

# Map of vegetation series of Ponza island (central Italy)

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**Abstract:** Stanisci, A., Feola, S. & Blasi, C. *Map of vegetation series of Ponza island (central Italy)*. *Lazaroa* 26: 93-113 (2005).

Cartography, syntaxonomy and syndynamics of plant communities of Ponza island are discussed. Seventeen plant associations have been identified and their successional position was pointed out. Six potential natural vegetation units were described and the different land cover types for each units were mapped (scale 1:10 000, printed at scale 1:25.000) and evaluated. The originality of taxa combination in the plant communities allowed us to propose two new associations, (*Calicotomo villosae-Rubetum ulmifolii* (mantle) and *Brassico fruticosae-Brachypodietum retusi* (secondary grassland), as well as two new subassociations. Although the residual woods are very fragmented and need a special protection against fires for their survival, the Ponza landscape has an important naturalistic and ecological value due to its high diversity of plant taxa and plant communities.

**Resumen:** Stanisci, A., Feola, S. & Blasi, C. *Mapa de las series de vegetación de la Isla de Ponza (Italia Central)*. *Lazaroa* 26: 93-113 (2005).

En este trabajo se presentan la cartografía, la sintaxonomía y la sindinámica de las comunidades vegetales. Se han identificado 17 asociaciones vegetales y se han descrito para cada una de ellas su posición sucesional. Se describen 6 tipos de unidades de vegetación natural potencial y se representan cartográficamente las distintas tipologías de cobertura del suelo (escala 1:25.000). La combinación original de los taxones en las distintas comunidades vegetales nos ha llevado a proponer dos nuevas asociaciones: *Calicotomo villosae-Rubetum ulmifolii* (manto mesofítico) y *Brassico fruticosae-Brachypodietum retusi* (pastizal secundario), y también dos nuevas subasociaciones. Si bien los bosques residuales de la isla son muy fragmentarios y necesitan una protección particular ante los efectos del fuego, la elevada diversidad específica y de comunidades vegetales evidencian el elevado valor naturalístico del paisaje de Ponza.

## INTRODUCTION

In the islands and coastal areas of the Mediterranean sea human pressure on natural landscape has been intense for milleniums. It exerted mainly through the use of fire, deforestation and pasturing, strongly conditioning the present order of the vegetation structure (e.g. BARBERO & *al.*, 1990; BIONDI, 2000; BLASI & *al.*, 1995; CARRANZA & *al.*, 2001; DE LUÍS & *al.*, 2001; KOMAREK, 1983; MAZZOLENI, 1993; MOUILLOT & *al.*, 2003; NAVEH, 1975; PAUSAS, 1999; TRABAUD, 1987).

Inhabited by man since the Neolithic, the island of Ponza, in the centre-southern Tyrrhenian Sea, underwent many changes in its plant landscape, as reported in the literature (ANZALONE & CAPUTO, 1974-75; BEGUINOT, 1905; STANISCI & PEZZOTTA, 1993; VERI & *al.*, 1980). In recent times the progres-

sive abandon of cultivation produced a generalized vegetation recover. However, this recover follows diverse dynamic ways and stages, according to the features of the physical environment, as it happens in other small Tyrrhenian islands (e.g. FERRO & FURNARI, 1970; LONGHITANO, 1982; MAZZOLENI & RICCIARDI, 1990).

Aim of the paper is to investigate the natural landscape of Ponza island identifying the main land units and plant communities and mapping vegetation series at the scale 1:25.000.

## AREA OF STUDY

Ponza island (7.2 km<sup>2</sup>) is the largest island of the Pontine archipelago, also composed by Zannone (1.07 km<sup>2</sup>), Palmarola (1.31 km<sup>2</sup>), Ventotene (1.23

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km<sup>2</sup>), S.Stefano (0.3 km<sup>2</sup>) and Gavi (0.1 km<sup>2</sup>). The archipelago is located along the Tyrrhenian coast of Lazio and Campania at a latitude between 40° 40' e 41° North; it can be divided both for geological and geographical reasons in two groups: a south-eastern group, composed by the islands of Ventotene and S. Stefano, located at about 40 km to the south of Gaeta, and a north-western group, at about 30 km to the south of the promontory of Circeo, composed by the islands of Ponza, Gavi, Palmarola and Zannone.

Volcanic deposits are the main rock types on the Ponza island, which is mainly built of rhyolitic hyaloclastic and lava deposits (Ponza Formation). They are the oldest rocks of the island, placed in a submarine environment. The youngest rocks outcrop only in the southern sector of the island (Monte Guardia) as a sequence of partly subaerial pyroclastic and trachytic lava deposits. Bentonite deposits are found only in the northern area of the island (Cala dell'acqua) (BELLUCCI & *al.*, 1999), while recent alluvial deposits are present in the bottom of the valley of Ponza's port, especially at S. Maria. The catchment basin of S. Maria is the largest one of the island, run through by a coaxial fault with the main pole filled up by recent alluvions with thicknesses rising from mountain to sea. A modestly important flow of fresh water connected to a flow present in the surrounding rhyolites, too, is present in the alluvions (CIUFFINI & DI EUGENIO, 1995).

The landscape is also strongly influenced by the structures of land containment realized and maintained by man throughout the ages, the terracings that deeply modify the drainage and the flowing of water (VAUDOUR, 1991).

The bioclimate is dry thermo-mediterranean, with 590 mm yearly average precipitations, a mean air temperature of 16,4 °C and a summer dryness which lasts 4 months (BLASI & *al.*, 2002b). It should be noted that the summer precipitation (33 mm) and the lowest temperature average in the coldest month are, respectively, the scarcest and the highest of the Lazio region (BLASI, 1994).

