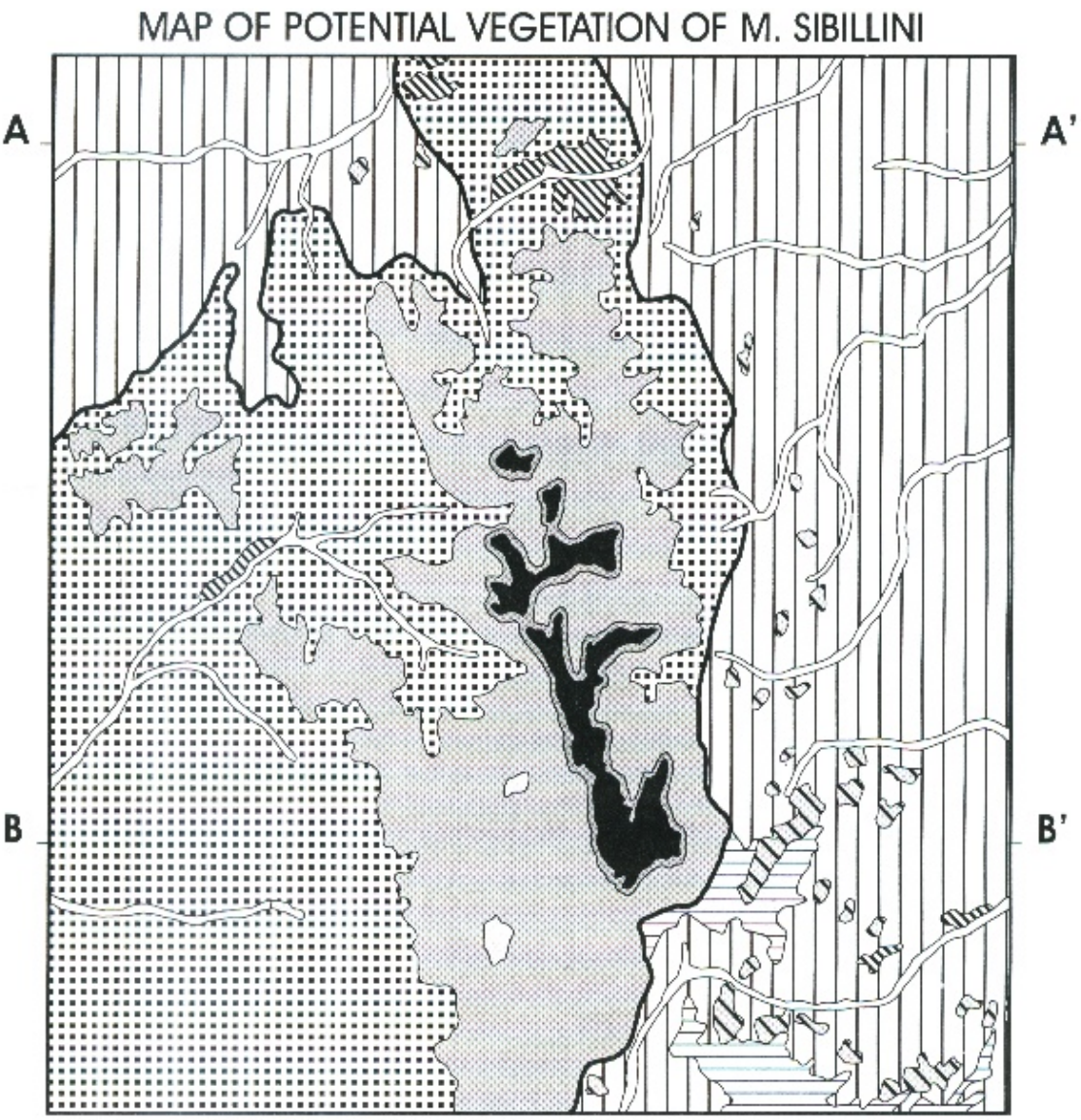
The principal ruderal and nitrophylous associations of the montane belt are *Chaerophylletum aurei, Heracleo-Rumicetum obtusifolii* and *Carduetum chrysacanthi*.

