Plant communities of travertine outcrops of the Saturnia area in southern Tuscany (central Italy).

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PLANT COMMUNITIES OF TRAVERTINE OUTCROPS OF THE SATURNIA AREA IN SOUTHERN TUSCANY (CENTRAL ITALY)

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Abstract
A phytosociological survey was carried out in a poorly known travertine area of southern Tuscany harbouring a rich vegetation mosaic with chamaephytic garrigues, species-rich xerophytic grasslands, chasmophytic coenoses, annual species-dominated communities, shrublands and thermophilous deciduous forests. Field sampling and data analysis allowed to identify and characterize several community types, some of which of significant interest due to their ecological specificity and rarity in peninsular Italy. In particular, our data confirm the associations *Pistacio terebinthi-Paliuretum spinosae* and *Pistacio terebinthi-Quercetum pubescentis*, respectively a shrub and forest community type previously unknown for Tuscany. In addition, a new therophytic association of travertine debris named *Sedetum hispanico-caespitosi* and placed in the *Hypochoerion achyrophori* alliance (*Brachypodietalia distachyi* order, *Tuberarietea* class) is also described. Finally, dynamic relationships between the vegetation types are highlighted and the presence of conservation priority habitats in the area are pointed out.
Key words: phytosociology, vegetation, travertine outcrops, shrublands, annual *Sedum*-rich communities, *Sedetum hispanico-caespitosi*.

Izvleček
Opravili smo fitocenološko raziskavo na malo znanem območju na travertinu v južni Toskani z bogatim mozaikom vegetacije z hamefitskimi garigami, vrstno bogatimi kserofitskimi travniki, hazmofitskimi združbami, združbami prevladujočih enoletnic, grmišči in termofilnimi listantimi gozdovi. S terenskim vzorčenjem in analizo podatkov smo opisali in označili številne vegetacijske tipe. Nekateri so še posebej pomembni, ker so ekološko posebni in redki na italijanskem poltotoku. Potrdili smo prisotnost asociacij *Pistacio terebinthi-Paliuretum spinosae* in *Pistacio terebinthi-Quercetum pubescentis*, grmiščnih in gozdnih združb, ki sta bili do sedaj neznani v Toskani. Opisali smo novo terofitsko asociacijo na travertinskem grušču *Sedetum hispanico-caespitosi* in jo uvrstili v zvezo *Hypochoerion achyrophori* (red *Brachypodietalia distachyi*, razred *Tuberarietea*). Prikazali smo dinamične odnose med vegetacijskimi tipi in izpostavili naravovarstveno prednostne habitate na raziskovanem območju.
Ključne besede: fitosociologija, vegetacija, travertin, grmišča, enoletne združbe z vrstami rodu *Sedum, Sedetum hispanico-caespitosi*.

1. INTRODUCTION

Although the ecological and landscape value of southern Tuscany is today widely recognized, plant diversity of this large territory is still incompletely unknown at both the species and community level. One of the interesting sites still waiting for a vegetation study is the travertine area of Poggio Bagno Santo and Pian di Palma (Manciano) in the middle part of the Albegna river valley, in the internal part of the historical region of Maremma (Grosseto province). This site is partially included in the Natura 2000 network, SCI "Medio corso del Fiume Albegna" (Regione Toscana 2010) and is recognized as one of the important biotopes of the Grosseto territory for its

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floristic richness and peculiar vegetation (Selvi & Stefanini 2005). Such a diversity is largely due to the occurrence of a mosaic including shrublands in the upper parts of the hill, alternated with sparse chasmophytic and lithophytic herb communities on the rocky travertine outcrops and cliffs, and relatively mature forest communities on the lower part of the slopes. Low garrigues and species-rich herbaceous communities, alternatively dominated by hemicryptophytes and chamaephytes or therophytes in the more xeric conditions, colonize the openings of the shrub-

Figure 1: Geographic location of the studied sites, with magnification of the areas of Poggio Bagno Santo and Pian di Palma.
Figure 1: Geografski položaj proučevanih rastišč s povečanim območjem Poggio Bagno Santo in Pian di Palma.

lands and the flat areas of Pian di Palma. Along with natural variation of site conditions, grazing by sheep is a major determinant of this mosaic, as typical in many Mediterranean ecosystems.

Since available vegetation data were still largely incomplete, however, additional fieldwork was carried out to better characterize and classify the communities of this area by means of the phytosociological approach. This work allowed to confirm the presence of forest, shrub and herbaceous communities with a distinct eastern-Mediterranean character, some of which were not previously known from Tuscany. Results are described in this paper to provide a contribution to the botanical knowledge of this region and, possibly, a tool for the management of the more valuable habitats in the biotope.

2. METHODS

2.1 Study Area

2.1.1 Geographical location and geomorphological aspects

Poggio Bagno Santo is a low travertine hill (286 m a.s.l.) located at the northwest of Saturnia in southern Maremma, on the right bank of the Albegna river. The northern slopes are gently connected to the flat travertine pavement of Pian di Palma, while the southern slope is characterized by high and rugged cliffs dominating the Albegna river (Figure 1). In this part the river flows with a marked slope in a narrow gorge between Poggio Bagno Santo and Poggio Pancotta (268 m) and Poggio Saturnia (294 m) on the left bank.

The whole area is composed by recent travertine deposits, mainly originated during the Pleistocene period (Servizio Geologico d'Italia 1965). Travertine is a very porous and permeable sedimentary rock with a chemical and organogenic origin, consisting of calcium carbonate crystals (Press & Siever 1985, Uggeri 2003). Travertine quarries are still active in the area of Pian di Palma, while those on Bagno Santo were abandoned several decades ago.

The area is also known since ancient times for its geothermal activity. Hot water springs are located at the foot of the hills, as the one occurring on the southwestern slope of Bagno Santo after which the hill takes its name.

2.1.2 Climate

Thermopluviometric data can be inferred from the Manciano bioclimatic station, which is located at a higher altitude (443 m a.s.l.) and shows a slightly lower mean annual temperature (13.4 °C) and slightly higher mean annual rainfall (867 mm). According to the climate classification by Thornthwaite & Mather (1957), the climate formula of Manciano is B'2 b'4 C2 (Bigi & Rustici (1984), while in the Rivas-Martinez & Rivas-Saenz (1996–2009) bioclimatic system this site falls in the category "Mediterranean pluviseasonal-oceanic" (Figure 2). Summer drought is therefore relatively pronounced especially in the Bagno Santo area, due to the lower altitude with respect of Manciano and especially the shallow rocky substrate consisting of a very porous rock such as the travertine.

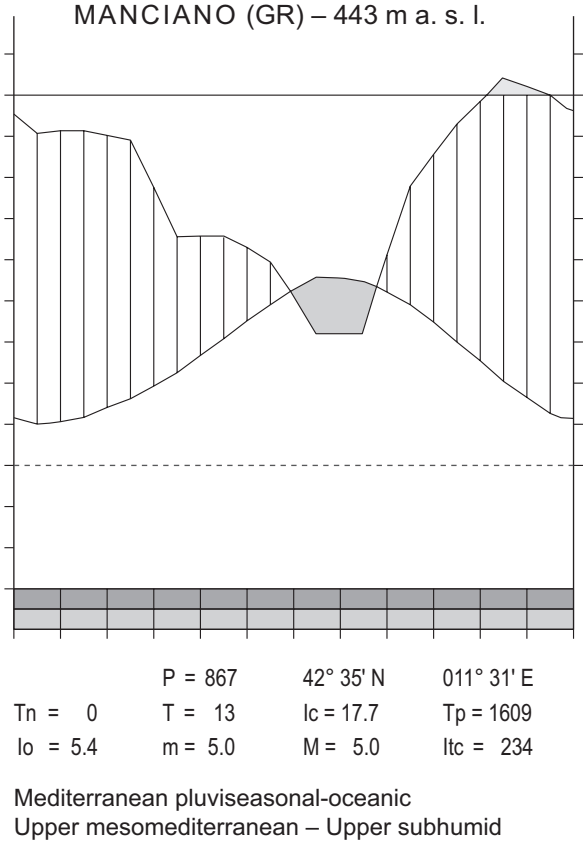

Figure 2: Bioclimatic diagram and diagnosis of the Manciano thermopluviometric station, according to Rivas-Martinez & Rivas-Saenz (1996–2009).

Slika 2: Bioklimatski diagram in analiza podatkov termopluviometrične postaje Manciano v skladu z Rivas-Martinez & Rivas-Saenz (1996–2009).