As regards the land use, we can mention that the economy of the island was based mainly on agriculture and fishing until the half of the last century, with the terraced cultivations occupying the 70% of the area during the 1950s. The shrubby and tree vegetation survived along the farms boundaries and in rare inaccessible sites (STANISCI & PEZZOTTA, 1993). At

present, barely the 10 % of the area is cultivated, even if the terraces in good condition are still common, mainly in the northern aspects, playing an effective role in the control of the erosion of the soil resource. Unfortunately about the 10% of the terracings have already been destroyed respectively to the largest extension around 1950 (CIUFFINI & DI EUGENIO, 1995). A study has been recently developed in order to locate the main environmental units, connecting them to the incidence of the fires in the period of time 1978-2000 (STANISCI & *al.*, 2004). This research pointed out a major frequency of fires in the environmental units concerning the hill slopes, mainly exploited for farming and settlements, with a peak in September-October, coinciding with the burning of stubbles. The frequent passing of fire on the island threatens the survival of the residual woods and makes the intermediate and pioneer stages of the main vegetation series more widespread.

## DATA AND METHODS

In order to interpret the present landscape and to understand the dynamic in progress, we applied the method related to the hierarchical land classification allowing to locate the main land units of an area and the main typologies of potential natural vegetation related to them (FORMAN & GODRON, 1996; GAVILÁN & *al.*, 1998; BLASI & CARRANZA, 1998; BLASI & *al.*, 1998; BLASI & *al.*, 2000b; BLASI & *al.*, 2000a; BLASI & *al.*, 2002b).

The vegetation was mapped at the scale of 1:10 000, using panchromatic aerial photos (flight S.T.A. 2/07/2000), phytosociological relevés and literature data (BELLUCCI & *al.*, 1999; VERI & *al.*, 1980; STANISCI & PEZZOTTA, 1993).

Phytosociological investigation followed BRAUN-BLANQUET (1932) and GÉHU & RIVAS-MARTÍNEZ (1981) approach. Previous information (ANZALONE & CAPUTO, 1974-1975; VERI & *al.*, 1980; BIONDI, 1999) were completed by 58 original phytosociological relevés. The classification of relevés was processed with Syn-tax V (PODANI, 1995), using average linkage and chord distance as methods of multivariate analysis.

For each vegetation series the percentage cover of the various serial stages has been considered.

The nomenclature of plant species refers to ANZALONE (1994, 1996), BLASI & ABBATE (in press)

and some specific studies (ANZALONE & CAPUTO, 1974-1975, VALSECCHI, 1993, BRULLO & al., 1999). Nomenclature of syntaxa quoted in the text is given in the taxonomical scheme, following WEBER & al (2000) and RIVAS-MARTÍNEZ & al.(2001)

The maps were computerized and handled with GIS, Arc View 3.2 (ESRI, 2000).

## RESULTS

The hierarchical land classification provided one land region (bioclimatic features), three land systems (lithological features), four land facets (of lithomorphological nature and phytoclimatic types in detail) and six land units (homogeneous in the lithomorphological view and for the potential natural vegetation) (see STANISCI & al., in press).

The six units of potential natural vegetation are (1) *Erico-Quercetum ilicis* on the southern sides, (2) *Quercenion virgilianae* on the northern sides, (3) *Fraxino angustifoliae-Ulmenion minoris* (fragments) on the bottom of the alluvial valley, (4) geosigmatum of the sandy shores, (5) geosigmatum of the sea cliffs, (6) geosigmatum of the drift cones (see attached cd-rom). The woodland series of the southern and northern hill slopes prevail (80% of the area), but they are represented mainly by macchia and garrigues forming the intermediate serial stages. On the contrary, the catenas of sea cliffs and drift cones consist of mature stages.

The real vegetation corresponds to 17 associations which are represented at the scale 1:25 000 on the map of the vegetation series (see attached cd-rom). Hereafter, they are described according to their synecology, structure, syndynamic and synchorology. The presentation is in accordance with the catenal or serial occurrence within each of the six units of the potential natural vegetation.

### SERIES OF THE *ERICO-QUERCETUM ILICIS*

It is the most widespread vegetation series of the island, even if mature stages are rare. *Genista thyrrhena* macchia occupies more than 50% of the series' area, the rest being almost represented by secondary grasslands, vineyards and deeply man-transformed areas (see map of the vegetation series and figure 1).

### *Erico arboreae-Quercetum ilicis* Brullo, Di Martino & Marceno 1977 (Tab. 1)

*Synecology and structure:* woodland with evergreen sclerophyllous species dominated by *Quercus ilex*, with a good covering of *Erica arborea*. It represents the mature phase in the south-facing hill slopes, in the top plateaus and in the round ridges. This association differs from the other acidophilous *Q. ilex* communities, rich with *Erica arborea*, due to the presence of many thermophilous species of the *Pistacio-Rhamnetalia alaterni*. The cover of herbaceous species is scarce, due to strong shading, while lianas are abundant, such as *Rubia peregrina*, *Asparagus acutifolius*, *Smilax aspera* and *Lonicera implexa*. In Ponza, the residual woods are characterized by a sudden floristic impoverishment and by the presence of ruderal and pioneer species, to be associated to the degradation of anthropic origin and to the high frequency of late summer fires.

*Syndynamics:* successional stages of the *Erico-Quercetum ilicis* series are the high macchia of the *Erico arboreae-Arbutetum unedonis*, the low macchia of the *Erico multiflorae-Genistetum tyrrhenae*, the garrigues of the *Oleo-Euphorbietum dendroidis*, the grasslands of the *Trifolio cherleri-Plantaginetum bellardii* and the *Brassico fruticosae-Brachypodietum retusi*.