In the marly-arenaceous sector the beech wood is represented by a different acidophyle association than that in the calcareous substrata, and is currently being defined; the secondary grasslands are characterized by *Nardus stricta* with the *Poo violaceae-Nardetum* association (Pedrotti 1982d).

The subalpine belt forms a fairly limited strip, between 1,800 and 1,900 meters, where dwarf shrubs have developed, particular among which are the dwarf juniper (*Juniperus nana*) and the buckthorn (*Rhamnus alpina*). The associations are the *Rhamno alpinae-Amelanchieretum ovalis* and one or more associations of *Juniperus nana*.

In the past the subalpine belt certainly was also characterized by *Pinus mugo*, a species which no longer exists in the Monti Sibillini, eradicated by man in order to obtain new areas for grazing domestic animals; the presence of *Pinus mugo* was established using pollen analysis (Paganelli 1958, 1982).

The alpine belt extends beyond 1,900 meters up to the crest line; here primary grasslands of *Sesleria apennina* and *Festuca violacea* ssp. *italica,* thus defined for their primary, that is, natural origin, and so not due to anthropic intervention (*Seslerietalia apenninae* order). In the Lago di Pilato Valley there are snow-bed vegetation with *Salix herbacea, Salix retusa, Hutchinsia alpina* and *Ranunculus alpester* (Paganelli 1957).



Vegetation Unit	Potential Vegetation	Vegetation belt	Environmental system (1)	(2)
Seslerietalia apenninae	zonal	alpine	*	·
Prunetalia spinosae	zonal	subalpine	*	·
Fagetalia sylvaticae	zonal	montane	*	·
Fagetalia sylvaticae	zonal	montane	·	*
Quercetalia pubescentis (Ostryo-Carpinion orientalis)	zonal	hill	*	·
Quercetalia pubescentis (Quercion pubescentis)	zonal	hill	·	*
Quercetalia robori-petraeae	zonal	hill	·	*
Quercetalia ilicis	extrazonal	hill	*	*
Salicetalia albae, Populetalia albae	azonal	hill/montane	*	*
Salicetalia auritae, Magnocaricetalia	azonal	hill/montane	*	·

Fig. 1. Map of potental vegetation of Monti Sibillini (1: 300,000); A – A' and B – B' indicate the position of the profiles reported in fig. 3.

Two types of vegetation, riverside and marsh, grow in more than one altitudinal belt. The riverside vegetation is formed of *Salix alba* and *Salix elaeagnos* willow groves with the *Salicetum elaeagni* and *Salicetum albae* associations of the *Salicion albae* alliance, *Salicetalia albae* order, and of *Alnus glutinosa* alder woods with the *Aro italici-Alnetum glutinosae* association, of the *Alno-Ulmion* alliance, *Populetalia albae* order, all developed along the waterways of the hilly and montane belts; the willow groves are common everywhere, while the alder woods are fairly fragmented and distributed only in Valnerina and along the Tronto (Pedrotti and Gafta 1996).

The marsh vegetation is present with the *Caricetum gracilis, Caricetum vesicariae* and *Caricetum distichae* associations (*Magnocaricetalia* order) of the Pian Grande, Pian Perduto and Pian Piccolo, where they occupy the dolines, pits and all the depressions of the soil (Cortini - Pedrotti *et al.* 1973; Pedrotti 1982c; Pedrotti and Cortini- Pedrotti 1982); the vegetation of the hygrophilous meadows, called "marcite" (irrigated meadows), developed in correspondence with the spring surfacings of the lower part of the Piano di S. Scolastica di Norcia, was provisionally named "Association of *Cynosurus cristatus, Lolium perenne* and *Ranunculus acer*" (Orsomando and Pedrotti 1982); in this location there are also groups of *Salix cinerea* of the *Salicion cinereae* alliance, *Salicetalia auritae* order.

Potential vegetation

The potential vegetation in the Monti Sibillini can be distinguished as zonal, azonal and extrazonal (Fig. 1).

The zonal vegetation corresponds to that of the altitudinal belts first described, that is, forests of the *Quercetalia pubescentis, Quercetalia robori-petraeae* and *Fagetalia sylvaticae* orders, subalpine shrub woods of the *Prunetalia spinosae* order and primary grasslands of the *Seslerietalia apenninae* order. The previous section describes the associations and alliances.