2.2 Data collection and analysis

This study is based on the classical Zurich-Montpellier approach (Braun-Blanquet, 1932; 1964), including his recent developments (Westhoff & Van Der Maarel, 1973; Géhu & Rivas-Martínez, 1981; Biondi, 2011; Blasi et al., 2011; Pott, 2011). After a preliminary study of the local flora in the years 2005–2008, we carried out 24 phytosociological relevés between late April and early May of the years 2008–2010, in order to sample the most representative community types.

Field data were first grouped in a raw table that was explored using cluster analysis as implemented in PAST software (Hammer et al. 2001). Abundance-dominance values were transformed according to Van Der Maarel (1979) and Noest et al. (1989), before calculating the Euclidean Distance matrix between the relevés and submit it to hierarchical clustering using the UPGMA algorithm. Plant names follow basically Tutin et al. (1964–80, 1993) and Pignatti (1982), with some later modifications as reported in the Checklist of the Italian Vascular Flora (Conti et al. 2005, 2007) and the recent checklist of the flora of Tuscan Maremma (Selvi 2010). Syntaxonomical nomenclature above the association level is in line with the Phytosociological Nomenclature Code (Weber et al. 2000) and largely based on Rivas-Martínez et al. (2002).

3. RESULTS AND DISCUSSION

Cluster analysis resulted in the dendrogram shown in Figure 3. Five physiognomically consistent groups could be recognized: herb communities of flat travertine pavements (group 1), small herb communities of cliffs and rocks (group 2), garrigues and grasslands (group 3), open woods and shrublands (group 4) and forests (group 5). Each of these groups is described below.

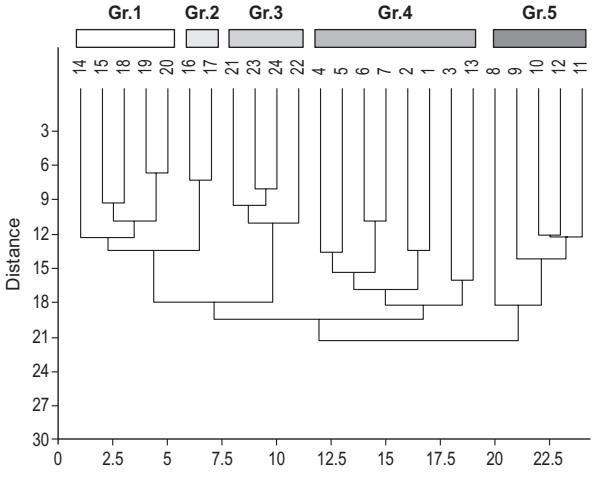

Figure 3: Dendrogram from UPGMA cluster analysis of the vegetation relevés.

Slika 3: Dendrogram UPGMA klasterske analize vegetacijskih popisov.

3.1 Annual-dominated communities of flat travertine pavements

The relevés of group no. 1 in the dendrogram are shown in Table 1. They describe sparse communities dominated by small Mediterranean annuals colonizing the flat surfaces of travertine debris, with a thin layer of organic soil and abundant mosses. Dominating species are the succulent *Sedum caespitosum* and *Sedum hispanicum*, along with *Plantago lagopus, Saxifraga tridactylites, Arenaria leptoclados*, *Cerastium brachypetalum* s.l., *Minuartia hybrida, Trifolium tomentosum, Trifolium nigrescens* and the grasses *Poa bulbosa, Catapodium rigidum* and *Vulpia ciliata*.

Selvi & Stefanini (2005) provisionally referred these communities to the *Alysso-Sedion albi*, that correspond to the EU prioritary habitat "Rupicolous calcareous or basophilic grasslands of the *Alysso-Sedion albi*" (Natura 2000 code: 6110; European Commission, 2007). According to the authors who described this alliance (Oberdorfer 1978), however, the vegetation of this *syntaxon* is characterized by abundant *Sedum album* and/or perennial species of *Sedum*, with also other annual species. Several authors have reported vegetation types of the *Alysso-Sedion albi* from central Italy, such as Venanzoni & Gigante (1999) from Umbria, Scoppola & Angiolini (2001) and Angiolini et al. (2009) from southern Tuscany, Di Pietro et al. (2006) from the Prenestini mountains around Rome, Foggi & Venturi (2009) from the Prato province in northern Tuscany, and Lastrucci et al. (2009) from eastern Tuscany. These authors describe associations or groupings usually dominated by perennial species of *Sedum*. Recently Fanelli (2007) described the association *Chaenorhino rubrifolii-Saxifragetum tridactylites* from the travertine area of Bagni di Tivoli near Rome and classified it in the *Alysso-Sedion albi* al-

liance in spite of the large prevalence of therophytes. Even more recently, Fanelli et al. (2010) recognized that several European authors exclude the annual-dominated communities from the alliance *Alysso-Sedion albi* (e.g. De Foucault 1999, Rivas-Martinez et al. 1997, 2002), though finally following the same classification of the *Chaenorhino rubrifolii-Saxifragetum tridactylites* association.

Due to the dominance of annual species and the nearly complete lack of perennial species of *Sedum* in our relevés, we therefore refer the examined communities to the class of the terophytic Mediterranean meadows. This class has been subject to contrasting nomenclatural interpretations (Braun-Blanquet et al. 1952; De Foucault 1999; Brullo et al. 2001; Fanelli et al. 2010) and indicated as *Thero-Brachypodietea, Tuberarietea/ Helianthemetea, Stipo-Trachynietea* and other names. According to the classification followed here (Rivas-Martinez et al. 2002), this syntaxon is called *Tuberarietea*.

Phytosociological works on carbonatic substrates in the temperate-oceanic areas of Latium refer similar annual-dominated vegetation types to the associations *Trifolio scabri-Hypochoeridetum achyrophori* and *Saxifrago-Hypochoeridetum achyrophori* (Scoppola et al. 2001). These associations include several species also found in our relevés but differ substantially in the dominant species, and cannot be used to classify the Bagno Santo community.

In a recent paper, Fanelli et al. (2010) discussed the syntaxonomy of the basophilous nanophanerophytic vegetation in central Italy based on above 100 phytosociological relevés, both published or unpublished. They suggest that this vegetation type, usually included in the single association *Trifolio scabri-Hypochoeridetum achyrophori,* is characterized by wide floristic variations and should be split in at least five distinct associations *(Medicagini rigidulae-Trifolietum scabri*, *Trifolio scabri-Hypochoeridetum achyrophori*, *Hippocrepido siliquosae-Brachypodietum distachyi*, *Trigonello gladiatae-Brachypodietum distachyi*, *Crucianello latifoliae-Hypochoeridetum achyrophori*). In their large general table, however, only three relevés include *Sedum caespitosum* and *S. hispanicum*. These relevés, which are anyway dominated by other species, represent the meadow vegetation on limestone (not travertine) areas of M. Castagneto-La Spera near Rieti and had already been discussed by Scoppola & Angiolini (2001).

None of the nanophanerophytic associations described to date is therefore physiognomically dominated by *Sedum caespitosum* and characterized by *S. hispanicum*. The former is a stenomediterranean species with a discontinuos distribution in Central and Southern Italy (Pignatti, 1982), whereas the latter is a more widely distributed Southeastern European *taxon* relatively unfrequent in Tuscany. Accordingly, these community can be referred to the new association *Sedetum hispanico-caespitosi* ass. nova hoc loco (typus rel. 20, Table 1). Besides the two *Sedum* species, constant differential species of this association are *Plantago lagopus* and *Saxifraga tridactylites*, as well as several others of higher syntaxonomical rank such as *Arenaria leptoclados, Catapodium rigidum*, etc. or typical of annual Mediterranean meadows (*Anthemis arvensis, Poa bulbosa*, etc.).

Concerning the higher ranks, Biondi & Guerra (2008) recently analyzed the syntaxonomy of the Italian annual meadows and described the endemic alliance *Hypochoerion achyrophori*. Following this classification, the new association can be placed in the northern and central Italian suballiance *Hypochoerenion achyrophori*. Alternative placements would have been in the *Sedenion caespitosi* suballiance according to Rivas-Martinez et al. (2002), or in the *Trachynion distachyae* alliance according to Fanelli et al.(2010).

3.2 Chasmophytic and comophytic vegetation of steep rocks and cliff edges

Another small group consists of two relevés (Table 2) representing the community type colonizing the steep and rugged travertine rocks (10–30° inclination) and the edge of cliffs over the Albegna river on Poggio Bagno Santo. This community includes either chasmophytic or comophytic species (plants growing in small soil pockets found in rock fissures), often developed in partial shade by forest and shrub vegetation surrounding such rocky surfaces. Dominant species are the hemicryptophyte *Cymbalaria muralis* (casmophytic) and the geophytes *Umbilicus rupestris*, *Muscari commutatum* and *Allium subhirsutum* (comophytic). Though not recorded in the relevés presented here, *Anthirrhinum latifolium* and *Sedum rupestre* are often found in these phytocoenoses, as well as the xerophytic ferns *Polypodium cambricum* and *Asplenium trichomanes*. Other species appear in

the fissures of the partially shaded rocks containing pockets of nutrient-rich soil from the mineralization of forest litterfall, such as the therophytes *Geranium purpureum*, a species of dry forest edges, *Galium aparine*, *Centranthus calcitrapa, Arabis turrita* and *Parietaria officinalis*.