*Synchorology:* this association is associated to the coastal and thermo-mediterranean hill environments with dry-subhumid ombrotype, on acid substrata, and occurs in southern Italy and in the Tyrrhenian islands (BRULLO & MARCENÒ, 1985, BRULLO & al., 2001). In Ponza, the few fragments of this coenosis are set aside in steep, hardly accessible sites.

### *Myrto communis-Pistacietum lentisci* (Molinier (1936) 1954) Rivas Martínez 1975 (Tab. 2)

*Synecology and structure:* macchia with *Pistacia lentiscus*, *Myrtus communis*, *Phillyrea angustifolia*, *Lonicera implexa* and *Phillyrea latifolia*.; it is not very frequent and prefers the hinterland southern slopes.

*Syndynamics:* the distribution of this association on the island has been reduced in the last years, both for the greater competitiveness of the *Erico multiflorae-Genistetum tyrrhenae* on the terraces run through by fire, and for its natural evolution to the *Erico-Quercetum ilicis* (as also evidenced by the continuous presence of *Erica arborea* in these coenoses).

Table 1  
*Erico arboreae-Quercetum ilicis* Brullo, Di Martino & Marcenò 1977 (1-5)  
*Erico arboreae-Quercetum ilicis quercetosum virgilianae subass. nova hoc loco* (6, 7)  
 (*Erico-Quercion ilicis*, *Quercetalia ilicis*, *Quercetea ilicis*)

	130	120	30	225	150	60	120
Altitude (m.a.s.l.)	130	120	30	225	150	60	120
Slope (°)	30	40	35	20	30	20	25
Area (m <sup>2</sup> )	50	90	70	40	50	70	60
Cover (%)	100	100	90	95	90	100	60
Exposure	N	NW	N	N	NW	N	N
Relèves Number	1	2	3	4	5	6	7
Assoc. characteristics:							
<i>Erica arborea</i>	3	2	1	2	3	2	3
<i>Arisarum vulgare</i>	.	.	+	2	1	+	2
<i>Arbutus unedo</i>	2	.	+	.	.	.	2
<i>Pulicaria odora</i>	1	.	.	.	.	+	1
<i>Clematis flammula</i>	1	.	.	.	.	1	+
<i>Rhamnus alaternus</i>	+	2	.	.	.	.	1
<i>Phillyrea angustifolia</i>	.	1	1	.	.	.	.
subass. characteristics:							
<i>Quercus virgiliana</i>	.	.	.	.	.	2	.
<i>Castanea sativa</i>	.	.	.	.	.	.	3
<i>Sorbus domestica</i>	.	.	.	.	.	.	+
All. and Ord. characteristics:							
<i>Quercus ilex</i>	4	5	5	4	4	4	3
<i>Phillyrea latifolia</i>	2	.	.	.	1	+	2
<i>Asplenium onopteris</i>	.	.	.	+	.	+	+
<i>Tamus communis</i>	.	.	.	1	.	.	+
<i>Viburnum tinus</i>	3	.	.	.	.	.	.
<i>Hedera helix</i>	.	.	.	.	.	1	.
Class. characteristics:							
<i>Asparagus acutifolius</i>	1	1	+	1	.	+	+
<i>Rubia peregrina</i>	2	1	.	+	2	+	.
<i>Lonicera implexa</i>	1	1	+	.	1	.	+
<i>Smilax aspera</i>	2	2	+	.	.	+	.
Companions of <i>Pistacio-</i>							
<i>Rhamnetalia alaterni</i> :							
<i>Myrtus communis</i>	2	2	.	.	.	.	1
<i>Teucrium flavum</i>	2	.	.	.	1	.	1
<i>Ampelodesmos mauritanicus</i>	.	.	+	.	.	.	1
<i>Pistacia lentiscus</i>	+	.	.	.	.	.	+
<i>Prasium majus</i>	.	.	.	+	.	.	.
<i>Euphorbia dendroides</i>	.	.	.	.	.	.	+
Companions:							
<i>Rubus ulmifolius</i>	.	1	+	2	1	1	2
<i>Brachypodium retusum</i>	1	.	+	2	.	1	3
<i>Spartium junceum</i>	+	.	.	+	1	+	.
<i>Carex divulsa</i>	.	.	+	+	.	+	1
<i>Genista thyrrrena</i>	.	.	+	.	.	+	2
<i>Galium aparine</i>	.	.	+	.	.	1	+

Other species: Companions: *Cistus salviifolius* and *Calicotome villosa* +, *Erica multiflora* 1, in 1; *Malva sylvestris* and *Urtica dioica* +, in 3; *Ficus carica* and *Calamintha nepeta* +, in 4; *Umbilicus rupestris*, *Hypochaeris glabra*, *Parietaria difusa* and *Fumaria capreolata* +, *Senecio cineraria* subsp. *bicolor* 1, in 6; *Umbilicus rupestris*, *Plantago lanceolata*, *Calicotome villosa*, *Parietaria difusa*, *Hypochaeris glabra*, *Valerianella microcarpa*, *Brassica montana*, *Dactylis glomerata* subsp. *hispanica* and *Dittrichia viscosa* +, *Cistus salviifolius*, *Daucus gingidium* and *Narcissus tazetta* 1, in 7.