The azonal vegetation develops in particular edaphic conditions represented in the Monti Sibillini by watercourses and marshy areas. In the waterways there is riverside vegetation with willow groves (*Salicetalia albae*) and alder woods (*Populetalia albae*). The marshy areas are found in localities with a high water-bearing stratum; here the azonal potential vegetation is represented by associations of the *Magnocaricetalia* order and by marsh willow groves (*Salicetalia auritae*).

The extrazonal vegetation of the Monti Sibillini group is represented by holm oak forests (*Quercetalia ilicis*) on the calcareous slopes with southern exposure.

The associations that constitute the potential vegetation and those dynamically linked to them define as many other vegetation series or sigmeta, each of which develop in a determinate vegetation belt or environmental system.

The limits of the forest

It can be held that originally, before anthropic intervention , which began in pre-Roman times, the forest developed as far as 1,800 meters, a limit which today we can only consider as potential. In fact, today no locality of the Monti Sibillini has forest at 1,800 meters, but – when it exists – it is found at lower altitudes, as on the slopes of Monte Argentella and Monte Palazzo Borghese, where small beech woods reach a maximum of 1,750 meters. All the residual beech woods present are always found at lower altitudes than the original limit of the forest, and this is due to man's intervention, which has always been very strong in the chain of the Monti Sibillini (Marchesoni 1952, 1959). Today in the areas once occupied by beech forests, vast secondary grasslands have developed.

The limit of the forest in the entire Monti Sibillini chain today is represented by monospecific beech forests (*Fagus sylvatica*); in the past, however, the beech wood also contained white pine (*Abies alba*) which today is gone because of deforestation in the last centuries. Even the existence of this species on the Monti Sibillini comes to us only through subfossil remains brought to light by pollen analysis (Marchesoni 1957, 1958; Paganelli 1982).

Map of potential vegetation with indication of environmental systems and vegetation belts

Using the unpublished map of the real vegetation of the Monti Sibillini on a scale of 1:50,000, the synthesis map of the potential vegetation was constructed, with indication of the environmental systems and the altitudinal belts on a scale of about 1:300,000, representing contemporaneously the environmental systems, altitudinal belts and potential vegetation distinguished as zonal, extrazonal and azonal (Fig. 1).

In this map it is possible to observe easily the spatial distribution of the plant associations identified and the contacts that they establish among themselves. The primary grasslands (*Seslerietalia apenninae*) "mark" the crest lines of the entire Monti Sibillini group and are bordered by a strip of shrubs of the subalpine belt (*Prunetalia* order). The most widespread forest orders (oak woods, turkey oak woods, flowering ash woods and beech woods) occupy very vast areas. The oak woods and turkey oak woods (*Quercetalia pubescentis, Quercion pubescentis*) are limited to the environmental system of the marly-arenaceous hills. The flowering ash (*Quercetalia pubescentis, Ostryo-Carpinion orientalis*) and the beech woods (*Fagetalia sylvaticae*) are limited to the environmental system of the calcareous chains where they follow one another forming two altimetrically distinct strips. Of note also are the chestnut woods (*Quercetalia robori-petraeae* order) that form nuclei spread around the hilly zone occupied by oak woods and the two different types of beech woods (*Fagetalia sylvaticae*), on the calcareous environmental system and the marly-arenaceous one.

The riverside vegetation (*Salicetalia albae* and *Populetalia albae* orders) is distributed in correspondence with the narrow alluvional strip along the valleys that furrow the Monti Sibillini group, while the marshy vegetation (*Magnocaricetalia*

and *Salicetalia auritae* orders) is limited to the localities with high water-bearing substratum.

The extrazonal holm oak woods (*Quercetalia ilicis*), finally, occupy some stages of the hilly belt with particular microclimatic conditions.

The map therefore possesses phytosociological (vegetation typology), ecological (environomental system and altitudinal belt) and phytogeographical (chorology of the vegetation) information. In order to facilitate reading and interpretation of the synthesis map, an attached table lists the vegetation units (on the level of vegetation orders) present in the Monti Sibillini and shows for every order the correspondence with the environmental systems, altitudinal belts and potential vegetation.