From the floristic point of view it is especially worth of note the presence of a conspicuous population of *Muscari commutatum* (*Liliaceae*) in the narrow fissures of travertine rocks of Bagno Santo, due the rarity of this bulbous geophyte in Italy. As a rare Mediterranean *taxon* it is included in the national list of the threatened plants and as a relevant species for the recognition of the IPAs in the country (Blasi et al. 2010).

Concerning the syntaxonomical classification of this type of vegetation we refer to Brullo & Guarino (2002), who published a synthetic treatment of the chasmophytic synantropic vegetation in Italy. Unlike in previous works (cited in Brullo & Guarino 1999), these authors place the phytocoenoses of natural cliffs and rock ledges and those of walls in two distinct classes, respectively *Asplenietea trichomanis* and *Parietarietea judaicae*. Among the characteristic species of the latter class, our samples include *Cymbalaria muralis* and *Umbilicus rupestris*, along with several other rupiculous plants. The presence of the somewhat nitrophilous species *Parietaria officinalis*, instead of *P. judaica*, indicates the presence of local deposits of nutrient-rich soil connected to forest edges.

Accordingly we provisionally refer the relevés of Table 2 to an informal grouping with *Cymbalaria muralis*, *Muscari commutatum* and *Allium subhirsutum* within the *Parietarietea* class.

3.3 Chamaephytic garrigues with *Euphorbia spinosa* and *Satureja montana*

The travertine plateau of Pian di Palma is characterized by a low garrigue community dominated by the two Mediterranean chamaephytes *Euphorbia spinosa* and *Satureja montana* (Table 3). Soil cover resulted relatively high also due to the abundance of other shrublets such as *Teucrium capitatum* and *Helichrysum italicum* and robust herbs and grasses such as *Cephalaria leucantha, Bromus erectus, Convolvulus cantabrica* and *Thymus longicaulis*. On the whole, these species indicate shallow carbonatic lithosoils with little organic material, under very slow pedogenetic evolution.

Satureja montana is a widespread Mediterranean species of mountain areas. Along the whole Apennine chain it is often dominant in the garrigues developed on various carbonatic substrates, even at relatively high altitudes. *Euphorbia spinosa* is also a basophilous species often abundant in limestone and serpentine garrigues, but more thermophilous and usually at lower altitudes than *S. montana* (Pignatti 1982, Allegrezza et al. 1997). According to Allegrezza et al. (1997), the rocky habitats of the limestone hills in central Italy harbour distinct associations with *Satureja montana*, some of which show floristic and ecological similarity with the Pian di Palma travertine community. In particular, the more thermophilous aspect of the *Cephalario leucanthae-Saturejetum montanae,* described as subass. *euphorbietosum spinosae,* is the community type that better corresponds to our vegetation samples for the cenological conditions and the presence of several characteristic species. The same association was also reported from some travertine areas between Siena and Viterbo (Scoppola & Angiolini 1997), but in a distinct variant characterized by the endemic *Santolina etrusca* that is lacking at Pian di Palma because of the carbonatic lithosoil.

According to Scoppola & Angiolini (1997), the *Cephalario leucanthae-Saturejetum montanae* association belongs to the alliance *Artemisio albae-Saturejion montanae* of the Mediterranean *Rosmarinetea* class, although the number of Mediterranean species decreases going towards the more inland areas and the communities become progressively more atypical for the class.

3.4 mesoxerophilous *Bromus erectus* grasslands

A second community type (Table 4) found on the travertine plateau of Pian di Palma occurs on slightly more evolved soils with a higher content of organic matter. Here, soil cover by xerophytic perennial herbs and grasses reaches 70–80%, while chamaephytes are less abundant than in the *Cephalario-Saturejetum*. Most typical species of this community are *Bromus erectus* and other hemicryptophytes such as *Koeleria splendens, Eryngium campestre, Convolvulus cantabrica*, *Cephalaria leucantha*, *Urospermum dalechampii, Galium corrudifolium, Potentilla hirta, Tragopogon dubius,*

Carlina corymbosa, Anthyllis vulneraria subsp. *rubriflora*, etc. The mainly W Mediterranean geophytes *Allium moschatum and Iris lutescens* are also relatively common, as well as the orchids *Orchis morio, Serapias vomeracea* and others observed outside the vegetation relevés. Annual species were not numerous, among them *Helianthemum salicifolium* and *Tordylium apulum*.

The phytosociological classification of the perennial grasslands of the *Brometalia erecti* order in the Apennines has been revised by Biondi et al. (1995, 2005), though recent studies suggest to place these communities in a separate *syntaxon* at the order level due to their floristic and ecological distinctness (Di Pietro 2011, Di Pietro et al. 2012). According to the recent study by Biondi & Galdenzi (2012), the order *Brometalia erecti* is restricted to north-western Italy (up to western Tuscany), while most Apennine communities belong to the *Scozonero villosae-Chrysopogonetalia grylli*.

Our vegetation samples include characteristic and differential species of the order *Brometalia erecti*, such as *Bromus erectus, Thymus longicaulis, Anthyllis vulneraria* ssp. *rubriflora, Eryngium campestre, Koeleria splendens*. The presence of also *Convolvulus cantabrica* and *Satureja montana* of the suborder *Artemisio albae-Bromenalia erecti* suggest to refer the Pian di Palma community to this *syntaxon*, that also fits in terms of edaphic and bioclimatic features. Classification at the association level is more difficult. Angiolini et al. (2003) referred the *Bromus erectus* grasslands from the calcareous massifs in southern Tuscany to two associations: *i)* the more xeric *Cerastio etrusci-Brometum erecti* to *Phleo-Bromion* alliance; *ii) Trifolio incarnati-Brometum erecti*, more mesophilous and rich in species of the *Molinio-Arrhenatheretea* class, attributed to *Bromion* alliance. However, floristic and ecological differences seem too large to refer our relevés to one of these associations, especially to the more mesic one. Also due to their small number, the present relevés can only be provisionally referred to a generic *Bromus erectus* grouping of xerophytic type within the *Artemisio albae-Bromenalia erecti*. These communities are likely to represent a dynamic stage of the edaphoxerophilous series leading to the supramediterranean *Quercus pubescens* forest. This type of series with *Bromus erectus* as an intermediate stage is also reported by Scoppola & Angiolini (1997) for other travertine garrigues between Siena and Viterbo.

3.5 Open scrub and shrublands

The shrub vegetation colonizing the rocky travertine slopes and summit area of Bagno Santo is dominated by mainly eastern Mediterranean species such as *Pistacia terebinthus* and *Paliurus spina-christi*, mixed with a few evergreen sclerophyllous species, especially *Phillyrea latifolia* and *Rhamnus alaternus*. *Paliurus spina-christi* is a vigorously resprouting spiny shrub favoured by sheep grazing and therefore locally dominant. Together with *Cercis siliquastrum, Pistacia terebinthus* and *Carpinus orientalis* this plant participates to distinct *syntaxa* of the Illyrian shrublands found in the coastal and subcoastal sectors of the Balkans, and commonly indicated as "Sibljak" (Blasi & Di Pietro 2002). All of these species are well represented in our relevés (Table 5), with the only exception of *Carpinus orientalis*. Though relatively widespread in the thermophilous woodlands of Latium and most regions of central and southern Italy, this tree is still to be confirmed in the Tuscan Maremma (Selvi 2010). Other abundant tree species in our samples are *Fraxinus ornus, Acer monspessulanum* and *Quercus pubescens*, all frequent on especially carbonatic substrates of the supramediterranean hill belt of southern Tuscany. The pubescent oak plays a key role in the dynamics of this vegetation, in most cases becoming increasingly dominant and causing the progressive transformation of the *Paliurus* shrubland into thermophilous oak forests, especially where sheep grazing is not longer present.

Numerous species of openings and meadows occur in the herbaceous layer of this community (*Bromus erectus, Allium subhirsutum, Carex caryophyllea*, etc.), due to the sparse soil cover by the woody species. Well developed herbaceous communities are found in the openings of the *Paliurus* shrubland, where ruderal and somewhat nitrophilous perennials of synanthropic vegetation such as *Calamintha nepeta* and *Marrubium incanum* are often dominant. Annual weeds of the *Stellarietea* class also occur in these phytocoenoses, together with some other therophytes of the travertine pavements.