Localities: 1: Campo Inglese; 2 and 5: Lucia Rosa; 3: Conti; 4 and 7: Monte Guardia; 6: Scotti, *holotypus subass.*

Table 2  
*Oleo-Euphorbietum dendroides* Trinajstić 1973 (1, 2)  
*Oleo-Euphorbietum dendroidis* variant with *Cistus monspeliensis* (3,4)  
*Myrto communis-Pistacietum lentisci* (5, 6)  
 (*Oleo-Ceratonion*, *Pistacio-Rhamnetalia alaterni*, *Quercetea ilicis*)

Altitude (m.a.s.l.)	30	30	150	70	130	110
Slope (°)	40	45	40	15	25	20
Area (m <sup>2</sup> )	90	60	40	60	60	55
Cover (%)	80	90	100	95	45	80
Exposure	SW	SE	S	SE	S	S
Reliefs N.	1	2	3	4	5	6
<i>Oleo-Euphorbietum dendroides</i> :						
<i>Euphorbia dendroides</i>	4	4	4	3	.	.
<i>Prasium majus</i>	1	.	1	1	1	.
<i>Oleo-Euphorbietum dendroidis</i>						
var. <i>Cistus monspeliensis</i> :						
<i>Cistus monspeliensis</i>	.	.	2	+	.	.
<i>Olea europaea</i> var. <i>oleaster</i>	.	.	+	.	.	.
<i>Myrto-Pistacietum lentisci</i> :						
<i>Myrtus communis</i>	.	.	1	.	2	+
<i>Pistacia lentiscus</i>	.	.	.	.	1	3
<i>Oleo-Ceratonion</i> :						
<i>Opuntia ficus-barbarica</i>	3	.	+	3	.	.
<i>Ampelodesmos mauritanicus</i>	.	.	.	1	.	+
<i>Teucrium flavum</i>	.	.	.	.	+	+
<i>Pistacio-Rhamnetalia alaterni</i> ,						
<i>Quercetea ilicis</i> :						
<i>Phillyrea angustifolia</i>	.	.	.	.	+	+
<i>Asparagus acutifolius</i>	.	.	.	+	+	.
<i>Lonicera implexa</i>	.	.	.	.	+	+
<i>Arisarum vulgare</i>	.	.	.	1	+	.
<i>Erica arborea</i>	.	.	.	.	+	+
<i>Phillyrea latifolia</i>	+	.	.	.	.	.
<i>Pulicaria odora</i>	.	.	.	.	+	.
Companions of <i>Cisto-Lavanduletea</i> :						
<i>Genista thyrrena</i>	2	+	.	3	3	2
<i>Erica multiflora</i>	2	+	.	.	2	1
<i>Lavandula stoechas</i>	.	.	.	2	.	+
<i>Cistus salviifolius</i>	.	.	.	.	.	+
Companions of <i>Prunetalia spinosae</i> :						
<i>Spartium junceum</i>	1	3	1	.	2	.
<i>Rubus ulmifolius</i>	.	+	1	+	.	.
Companions:						
<i>Brachypodium retusum</i>	2	2	2	4	1	1
<i>Helichrysum italicum</i>	3	2	.	1	.	+
<i>Dittrichia viscosa</i>	1	.	+	+	2	.
<i>Briza maxima</i>	+	+	.	+	+	.
<i>Daucus gingidium</i>	+	+	+	.	1	.
<i>Hyparrhenia hirta</i>	3	1	.	+	.	.
<i>Matthiola incana</i>	+	+	+	.	.	.

Other species: Companions: *Hypochaeris glabra*, *Silene gallica*, *Avena barbata*, *Bromus madritensis*, *Gaudinia fragilis* and *Galactites elegans*+, *Brassica fruticulosa* 1, in 1; *Foeniculum vulgare*, *Lobularia maritima*, *Trifolium angustifolium*, *T. stellatum* and *Artemisia arborescens* +, *Senecio cineraria* subsp. *bicolor* 1, in 2; *Brassica fruticulosa*, *Vicia sativa*, *Thymelaea hirsuta*, *Vitis vinifera*, *Allium roseum*, *Plantago bellardii*, *Allium sphaerocephalon* and *Cydonia oblonga* +, *Senecio cineraria* subsp. *bicolor*, *Lobularia maritima*, *Brassica montana* and *Trifolium angustifolium* 1, in 3; *Asteriscus spinosus* +, in 4; *Hypochaeris glabra*, *Foeniculum vulgare*, *Rosmarinus officinalis*, *Carex flacca*, *Anagallis arvensis*, *Linum tryginum*, *Reichardia picroides* and *Plantago lanceolata*+, *Micromeria graeca* 1, in 5; *Micromeria graeca* and *Daphne sericea* +, *Thymelaea hirsuta* 1, *Rosmarinus officinalis* 3, in 6.

Localities: 1: Cala Gaetano; 2 and 3: Faro; 4: Guarini; 5: Core; 6: Capo Bosco.



MAP OF VEGETATION SERIES OF PONZA ISLAND (CENTRAL ITALY)



*Synchorology*: the *Myrto-Pistacietum lentisci* is a community occurring along the Mediterranean coasts from Spain to Croatia. In Ponza, it is more abundant on the southern side of Capo Bosco besides other small scattered fragments.

***Erico multiflorae-Genistetum tyrrhenae*** Biondi 1997 (Tab. 3)

*Synecology and structure*: this low macchia ranges more widely in the island, where it occupied a large part of the abandoned terracings (man was an advantage for it, as he used the *Genista* as windbreak). The floristic composition is characterized by the dominance of the endemic *Genista tyrrhena*, by the presence of *Erica multiflora* and of several species of the order *Lavanduletalia stoechadis* and the class *Cisto-Lavanduletea*, like *Cistus salvifolius*, *Lavandula stoechas* and *Cistus monspeliensis*.

A particular subassociation of the *Erico multiflorae-Genistetum tyrrhenae* and a variant, can be distinguished for Ponza, namely the subassociation *lavanduletosum stoechadis* with *Lavandula stoechas*, *Ampelodesmos mauritanicus* and *Hyparrhenia hirta*, which is a bush-garrigue facing areas recently run through by fire, and the variant with *Erica arborea*, *Pulicaria odora* and *Quercus ilex*, a more advanced stage towards the *Erico-Quercetum ilicis*.