The potential vegetation map with indication of the environmental systems and altitudinal belts has constituted the basis for identification and mapping of the environmental units of the Monti Sibillini, analogously to the work done for the Stelvio National Park (Gafta and Pedrotti 1997; Pedrotti 1997, 1999). Both the map of the potential vegetation and the map of environmental units have served, in turn, in the landscape planning of the territory of the Monti Sibillini National Park, established in 1988.

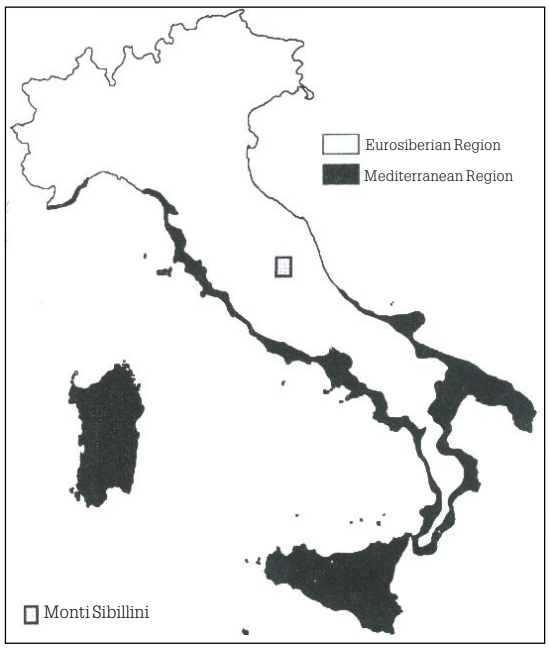


Fig. 2. Delimitation of eurosiberian and mediterranean regions in Italy (after Pedrotti 1992b).

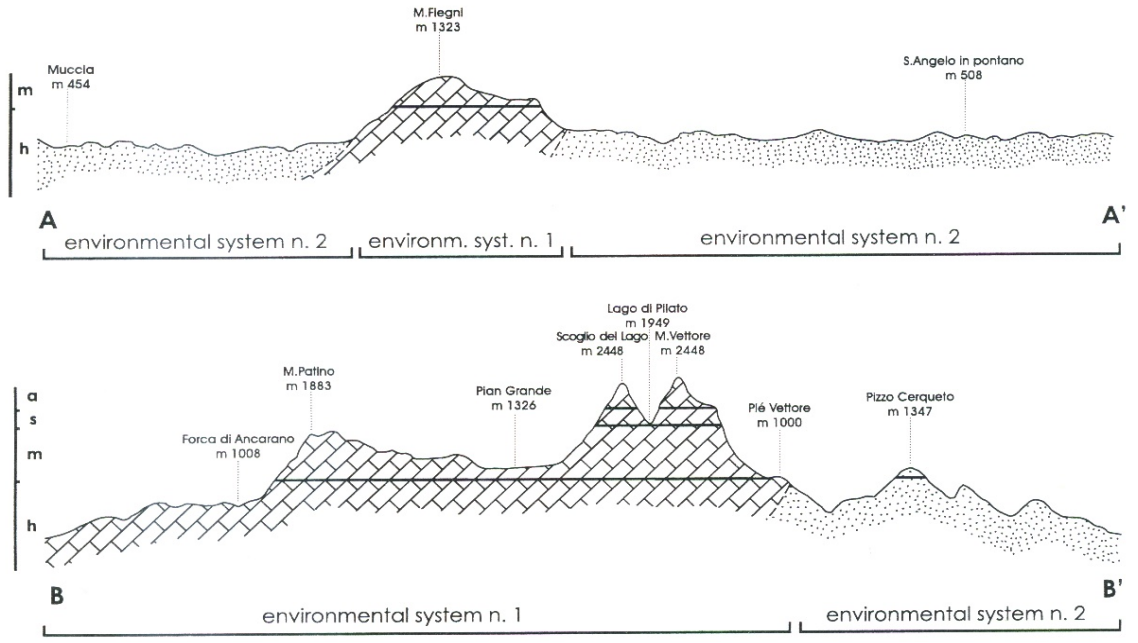


Fig. 3. Environmental systems and vegetation belts of Monti Sibillini; h, m, s and a: hilly, montane, subalpine and alpine belts; the geographic position of the profiles is indicated on the fig. 1 map.

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