In Tuscany, *Paliurus spina-christi* is relatively widespread in the shrublands in the warmer and drier sites of the southern parts of the region, especially in the more inland areas. However, the phytosociological affinities of the *Paliurus* vegetation has been scarcely studied. According to Angiolini et al. (2006), a dense shrub vegetation with *Paliurus* and stenomediterrannean species such as

Phillyrea latifolia, *Rosa sempervirens* and *Clematis flammula* occurs in the Trasubbie river bed, a site of Regional Importance in the central-eastern part of the Grosseto province. However, this vegetation is only recognized as a generic grouping with no syntaxonomical position. On the other hands it differs from the Bagno Santo community in the lack of *Pistacia terebinthus* and *Cercis siliquastrum*.

In the central Tyrrhenian region (Latium), the shrublands with *Paliurus spina-christi* have been referred to two syntaxa of the *Pruno-Rubenion* suballiance: the *Pistacio terebinthi-Paliuretum* association from southern Latium (Blasi & Di Pietro 2002) and the subassociation *paliuretosum spina-christi* of *Lonicero etruscae-Rosetum sempervirentis*. The latter represents dense and structured shrub formations in the hill belt of northern Latium, mainly on clayey substrates (Cutini et al. 1996, Blasi et al. 2002). Although the *Pistacio terebinthi-Paliuretum spinae-christi* has never been recorded from Tuscany, the vegetation represented by our samples show clear floristic and ecologic affinities to this association. In particular, the frequency of the characteristic shrub species allows to refer the Bagno Santo community to this *syntaxon*, despite the lack of *Carpinus orientalis*.

3.6 Thermophilous deciduous forests

The slopes of Bagno Santo are covered by a mature and relatively undisturbed broad-leaf woodland with tall trees and rich understory vegetation (Selvi & Stefanini 2005).

Based on our relevés (Table 6) this thermophilous forest community is dominated by *Quercus pubescens* and *Acer monspessulanum*, with abundant *Fraxinus ornus* and, to lesser extent, the relatively more mesophilous *Ostrya carpinifolia*. Of particular interest is the presence of mainly eastern Mediterranean tree species that are unfrequent in Tuscany, such as *Cercis siliquastrum*, *Celtis australis* and *Pistacia terebinthus*. The latter occurs with aged, single-stem individuals of remarkable size, that reach the upper layers of the forest canopy. The shrub layer is rich in *Paliurus spina-christi*, while the herbaceous understory includes *Ruscus aculeatus, Hedera helix, Tamus communis* and some species linked to relatively rich and mesic forest soils, such as *Melica uniflora* and *Brachypodium sylvaticum*. A relatively good level of nutrients in the soil is indicated by slightly nitrophilous species that colonize the fissures of the rocks rich in organic forest soil, such as *Parietaria officinalis* and *Geranium robertianum*.

The syntaxonomy of the thermophilous deciduous forests in the Italian peninsula is still subject to different treatments, because of the difficult interpretation of the effects of the orographic, geopedologic and bioclimatic variations of this area and the strong impact of human activities since millennia (Blasi et al. 2004). Therefore, the Apennine deciduous forests have been classified in more or less contrasting ways by different authors (Ubaldi et al. 1987, Scoppola et al. 1995, Arrigoni 1998, Pignatti 1998, Biondi et al. 2002, 2010, Ubaldi 2003, Blasi et al. 2004, Di Pietro et al. 2010). In this study, we refer to the treatment of the order *Quercetalia pubescenti-petraeae* in the Italian peninsula by Blasi et al. (2004). Among the five alliances proposed in this work, that of *Carpinion orientalis* is the one that best matches with our relevés in terms of floristic composition. This grouping is widely distributed in the suboceanic areas of peninsular Italy (meso-mediterranean to upper submontane thermotypes), mainly on carbonatic soils. Four suballiances have been recognized: *Laburno-Ostryenion*, *Lauro-Quercenion pubescentis*, *Cytiso sessilifolii-Quercenion pubescentis*, *Campanulo mediae-Ostryenion*. The more thermophilous woodlands of the mid-mesomediterranean or lower hill belt are included in the *Lauro-Quercenion pubescentis,* characterized and usually dominated by *Carpinus orientalis, Quercus pubescens, Acer monspessulanum, Fraxinus ornus, Pistacia terebinthus* and *Cercis siliquastrum*. All these species are well represented in our relevés from Bagno Santo (Table 6), with the only exception of *Carpinus orientalis* as already observed for the shrubland communities described above. In the synoptic table of the *Lauro-Quercenion pubescentis* by Blasi et al. (2004), the associations floristically closer to our samples are *Clematido flammulae-Quercetum pubescentis* (Ubaldi et al. 1993), *Roso sempervirentis-Quercetum pubescentis carpinetosum orientalis* (Blasi & Di Pietro 1998) and *Lonicero etruscae-Carpinetum orientalis* (Blasi et al. 2001).

Although *Clematido flammulae-Quercetum pubescentis* shares several species with our samples it includes a group of more mesophilous species usually found at higher elevations (*Chamaecytisus hirsutus, Cytisus sessilifolius*) and should therefore be excluded. *Lonicero etruscae–Carpinetum orientalis* is dominated by *Carpinus orientalis* and *Ostrya carpinifolia*, the former absent and the latter scarcely represented in our area; *Quercus pubescens* has a rela-

tively secondary role. Furthermore one of the most important characteristic species of this association, *Sesleria autumnalis*, is not present in our study area.

Scoppola & Angiolini (2001) had already reported the occurrence of woodlands close to the *Roso sempervirentis-Quercetum pubescentis* from the travertine outcrops in the western sector of central Italy. In particular, the floristic assemblage of the Bagno Santo forest matches that of the subassociation *carpinetosum orientalis* described from the Ausoni and Aurunci mountains in southern Latium (Blasi & Di Pietro 1998). The classification problem is further complicated by the studies of Allegrezza et al. (2002) and Biondi et al. (2010). Allegrezza et al. (2002) re-analyzed the relevés of Blasi & Di Pietro (1998) and stated that *Roso sempervirentis-Quercetum pubescentis carpinetosum orientalis* has to be treated as a distinct association named *Pistacio terebinthi-Quercetum pubescentis*; this new association was divided in two subassociations, of which the more thermophilous one was named *rosetosum sempervirentis*. Our relevés differ from this *syntaxon* by the lack of *Carpinus orientalis,* the presence of *Celtis australis* and *Paliurus spina-christi*, and the higher cover of *Acer monspessulanum* (Table 6). However, the ecological similarities and the presence of important differential species of subass. *rosetosum sempervirentis* such as *Cercis siliquastrum* and *Rosa sempervirens* allows to refer to the Bagno Santo forest to this *syntaxon*.

Finally, a taxonomical problem with potential consequences on the syntaxonomy of this forest vegetation concerns the identity of the oak species upon which *Roso sempervirentis-Quercetum* and *Lauro-Quercenion* are based. According to Biondi et al. (2010) the oak originally found in the communities of these *syntaxa* was not *Quercus pubescens s.s.* but *Q. virgiliana* Ten. In this case, the association and subassociation names found in the literature should be used only in a broad sense. *Quercus virgiliana* is a weakly differentiated species still not reported from Tuscany, even in recent floristic checklists focusing on the Tuscan Maremma (Selvi, 2010). At present there are no sufficient elements to confirm its presence in the Saturnia area, but this is possible and more detailed observations are needed to bring more light on this issue.

4. CONCLUSION

This study describes the vegetation types of a poorly known area of southern Tuscany, some of which of significant interest due to their ecological specificity and rarity in peninsular Italy. In particular, our data confirm the presence in Tuscany of shrub communities of the *Pistacio-Paliuretum*, an association previously known only from southern Latium, and allow to characterize a new therophytic association of travertine outcrops, named *Sedetum hispanico-caespitosi*. Besides the ecological and floristic features of the communities described, field relevés have also allowed to interpret their dynamic relationships, as schematically shown in the transect of Figure 4.