*Syndynamics*: along the steepest rocky slopes, the coenosis with *G. tyrrhena*, together with *Erica multiflora* and sometimes *Opuntia ficus-barbarica*, represents a permanent community. But in other cases where the structure of an organic horizon in the soil is possible, these communities have to be intended as dynamic stages of a progressive sequence evolving very slowly toward the *Q.ilex*-forest.

*Synchorology*: this association was included by BIONDI (1999) in the new alliance *Calicotomo villo-*

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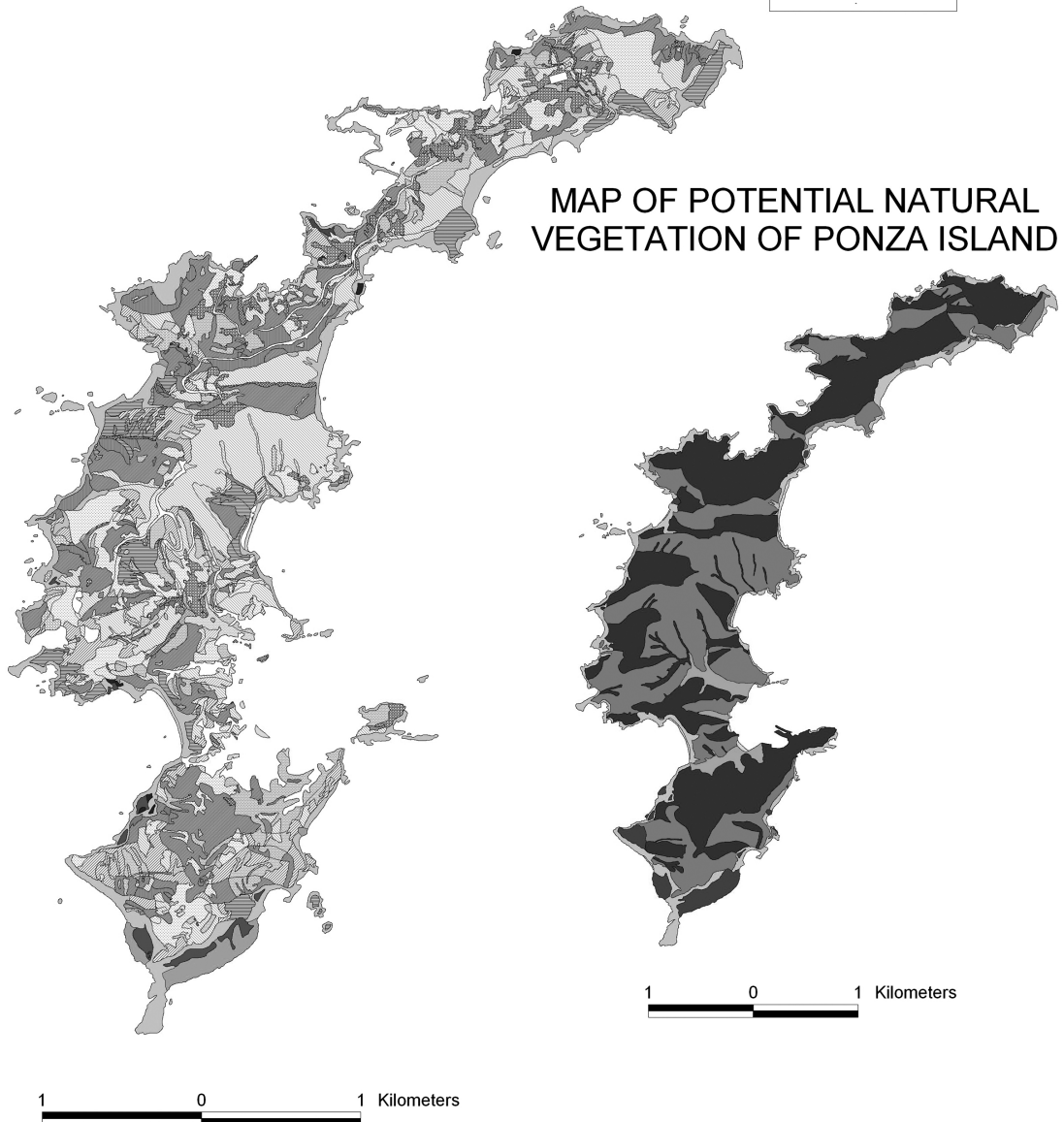


Table 3  
*Erico multiflorae-Genistetum tyrrhenae* Biondi 1997 (1-5)  
*Erico multiflorae-Genistetum tyrrhenae* variant with *Erica arborea* (6-8)  
*Erico multiflorae-Genistetum tyrrhenae lavanduletosum stoechadis subass. nova hoc loco* (9-12)  
 (*Calicotomo villosae-Genistion tyrrhenae, Lavanduletalia stoechadis, Cisto-Lavanduletea*)