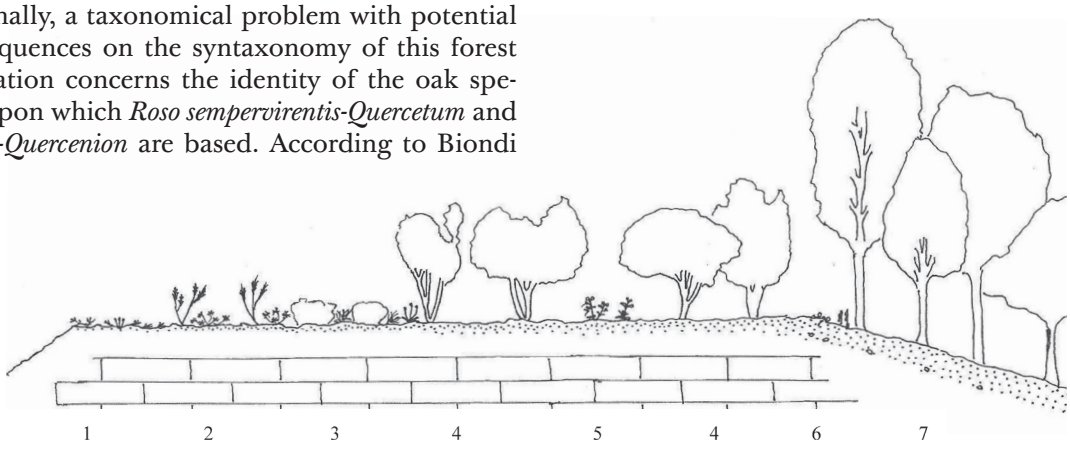

Figure 4: Schematic transects of the vegetation dynamic stages on the travertine outcrops of Poggio Bagno Santo and Pian di Palma: 1 = *Sedetum hispanico-caespitosi* ass. nova; 2 = *Bromus erectus*-dominated conenoses; 3 = *Cephalario leucanthae-Saturejetum montanae euphorbietosum spinosae*; 4 = *Pistacio terebinthi-Paliuretum spinae-christi*; 5 = *Calamintha nepeta* and *Marrubium incanum* conenoses; 6 = *Cymbalaria muralis, Muscari commutatum* and *Allium subhirsutum* conenoses; 7 = *Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis.*

Slika 4: Shema transekta dinamike vegetacijskih tipov na travertinu na območju Poggio Bagno Santo in Pian di Palma: 1 = *Sedetum hispanico-caespitosi* ass. nova; 2 = združba z vrsto *Bromus erectus*; 3 = *Cephalario leucanthae-Saturejetum montanae euphorbietosum spinosae*; 4 = *Pistacio terebinthi-Paliuretum spinae-christi*; 5 = združbi z vrstama *Calamintha nepeta* in *Marrubium incanum*; 6 = združbe z vrstami *Cymbalaria muralis, Muscari commutatum* in *Allium subhirsutum*; 7 = *Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis.*

Based on the Habitat Directive 92/43/CE, the European Interpretation Manual (European Commission, 2007) and the Italian Manual (Biondi & Blasi 2009), our data do not support the presence of typical aspects of the priority habitat *Alysso-Sedion albi* (Rupicolous calcareous or basophilic grasslands, Natura 2000 code 6110), while they confirm the priority habitats *Festuco-Brometalia* (Semi-natural dry grasslands and scrubland *facies* on calcareous substrates, Natura 2000 code 6210) and *Thero-Brachypodietea* (Pseudo-steppe with grasses and annuals, Natura 2000 code 6220).

Syntaxonomic scheme

Tuberarietea guttatae (Br.-Bl. in Br.-Bl., Roussine & Nègre 1952) Rivas Goday & Rivas-Martínez 1963
Brachypodietalia distachyi Rivas-Martínez 1978
Hypochoerion achyrophori Biondi & Guerra 2008
Hypochoerenion achyrophori Biondi & Guerra 2008
Sedetum hispanico-caespitosi ass. nova hoc loco

Parietarietea judaicae Rivas-Martínez ex Rivas Goday 1964
Cymbalaria muralis, Muscari commutatum and *Allium subhirsutum* coenoses

Rosmarinetea officinalis Rivas-Martínez, T.E. Diaz, F. Prieto, Loidi & Penas 1991
Rosmarinetalia officinalis Br.-Bl. ex Molinier 1934
Artemisio albae-Saturejon montanae Allegrezza, Biondi, Formica & Ballelli 1997
Cephalario leucanthae-Saturejetum montanae Allegrezza, Biondi, Formica & Ballelli 1997
euphorbietosum spinosae Allegrezza, Biondi, Formica & Ballelli 1997

Festuco-Brometea Br.-Bl. & Tx. ex Br.-Bl. 1949
Brometalia erecti Br.-Bl. 1936
Artemisio albae- Bromenalia erecti Biondi, Blasi ex Biondi, Ballelli, Allegrezza, Zuccarello 1995
Bromus erectus coenoses

Rhamno-Prunetea Rivas Goday & Borja ex Tuxen 1962
Prunetalia spinosae Tuexen 1952
Pruno-Rubion ulmifolii Bolòs 1954
Pruno-Rubenion ulmifolii Arnaiz & Loidi 1983
Pistacio terebinthi-Paliuretum spinae-christi Blasi & Di Pietro 2001

Querco-Fagetea Br.-Bl. & Vlieg. in Vlieg. 1937
Quercetalia pubescenti-petreae Klika 1933 corr. Blasi, Di Pietro & Filesi 2004
Carpinion orientalis Horvat 1958
Lauro nobilis-Quercenion virgilianae Ubaldi 1995 corr. Biondi, Casavecchia & Pesaresi 2010
Pistacio terebinthi- Quercetum pubescentis Allegrezza, Baldoni, Biondi, Taffetani & Zuccarello 2002
rosetosum sempervirentis Allegrezza, Baldoni, Biondi, Taffetani & Zuccarello 2002

Other syntaxa quoted in text and tables
Alysso-Sedion albi Oberdorfer et Müller in Müller 1961
Asplenietea trichomanis (Br.-Bl. in Meier & Br.-Bl. 1934) Oberdorfer 1977
Campanulo mediae-Ostryenion Ubaldi 1995
Cerastio etrusci-Brometum erecti Angiolini, Riccucci & De Dominicis 2003
Chaenorhino rubrifolii-Saxifragetum tridactylites Fanelli 2007
Clematido flammulae- Quercetum pubescentis Ubaldi, Zanotti & Puppi 1993
Crucianello latifoliae-Hypochoeridetum achyrophori Filesi, Blasi & Di Marzio 1996
Cytiso sessilifolii-Quercenion pubescentis Ubaldi 1995
Galio-Urticetea Passarge ex Kopecký 1969
Hippocrepido siliquosae-Brachypodietum distachyi Fanelli, Bianco, De Sanctis & Serafini Sauli 2010
Laburno-Ostryenion (Ubaldi 1995) Blasi, Di Pietro & Filesi 2004
Lonicero etruscae–Carpinetum orientalis Blasi, Di Pietro, Filesi & Fortini 2001
Lonicero etruscae-Rosetum sempervirentis Cutini, Fabozzi, Fortini, Armanini & Blasi 1996 *paliuretosum spina-christi* Blasi, Cutini, Di Pietro & Fortini 2002
Lygeo-Stipetea Rivas-Martínez 1978
Medicagini rigidulae-Trifolietum scabri Fanelli, Bianco, De Sanctis & Serafini Sauli 2010Tüxen
Phleo-Bromion Biondi & Blasi ex Biondi et al. 1995
Poetea bulbosae Rivas Goday & Rivas-Martínez in Rivas-Martínez 1978
Quercetalia ilicis Br.-Bl. ex Molinier 1934 em. Rivas-Martínez 1975
Quercetea ilicis Br.-Bl. ex A. & O. Bolòs 1950
Roso sempervirentis- Quercetum pubescentis Biondi 1986 *carpinetosum orientalis* Blasi & Di Pietro 1998
Saxifrago-Hypochoeridetum achyrophori Biondi, Izco, Ballelli & Formica 1997

Sedenion caespitosi Rivas-Martínez 1978
Stellarietea mediae (Br.-Bl. 1931) Tüxen, Lohmeyer & Preising. in Tüxen 1950
Stipo-Trachynietea Brullo 2001
Thero-Brachypodietea Br.-Bl. ex A. Bolos & Bolos in A. Bolos 1950
Trachynion distachyae Rivas-Martínez 1978*Trifolio-Geranietea sanguinei* Th. Müller 1961
Trifolio scabri-Hypochoeridetum achyrophori Biondi, Izco. Ballelli & Formica 1997
Trigonello gladiatae-Brachypodietum distachyi Fanelli, Bianco, De Sanctis, Serafini Sauli, 2010

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Table 1: Annual-dominated communities of flat travertine pavements, *Sedetum hispanico-caespitosi* ass. nova.
Tabela 1: Združbe enoletnic na travertinskih ploščah, *Sedetum hispanico-caespitosi* ass. nova.