Altitude (m.a.s.l.)	95	75	60	85	176	15	125	225	85	140	130	80
Slope (°)	10	25	10	10	0	20	25	10	25	15	0	10
Area (m <sup>2</sup> )	100	40	50	50	45	40	80	30	80	60	70	100
Cover (%)	100	100	100	100	90	95	95	100	90	80	70	100
Exposure	S	NW	SW	NE	-	NE	N	N	SW	W	-	S
Relèves N.	17	15	16	14	25	34	12	11	10	58	52	51
<i>Erico-Genistetum tyrrhenae:</i>												
<i>Genista thyrrhena</i>	5	4	3	3	4	2	4	5	4	3	4	3
<i>Erica multiflora</i>	2	3	.	.	.	.	.	.	+	2	.	.
<i>Erico-Genistetum tyrrhenae</i> variant with <i>Erica arborea</i> :												
<i>Pulicaria odora</i>	.	1	.	1	+	2	1	+	1	+	+	+
<i>Erica arborea</i>	.	1	.	.	.	2	3	3	.	+	.	+
<i>Quercus ilex</i>	.	.	.	.	.	3	+	.	.	.	.	.
<i>Erico multiflorae-Genistetum tyrrhenae</i> <i>lavanduletosum stoechadis:</i>												
<i>Ampelodesmos mauritanicus</i>	.	.	.	.	1	.	1	.	4	1	1	+
<i>Lavandula stoechas</i>	.	.	.	.	.	.	.	.	3	1	2	+
<i>Hyparrhenia hirta</i>	.	.	.	.	.	.	.	.	+	1	+	+
<i>Lavanduletalia, Cisto-Lavanduletea:</i>												
<i>Cistus salvifolius</i>	.	.	.	1	2	1	1	2	2	1	2	.
<i>Simethis mattiazzi</i>	.	.	.	.	2	.	.	.	.	+	.	.
<i>Cistus monspeliensis</i>	.	+	.	3	.	.	.	.	.	.	.	.
Companions of <i>Quercetea ilicis</i> :												
<i>Phillyrea angustifolia</i>	+	2	2	1	1	3	.	.	.	1	1	+
<i>Asparagus acutifolius</i>	+	+	+	.	.	1	+	.	+	.	+	+
<i>Phillyrea latifolia</i>	.	+	2	2	1	.	3	.	3	+	+	.
<i>Euphorbia dendroides</i>	1	+	2	+	2	+	.	.	+	+	.	.
<i>Pistacia lentiscus</i>	2	+	+	+	.	2	1	.	1	+	.	.
<i>Lonicera implexa</i>	+	+	+	+	.	.	+	.	+	.	.	.
<i>Arisarum vulgare</i>	.	.	.	.	.	1	1	+	.	.	+	1
<i>Prasium majus</i>	+	.	+	.	.	.	+	.	1	.	.	.
<i>Teucrium flavum</i>	+	+	.	.	+	2	.	.	.	.	.	.
<i>Rubia peregrina</i>	.	.	.	.	.	1	+	.	+	.	.	.
<i>Myrtus communis</i>	1	+	.	+	.	.	.	.	.	.	.	.
<i>Rhamnus alaternus</i>	.	.	.	.	.	.	1	.	.	.	+	.
<i>Carex flacca</i>	.	+	.	.	.	.	.	.	.	+	.	.
<i>Asplenium onopteris</i>	+	.	.	.	.	.	+	.	.	.	.	.
<i>Smilax aspera</i>	.	+	+	.	.	.	.	.	.	.	.	.
<i>Daphne sericea</i>	+	1	.	.	.	.	.	.	.	.	.	.
<i>Tamus communis</i>	.	.	.	.	.	.	1	.	.	.	.	.
<i>Arbutus unedo</i>	.	.	.	.	.	.	+	.	.	.	.	.
<i>Juniperus phoenicea</i>	.	+	.	.	.	.	.	.	.	.	.	.
Companions:												
<i>Brachypodium retusum</i>	3	3	+	3	3	4	3	2	3	4	4	5
<i>Rubus ulmifolius</i>	+	.	+	.	.	.	+	2	.	+	+	+
<i>Helichrysum italicum</i>	+	+	.	+	.	1	.	.	1	.	+	+
<i>Briza maxima</i>	.	.	.	.	.	+	.	+	+	+	+	+
<i>Daucus gingidium</i>	.	.	+	.	1	.	+	+	.	+	.	+
<i>Scorpiurus muricatus</i>	.	.	.	.	+	.	.	.	1	+	+	+
<i>Lotus edulis</i>	.	.	.	.	.	.	.	.	.	+	+	+
<i>Lobularia maritima</i>	.	.	.	.	.	.	.	.	.	+	+	+



Table 3 (Cont.)

<i>Spartium junceum</i>	+	.	1	.	.	.	1	.	.	.	.	1
<i>Dittrichia viscosa</i>	.	.	.	.	.	.	.	.	2	1	.	1
<i>Brassica fruticulosa</i>	.	.	.	.	.	.	.	.	1	.	+	+
<i>Hypochoeris glabra</i>	.	.	.	.	.	.	.	.	1	1	.	+
<i>Reichardia picroides</i>	.	.	.	.	+	.	.	.	.	+	.	+
<i>Avena barbata</i>	.	.	.	.	+	.	.	.	1	.	.	+
<i>Linum bienne</i>	.	.	.	.	.	.	.	.	.	.	+	+
<i>Galactites elegans</i>	.	.	.	.	.	.	.	.	2	.	.	+
<i>Silene gallica</i>	.	.	.	.	.	.	.	.	.	+	+	.
<i>Anagallis arvensis</i>	.	.	.	.	.	.	.	.	.	+	+	.
<i>Linum trigynum</i>	.	.	.	.	+	.	.	.	.	+	.	.