Relevè nr.	**19**	**20***	**14**	**15**	**18**
Aspect	0	0	0	0	0
Slope (°)	0	0	0	0	0
Altitude (m asl)	235	235	250	257	245
Area (m2)	2	1,5	1	1	1
Total cover (%) (without bryophytes)	20	25	50	20	35
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	PP	PP	BS	BS	BS
Number of species per relevè	27	25	25	20	22
Sedetum hispanico-caespitosi					
Sedum caespitosum	1	2	3	1	2
Plantago lagopus	+	+	1	1	.
Saxifraga tridactylites	1	+	.	1	+
Sedum hispanicum	+	+	+	1	.
	.	.	.	.	.
Hypochoerenion / Hypochoerion achyrophori, Brachypodietalia distachyi, Tuberarietea					
Arenaria leptoclados	1	+	1	+	+
Catapodium rigidum	.	r	+	+	1
Vulpia ciliata	+	+	+	.	+
Cerastium brachypetalum s.l.	.	.	1	+	+
Minuartia hybrida	+	.	+	.	1
Crepis neglecta	+	+	.	.	r
Filago pyramidata	r	+	.	.	.
Hedypnois rhagadioloides	r	.	.	+	.
Trifolium campestre	r	.	.	.	r
Hypochoeris achyrophorus	.	.	.	+	.
Campanula erinus	.	.	.	+	.
Helianthemum salicifolium	.	r	.	.	.
Sideritis romana	.	.	.	.	+
Valerianella eriocarpa	.	.	+	.	.
Trifolium scabrum	.	.	.	.	+
Medicago minima	.	.	.	.	r
Other annual-dominated community species					
(Stellarietea, Poetea bulbosae)					
Anthemis arvensis	+	r	1	+	r
Poa bulbosa	+	+	.	1	1
Capsella rubella	.	r	+	+	r
Crepis sancta	+	+	+	+	.
Trifolium tomentosum	.	.	2	+	1
Veronica acinifolia	r	.	+	.	r
Cerastium ligusticum	1	1	.	.	.
Aphanes arvensis	.	.	.	+	1
Trifolium nigrescens	.	+	1	.	.
Erodium cicutarium	+	r	.	.	.
Geranium pusillum	r	.	+	.	.
Parentucellia latifolia	+	+	.	.	.
Poa annua	.	.	+	+	.
Ranunculus flabellatus	+	+	.	.	.
Sherardia arvensis	+	+	.	.	.

Relevè nr.	19	20*	14	15	18
Trisetaria panicea	.	.	.	+	+
Sagina apetala	.	.	1	.	.
Sedum stellatum	.	.	.	1	.
Adonis annua	.	.	+	.	.
Calendula arvensis	.	+	.	.	.
Koeleria cristata	.	.	+	.	.
Papaver rhoeas	.	.	+	.	.
Reichardia picroides	+	.	.	.	.
Trifolium subterraneum	.	+	.	.	.
Bunias erucago	.	.	+	.	.
Vulpia ligustica	.	.	.	.	r
Other species					
Salvia clandestina	1	+	.	.	.
Eryngium campestre	+	+	.	.	.
Romulea bulbocodium	+	+	.	.	.
Calamintha nepeta	.	.	.	.	r
Centaurea solstitialis	.	.	.	r	.
Convolvulus cantabrica	+	.	.	.	.
Dactylis hispanica	+	.	.	.	.
Hordeum murinum	.	.	+	.	.
Juncus bufonius	.	.	r	.	.
Salvia verbenaca	.	.	+	.	.
Torilis nodosa	.	.	.	.	r

* = type relevé

Table 2: Chasmophytic and comophytic vegetation of steep rocks and cliff edges, *Cymbalaria muralis, Muscari commutatum* and *Allium subhirsutum* coenoses, *Parietarietea.*

Tabela 2: Hazmofitska in komofitska vegetacija na strmih skalah in robovih klifov, *Cymbalaria muralis*, *Muscari commutatum* and *Allium subhirsutum coenoses*, *Parietarietea*.

Relevè nr.	16	17
Aspect	0	0
Slope (°)	30	10
Altitude (m asl)	255	250
Area (m2)	2	1
Total cover (%)	40	20
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	BS	BS
Number of species per relevè	16	7
***Parietarietea* and other chasmophytic and comophytic species**		
Cymbalaria muralis	1	1
Muscari commutatum	+	+
Asplenium trichomanes	+	+
Umbilicus rupestris	.	1
Polypodium cambricum	+	.
Galio-Urticetea* and *Trifolio-Geranietea		
Allium subhirsutum	1	1
Geranium purpureum	+	+
Parietaria officinalis	.	+
Centranthus calcitrapa	+	.
Galium aparine	r	.
Arabis turrita	r	.
Other species		
Aetheorrhiza bulbosa	1	.
Lens ervoides	+	.
Aristolochia lutea	+	.
Asparagus acutifolius	+	.
Ranunculus millefoliatus	+	.
Teucrium chamaedrys	+	.

Table 3: Chamaephytic garrigues, *Cephalario leucanthae-Saturejetum montanae euphorbietosum spinosae*, low altitude variant.

Tabela 3: Hamefitske garige, *Cephalario leucanthae-Saturejetum montanae euphorbietosum spinosae*, nižisnka varianta.

Relevè nr.	**23**	**24**
Aspect	0	0
Slope (°)	0	0
Altitude (m asl)	235	235
Area (m2)	10	10
Total cover (%)	80	70
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	PP	PP
Number of species per relevè	32	35
Cephalario leucanthae-Saturejetum montanae		
Satureja montana	2	1
Thymus longicaulis	1	1
Cephalaria leucantha	2	1
euphorbietosum spinosae		
Euphorbia spinosa	2	3
Galium corrudifolium	+	+
other *Rosmarinetea* species		
Teucrium capitatum	1	2
Convolvulus cantabrica	1	1
Alysso-Sedion albi		
Sedum rupestre	+	+
Sedum acre	.	+
Grassland species		
Bromus erectus	2	2
Allium moschatum	1	1
Iris lutescens	1	1
Urospermum dalechampii	+	+
Eryngium campestre	+	+
Filipendula vulgaris	r	r
Carlina corymbosa	r	r
Potentilla hirta	+	+
Sanguisorba minor	.	+
Salvia verbenaca	.	+
Koeleria splendens	.	+
Travertine annual-dominated community species		
Ranunculus flabellatus	r	r
Reichardia picroides	+	+
Sherardia arvensis	+	+
Geranium pusillum	r	r
Helianthemum salicifolium	+	+
Hypochoeris achyrophorus	+	.
Sideritis romana	.	+
Trifolium campestre	.	+
Arenaria leptoclados	.	+
Biscutella mollis	+	.
Crepis sancta	r	.
Other species		
Avena barbata	+	+
Dactylis hispanica	+	+
Melica transylvanica	+	+
Marrubium incanum	.	+
Romulea bulbocodium	r	+
Anemone hortensis	+	.
Coronilla scorpioides	r	.
Crepis neglecta	.	r
Echium italicum	.	r
Osyris alba	r	.
Pallenis spinosa	r	.

Table 4: *Bromus erectus* grasslands, *Artemisio albae-Bromenalia erecti*.
Tabela 4: Travišča z vrsto *Bromus erectus*, *Artemisio albae-Bromenalia erecti*.

Relevè nr.	**21**	**22**
Aspect	0	0
Slope (°)	0	0
Altitude (m asl)	235	235
Area (m2)	40	40
Total cover (%)	80	70
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	PP	PP
Number of species per relevè	35	36
Brometalia erecti* and *Artemisio albae-Bromenalia erecti		
Bromus erectus	4	3
Eryngium campestre	1	1
Convolvulus cantabrica	1	1
Teucrium capitatum	+	1
Urospermum dalechampii	+	1
Galium corrudifolium	+	+
Koeleria splendens	+	+
Potentilla hirta	+	+
Thymus longicaulis	+	+
Tragopogon dubius	+	+
Carlina corymbosa	+	+
Filipendula vulgaris	r	+
Satureja montana	1	+
Anthyllis vulneraria ssp. *rubriflora*	+	.
Cleistogenes serotina	.	+
Salvia verbenaca	.	+
Sanguisorba minor	.	+
Melica transylvanica	+	.
Crupina vulgaris	r	.
Lygeo-Stipetea		
Allium moschatum	1	1
Iris lutescens	1	1
Travertine annual-dominated community species		
Reichardia picroides	1	1
Helianthemum salicifolium	+	1
Tordylium apulum	+	1
Crepis neglecta	+	+
Geranium pusillum	+	+
Ranunculus flabellatus	+	+
Sherardia arvensis	+	+
Anthemis arvensis	r	+
Arenaria leptoclados	.	1
Crepis sancta	+	.
Filago pyramidata	+	.
Hypochoeris achyrophorus	+	.
Orlaya grandiflora	+	.
Veronica acinifolia	+	.
Biscutella mollis	r	.
Cerastium ligusticum	r	.
Coronilla scorpioides	r	.
Pallenis spinosa	r	.
Bromus rubens	.	+
Poa bulbosa	.	+
Sedum hispanicum	.	+
Sideritis romana	.	+
Trifolium campestre	.	+
Trifolium stellatum	.	+
Vulpia ciliata	.	+
Crepis setosa	.	r
Hippocrepis ciliata	.	r
Other species		
Euphorbia spinosa	1	2
Cephalaria leucantha	1	1
Romulea bulbocodium	+	1
Sedum rupestre	+	1
Dactylis hispanica	+	+
Orchis morio	r	+
Serapias vomeracea	r	+
Ornithogalum narbonense	r	r
Anemone hortensis	+	.
Osyris alba	r	.
Sedum acre	.	+
Bellis perennis	.	r
Echium italicum	.	r
Marrubium incanum	.	r

Table 5: *Open scrub and shrublands.* a: *Pistacio terebinthi-Paliuretum spinae-christi;* **b**: transition aspect between *Pistacio-Paliuretum* shrublands and *Quercus pubescens* woods
Tabela 5: Odprta grmišča. a: *Pistacio terebinthi-Paliuretum spinae-christi;* **b**: prehod med grmišči *Pistacio-Paliuretum* in gozdovi *Quercus pubescens* woods

	a	a	a	a	a	a	a	b
Relevè nr.	**1**	**2**	**6**	**7**	**4**	**5**	**3**	**13**
Aspect	0	SE	W	SE	E	E	E	0
Slope (°)	0	<5	5	7	3	5	2	0
Altitude (m asl)	275	261	245	255	230	245	240	215
Area (m2)	100	100	50	100	60	70	70	200
Total cover (%) (without bryophytes)	70	75	75	90	85	90	80	90
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	BS	BS	BS	BS	BS	BS	BS	PP
Number of species per relevè	38	44	23	27	49	50	33	39
Pistacio terebinthi-Paliuretum spinae-christi								
Paliurus spina - christi	3	3	1	1	3	3	3	2
Pistacia terebinthus	3	2	1	2	2	3	1	2
Phyllirea latifolia	2	2	3	3	r	1	+	.
Cercis siliquastrum	.	3	2	1	1	2	r	.
Melica transylvanica	+	r	1	.	+	+	.	.
Pruno-Rubenion, Pruno-Rubion ulmifolii, Prunetalia spinosae, Rhamno-Prunetea								
Asparagus acutifolius	1	1	+	+	r	1	.	1
Ruscus aculeatus	.	.	2	.	.	1	.	.
Clematis flammula	.	.	r	.	.	.	+	.
Pyrus amygdaliformis	.	.	.	.	.	.	1	.
Rubia peregrina	.	.	.	.	.	.	+	.
Rosa sempervirens	.	.	.	.	.	.	+	.
Crataegus monogyna	.	.	.	.	.	.	.	+
Prunus spinosa	.	.	.	.	.	.	r	.
Tamus communis	.	.	r	.	.	.	.	.
Quercetalia pubescenti-petraeae, Querco-Fagetea								
Fraxinus ornus	1	1	1	1	.	2	1	.
Acer monspessulanum	1	2	.	2	.	1	1	.
Quercus pubescens	.	.	.	+	.	.	2	3
Ulmus minor	.	.	.	.	+	+	.	.
Celtis australis	.	+	.	.	.	.	.	.
Quercetalia, Quercetea ilicis								
Rhamnus alaternus	+	1	.	.	.	r	.	.
Cyclamen repandum	r	+	.	.	.	.	.	r
Olea sylvestris	.	1	.	.	.	.	.	.
Osyris alba	.	.	.	.	.	.	2	.
Carex distachya	.	.	.	1	.	.	.	.
Smilax aspera	.	.	.	.	.	r	.	.
Other species								
Bromus erectus	+	.	.	r	1	1	1	2
Allium subhirsutum	2	2	+	+	.	r	.	.
Calamintha nepeta	1	+	.	r	r	.	.	1
Carex caryophyllea	+	.	+	+	.	1	.	1
Dactylis hispanica	1	+	r	.	+	1	.	.
Convolvulus cantabrica	+	+	.	.	+	r	1	.

Relevè nr.	1	2	6	7	4	5	3	13
Arabis hirsuta	+	+	r	.	.	r	.	r
Orlaya grandiflora	.	r	.	.	r	+	+	r
Urospermum dalechampii	+	.	.	r	r	.	+	+
Brachypodium distachyum	.	r	+	.	1	1	.	.
Bromus sterilis	1	1	+	.	.	.	.	+
Cynosurus echinatus	.	.	+	+	1	1	.	.
Knautia integrifolia	.	.	r	+	+	1	.	.
Teucrium chamaedrys	.	1	.	r	.	+	.	+
Hypochoeris achyrophorus	.	.	.	+	+	+	r	.
Serratula cichoracea	.	r	.	+	.	r	r	.
Sideritis romana	.	.	.	r	r	.	+	+
Thymus longicaulis	.	.	.	.	+	+	+	+
Aristolochia rotunda	.	.	1	1	.	+	.	.
Eryngium campestre	.	.	.	.	+	.	1	1
Euphorbia spinosa	1	1	.	.	.	.	.	+
Brachypodium ramosum	.	+	.	.	.	+	.	1
Gastridium ventricosum	.	.	.	.	1	+	+	.
Geranium robertianum	.	.	1	+	.	r	.	.
Crepis zacintha	.	.	.	.	+	r	.	r
Geranium purpureum	+	+	.	.	.	.	.	+
Teucrium capitatum	.	.	.	.	r	.	+	+
Trifolium angustifolium	.	+	.	.	+	r	.	.
Trifolium stellatum	+	.	.	.	.	r	.	+
Aegilops geniculata	.	.	.	.	1	1	.	.
Aristolochia lutea	+	2	.	.	.	.	.	.
Gaudinia fragilis	.	.	.	.	1	+	.	.
Ranunculus millefoliatus	+	1	.	.	.	.	.	.
Trifolium lappaceum	.	.	.	r	1	.	.	.
Aetheorrhiza bulbosa	+	+	.	.	.	.	.	.
Anemone hortensis	+	+	.	.	.	.	.	.
Anthemis arvensis	+	.	.	.	+	.	.	.
Arenaria leptoclados	.	+	.	.	.	.	.	+
Arum italicum	r	+	.	.	.	.	.	.
Bromus hordeaceus	.	.	.	.	+	+	.	.
Bromus rubens	.	.	.	.	+	+	.	.
Campanula rapunculus	.	.	.	+	.	r	.	.
Carlina corymbosa	.	.	.	.	r	.	.	+
Catapodium rigidum	.	+	.	r	.	.	.	.
Crepis neglecta	.	.	.	.	+	.	.	+
Euphorbia exigua	.	.	.	.	.	r	.	+
Galium corrudifolium	.	.	.	.	.	.	+	+
Geranium dissectum	.	.	.	.	r	+	.	.
Lathyrus cicera	r	+	.	.	.	.	.	.
Orchis tridentata	+	r	.	.	.	.	.	.
Poa bulbosa	+	.	.	.	.	.	.	+
Poa trivialis	+	+	.	.	.	.	.	.
Salvia clandestina	.	.	.	.	+	+	.	.
Sanguisorba minor	.	.	.	.	r	.	+	.
Sedum rupestre	+	+	.	.	.	.	.	.
Torilis japonica	.	+	r	.	.	.	.	.
Torilis nodosa	.	.	.	.	+	+	.	.
Trifolium campestre	.	.	.	.	+	+	.	.