Other species: Companions: *Daphne sericea* +, in 1; *Carex flacca* and *Centaurium maritimum* +, *Daphne sericea* 1, in 2; *Artemisia arborescens* 1, in 3; *Plantago lanceolata* and *Hypochoeris radicata* +, in 5; *Calamintha nepeta* and *Serapias vomeracea* +, *Olea europaea* 1, in 6; *Valerianella microcarpa*, *Calamintha nepeta*, *Arbutus unedo*, *Umbilicus rupestris* and *Senecio cineraria* subsp. *bicolor* +, in 7; *Plantago lanceolata*, *Valerianella microcarpa*, *Serapias vomeracea* and *Hypericum perforatum* +, in 8; *Vulpia myuros*, *Dactylis glomerata* subsp. *hispanica*, *Trifolium cherleri* and *Allium roseum* +, *Logfia gallica* and *Rosmarinus officinalis* 1, in 9; *Carex flacca*, *Trifolium angustifolium* and *T. stellatum* +, *Hyoseris radiata* 1, in 10; *Medicago polymorpha*, *Romulea columnae*, *Plantago bellardii* and *Linum bienne* +, in 11; *Sherardia arvensis*, *Vicia sativa* and *Thymelaea hirsuta* +, *Agave americana* 1, in 12. Localities: 1 and 3: Piana Incenso; 2 and 4: Montagnella; 5, 10 and 11: Monte Pagliaro; 6: Santa Maria; 7 and 8: Monte Guardia; 9: Santa Maria; 12: Giancos.

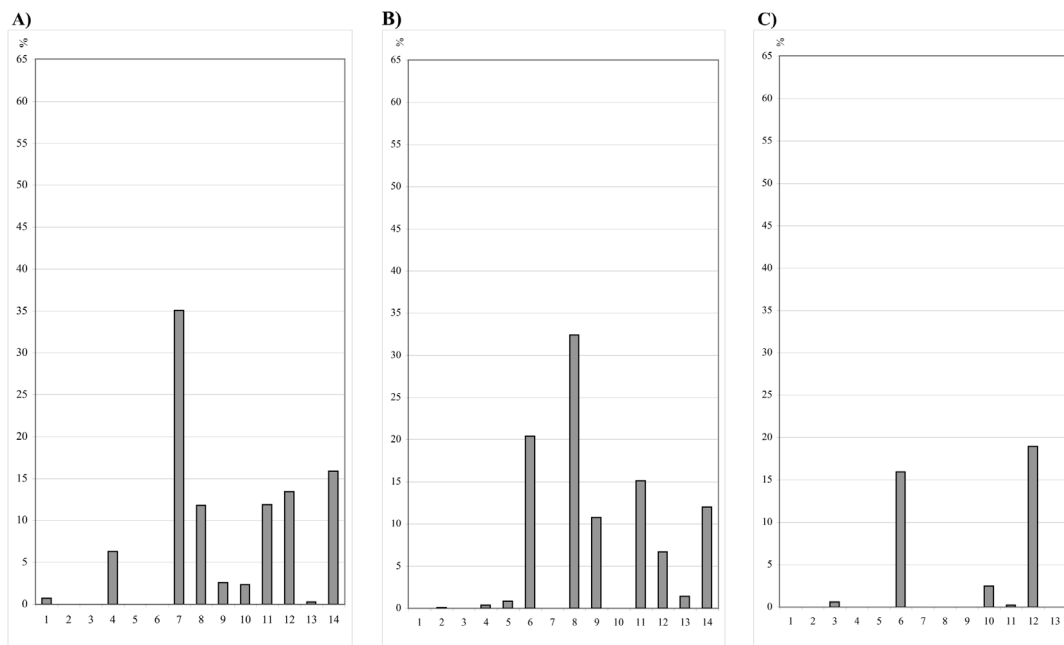


Figure 1.—Percentage of woody plant communities (1-10) and main land use (11-14) in the woodland series (A-C) of Ponza. (A) series of *Quercenion virgiliana*, (B) series of *Erico-Quercetum ilicis*, (C) series of *Fraxino angustifoliae-Ulmenion minoris*. (1) *Erico-Quercetum ilicis quercetosum virgiliana*, (2) *Erico-Quercetum ilicis*, (3) *Fraxino angustifoliae-Ulmenion minoris*, (4) *Erico-Arbutetum unedonis*, (5) *Myrto-Pistacietum lentisci*, (6) *Erico multiflorae-Genistetum tyrrhenae*, (7) *Erico multiflorae-Genistetum tyrrhenae* var. with *Erica arborea*, (8) *Erico multiflorae-Genistetum tyrrhenae lavanduletosum stoechadis*, (9) *Oleo-Euphorbietum dendroidis* var. with *Cistus monspeliensis*, (10) *Calicotomo villosae-Rubetum ulmifolii*, (11) secondary grasslands, (12) vineyards, (13) bare rock, (14) artificial area.

*sae Genistion tyrrhenae* of the south-west Tyrrhenian region on acidic soils.

***Trifolio cherleri-Plantaginetum bellardii*** Rivas Goday 1957 (Tab. 4)

*Synecology and structure:* it corresponds to terrophytic, silicicolous and pioneer grasslands growing on oligotrophic, generally thin to very thin, scarcely acidic soils with varying texture. The association characteristic species are generally present, *Trifolium cherleri* and *Aira cupaniana*, together with the alliance characteristic species, *Hypochaeris glabra*, *Linum trigynum* and *Vulpia myuros*. Inside the association, a variant with the presence of the perennial species *Brachypodium retusum* and *Pulicaria odora* can be described.

*Syndynamics:* it takes root almost always in the clearings of the acidophilous macchia, of which it represents the extreme stages of degradation, and in the same time it occurs in areas cultivated in the past and characterized today by a soil loss that was prevented before by terracings. In the more humid stretches close to small water ponds, these grasslands form a mosaic with the *Isoetion* community.

*Synchorology:* the *Trifolio cherleri-Plantaginetum bellardii* was described in Spain (RIVAS GODAY, 1957) and similar communities were recognized for the southern France, Corsica (GAMISANS & MURACCIOLE, 1984), Sardinia (Valsecchi, 1976), Sicily (Ferro & Di Benedetto, 1979, Di Benedetto, 1983, Ferro & Furnari, 1970) and on the Lazio coasts (Lucchese & Pignatti, 1987). In Ponza, it prevails at Mount Guardia and at Piano Incenso.