Relevè nr.	1	2	6	7	4	5	3	13
Trifolium scabrum	.	.	.	.	+	.	.	+
Vicia sativa ssp. nigra	.	+	.	.	.	r	.	.
Ammoides pusilla	.	.	.	.	1	.	.	.
Brachypodium rupestre	.	.	.	.	.	.	1	.
Cerastium ligusticum	.	.	.	.	.	.	.	1
Reichardia picroides	.	.	.	.	.	.	.	1
Satureja montana	.	.	.	.	.	.	.	1
Asplenium ceterach	.	r	.	.	.	.	.	.
Avena barbata	.	.	.	.	+	.	.	.
Biscutella mollis	.	.	.	.	.	.	.	+
Bombycilaena erecta	.	.	.	.	+	.	.	.
Briza maxima	.	.	.	.	+	.	.	.
Bupleurum baldense	.	.	.	.	.	+	.	.
Campanula erinus	.	.	.	r	.	.	.	.
Carex divulsa	+	.	.	.	.	.	.	.
Centaurea bracteata	.	.	.	.	.	.	+	.
Centaurium erythraea	.	.	.	.	r	.	.	.
Coronilla scorpioides	.	.	.	.	.	.	.	r
Crepis sancta	.	.	.	.	.	.	.	+
Cynoglossum creticum	.	.	.	.	.	.	.	r
Dorycnium hirsutum	.	.	.	.	.	.	+	.
Filipendula vulgaris	.	.	.	.	.	.	r	.
Fumaria capreolata	.	r	.	.	.	.	.	.
Galium aparine	.	+	.	.	.	.	.	.
Geranium lucidum	.	.	r	.	.	.	.	.
Iris lutescens	.	.	.	.	.	.	.	r
Lathyrus ochrus	r	.	.	.	.	.	.	.
Linum strictum	.	.	.	.	r	.	.	.
Lolium perenne	.	.	.	.	.	+	.	.
Marrubium incanum	.	.	.	.	.	.	.	r
Medicago arabica	.	+	.	.	.	.	.	.
Medicago minima	+	.	.	.	.	.	.	.
Melilotus neapolitana	.	.	.	.	.	.	r	.
Nigella damascena	.	.	.	.	+	.	.	.
Ophrys sphecodes	.	.	.	.	.	r	.	.
Pallenis spinosa	.	.	.	.	r	.	.	.
Plantago bellardi	.	.	.	.	+	.	.	.
Plantago lagopus	.	.	.	.	+	.	.	.
Poa pratensis	.	.	.	.	.	+	.	.
Potentilla hirta	.	.	.	.	.	.	+	.
Ruscus hypoglossum	.	.	.	r	.	.	.	.
Tanacetum corymbosum ssp. *achilleae*	.	.	.	.	.	r	.	.
Theligonium cynocrambe	.	r	.	.	.	.	.	.
Tordylium apulum	+	.	.	.	.	.	.	.
Tragopogon dubius	.	.	.	.	.	.	+	.
Trifolium cherleri	.	.	.	.	+	.	.	.
Trifolium striatum	.	.	.	.	.	+	.	.
Urospermum picroides	.	.	r	.	.	.	.	.
Veronica acinifolia	+	.	.	.	.	.	.	.
Vulpia bromoides	+	.	.	.	.	.	.	.

Table 6: Thermophilous deciduous forests dominated by *Quercus pubescens* and *Acer monspessulanum, Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis.*

Tabela 6: Termofilni listopadni gozdovi z prevladujočimi vrstami *Quercus pubescens* in *Acer monspessulanum, Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis.*

Relevè nr.	**8**	**9**	**10**	**12**	**11**
Aspect	0	E	0	W	W
Slope (°)	0	8	0	20	15
Altitude (m asl)	220	240	240	210	255
Area (m2)	200	250	200	300	250
Total cover (%) (without bryophytes)	95	95	95	95	95
Site (BS: Poggio Bagno Santo; PP: Pian di Palma)	PP	BS	BS	PP	BS
Number of species per relevè	28	46	34	31	29
Pistacio terebinthi-Quercetum pubescentis					
Smilax aspera	.	2	.	+	2
Acer campestre	.	1	1	.	.
Pistacia terebinthus	.	+	.	.	.
rosetosum sempervirentis					
Cercis siliquastrum	.	1	3	2	1
Rosa sempervirens	.	+	.	.	+
Brachypodium ramosum	2	.	.	.	.
Cyclamen repandum	+	.	.	.	.
local variant differential species					
Paliurus spina - christi	2	1	1	.	2
Celtis australis	.	.	2	1	1
Lauro-Quercenion, Carpinion orientalis					
Acer monspessulanum	3	4	3	4	2
Asparagus acutifolius	.	+	.	r	+
Clematis flammula	1	+	+	.	.
Rubia peregrina	.	1	+	.	r
Phyllirea latifolia	.	+	.	.	1
Ostrya carpinifolia	.	1	.	.	.
Lonicera etrusca	.	+	.	.	.
Anemone hortensis	+	.	.	.	.
Arabis turrita	.	+	.	.	.
Quercetalia pubescenti-petraeae, Querco-Fagetea					
Quercus pubescens	4	3	3	2	4
Fraxinus ornus	2	2	1	2	2
Ruscus aculeatus	2	3	2	+	2
Hedera helix	1	1	1	1	1
Tamus communis	.	1	1	r	+
Cornus mas	.	1	.	1	+
Melica uniflora	.	1	+	1	.
Brachypodium sylvaticum	.	+	1	.	+
Melittis melissophyllum	.	1	.	r	+
Viola alba ssp. *dehnhardtii*	+	+	.	+	.
Lithospermum purpurocaeruleum	.	r	+	.	r
Helleborus foetidus	.	r	r	+	.
Poa sylvicola	.	+	+	+	.
Silene italica	1	.	r	.	.

Relevè nr.	8	9	10	12	11
Quercus cerris	.	1	.	.	.
Stachys officinalis	1	.	.	.	.
Scutellaria columnae	.	+	.	.	.
Pulicaria odora	+	.	.	.	.
Lathyrus venetus	.	+	.	.	.
Cyclamen hederifolium	.	.	.	+	.
Geum urbanum	.	.	.	r	.
Other species					
Geranium robertianum	.	2	1	2	2
Allium subhirsutum	.	+	+	+	+
Aristolochia rotunda	.	.	1	+	1
Brachypodium rupestre	2	+	.	.	r
Crataegus monogyna	.	.	1	+	+
Myrrhoides nodosa	.	+	+	r	.
Parietaria officinalis	.	.	r	+	+
Calamintha nepeta	1	.	.	.	r
Quercus ilex	.	1	+	.	.
Serratula cichoracea	1	.	.	.	+
Arabis hirsuta	+	.	r	.	.
Asplenium onopteris	.	r	.	r	.
Cardamine graeca	.	r	.	+	.
Carex distachya	.	.	+	.	+
Geranium lucidum	.	.	+	+	.
Ranunculus velutinus	.	+	.	r	.
Torilis japonica	.	.	+	.	+
Bromus erectus	1	.	.	.	.
Carex hallerana	1	.	.	.	.
Filipendula vulgaris	1	.	.	.	.
Stellaria media	.	.	.	1	.
Alliaria petiolata	.	.	.	.	r
Asplenium trichomanes	.	r	.	.	.
Bellis perennis	+	.	.	.	.
Bromus sterilis	.	.	+	.	.
Carex depauperata	.	.	r	.	.
Carlina corymbosa	+	.	.	.	.
Cruciata glabra	.	r	.	.	.
Cymbalaria muralis	.	r	.	.	.
Cynosurus echinatus	.	.	+	.	.
Ficus carica	.	+	.	.	.
Helianthemum nummularium	+	.	.	.	.
Lotus hispidus	r	.	.	.	.
Melica transylvanica	.	.	+	.	.
Moehringia pentandra	.	r	.	.	.
Ornithogalum etruscum	.	r	.	.	.
Prunus spinosa	.	+	.	.	.
Ranunculus bulbosus	+	.	.	.	.
Rhamnus alaternus	.	.	+	.	.
Sonchus oleraceus	.	.	.	r	.
Theligonium cynocrambe	.	.	.	r	.
Thymus longicaulis	+	.	.	.	.
Trifolium ochroleucum	+	.	.	.	.
Umbilicus rupestris	.	r	.	.	.

Pian di Palma *Bromus erectus* grasslands, with cushions of *Euphorbia spinosa.*

Travišča z vrsto *Bromus erectus* in blazinicami *Euphorbia spinosa* na območju Pian di Palma.

Pian di Palma chamaephytic garrigues with *Euphorbia spinosa*, *Satureja montana*, *Helichrysum italicum* and others.

Hamefitska gariga z vrstami *Euphorbia spinosa*, *Satureja montana*, *Helichrysum italicum* in drugimi na območju Pian di Palma.

Shrub community of *Pistacio terebinthi-Paliuretum spinae-christi* on the rocky hill slopes of Poggio Bagno Santo.

Grmiščne združbe *Pistacio terebinthi-Paliuretum spinae-christi* na gričevju Poggio Bagno Santo.

Aerial view of the mixed thermophilous deciduous forest (*Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis*) on the slopes of Poggio Bagno Santo facing the Albegna river.

Pogled iz zraka na mešane termofilne listopadne gozdove (*Pistacio terebinthi-Quercetum pubescentis rosetosum sempervirentis*) na pobočju gričevja Poggio Bagno Santo proti reki Albegna.

The flat travertine pavement of Pian di Palma, with open woodland and species-rich grassland communities.

Ravne plošče travertina na območju Pian di Palma z odprtimi gozdovi in vrstno bogatimi travišči.

Sedum caespitosum, one of the most physiognomically typical species of the annual-dominated communities on flat travertine pavements (*Sedetum hispanico-caespitosi*).

Sedum caespitosum je vrsta, ki daje značilen fiziognomski videz združbam na travnatih ploščah, v katerih prevladujejo anoletnice (*Sedetum hispanico-caespitosi*).