***Isoetion*** Br.-Bl. 1936

*Synecology and structure:* communities with *Isoetes durieui*, *Juncus capitatus*, *Radiola linoides* and *Menta pulegium* develop nearby the water puddles and next to the clayey level areas able to hold temporarily a certain quantity of meteoric water in the upper ground stage. These coenoses are being enriched with the rare *Isoetes histrix* at Mount Pagliaro and Piano Incenso.

*Synchorology:* the alliance *Isoetion* occurs widely in the western Mediterranean region (Quézel & Santa, 1962-63). In Ponza, these communities have been sampled at Piano Incenso, on the top plateau of Mount Guardia, upon the Frontone bay and the Campo Inglese.

***Brassico fruticosae-Brachypodietum retusi*** ass. nova hoc loco (Tab. 5, holotypus rel. 5)

*Synecology and structure:* this community colonizes the very recently abandoned tilled lands and the loose uncultivated ground nearby the country houses. It corresponds to a meadow formation composed by both perennial and annual species. It is characterized by the presence of *Brassica fruticulosa* and *Silene bellidifolia*, and it is dominated physiognomically by *Brachypodium retusum*. The latter species comes from dry walls, where it is set aside when the terracings are in use.

*Syndynamics:* despite the generalized abandon of the tilled lands, many vineyards still persist today enclosed with dry walls composed of lavic stone, while the level part of the terracing is generally used for horticultural cultivation. The latter being abandoned, the *Brassico fruticosae-Brachypodietum retusi* develops, dynamically connected to the shrubs of the *Pruno-Rubion ulmifolii* in the fresher and more shadowy sites and the shrubs of the *Oleo-Ceratonion* and the *Lavanduletalia* in the most sunny ones.

*Synchorology:* the community is particular to Ponza but, according to physiognomic descriptions in literature (Longhitano, 1982), it is potentially present in the recently abandoned tilled lands of the Italian volcanic islands. It presents affinities with the *Fumario agrariae-Brassicetum fruticosae* (Brullo & al., 2001) which occupies abandoned tilled on loose dune sandy grounds.

#### QUERCENION VIRGILIANAE SERIES

On northern slopes and colluvial sites of the island we assumed as potential natural vegetation a deciduous Mediterranean oak forest, recently set in the new suballiance *Quercenion virgilianae* (*Pino-Quercion congestae*), distributed in the Tyrrhenian central-southern Italy and in Sicily (Blasi & al., 2004). Such forests disappeared during the last century for the intense land exploitation. Nowadays only some scattered and isolated deciduous trees can be found as witnesses of the ancient woodland landscape.

This series is today mainly dominated by macchia which occupies about the 50% of the series' area (see map of the vegetation series and figure 1).

Table 4  
*Trifolium cherleri*-*Plantaginatum bellardii* Rivas Goday 1957  
 (*Helianthemion guttatae*, *Helianthemetalia guttatae*, *Helianthemetea guttatae*)

Altitude (m.a.s.l.)	275	210	100	100	275	270	275
Slope (°)	0	0	0	0	0	0	0
Area (m <sup>2</sup> )	10	10	25	10	10	10	10
Cover (%)	95	50	90	80	95	70	95
Relevés Number	1	2	3	4	5	6	7
Assoc. characteristics:							
<i>Aira cupaniana</i>	3	3	+	+	2	3	1
<i>Trifolium cherleri</i>	+	.	.	3	3	2	3
Var. <i>Brachypodium retusum</i> and <i>Pulicaria odora</i> :							
<i>Brachypodium retusum</i>	2	1	4	1	+	.	.
<i>Pulicaria odora</i>	1	1	3	2	+	.	+
<i>Dittrichia viscosa</i>	+	1	2	.	.	.	.
<i>Dactylis glomerata</i> subsp. <i>hispanica</i>	.	.	+	+	.	.	.
<i>Hyparrhenia hirta</i>	.	.	4	.	.	.	.
<i>Hypericum perforatum</i>	.	.	.	1	.	.	.
All. characteristics:							
<i>Hypochaeris glabra</i>	2	2	1	1	.	1	3
<i>Linum trigynum</i>	.	3	1	+	+	1	.
<i>Vulpia myuros</i>	.	1	.	3	2	2	.
<i>Galium divaricatum</i>	.	.	.	.	2	.	3
Ord. characteristics:							
<i>Briza maxima</i>	1	+	1	+	+	2	+
<i>Trifolium campestre</i>	1	+	1	1	.	+	+
<i>Silene gallica</i>	.	.	1	+	1	+	+
<i>Logfia gallica</i>	.	1	+	2	+	2	.
<i>Rumex bucephalophorus</i>	2	.	+	.	.	.	.
<i>Trifolium subterraneum</i>	.	.	.	.	.	.	+
<i>Ornithopus compressus</i>	.	.	.	.	+	.	.
Cl. characteristics:							
<i>Euphorbia exigua</i>	+	3	+	.	+	+	+
<i>Aegilops geniculata</i>	2	.	.	+	3	2	+
<i>Centaurium maritimum</i>	+	1	+	+	1	.	.
<i>Scorpiurus muricatus</i>	.	1	1	.	.	+	+
<i>Cynosurus echinatus</i>	1	.	1	.	+	.	+
<i>Vulpia ligustica</i>	4	.	.	1	.	.	4
<i>Erodium botrys</i>	.	.	.	.	.	3	4
<i>Trifolium stellatum</i>	.	.	.	.	.	1	.
Companions of <i>Stellarietea</i> :							
<i>Anagallis arvensis</i>	+	2	+	+	+	+	.
<i>Avena barbata</i>	3	.	.	.	1	1	+
<i>Reichardia picroides</i>	1	.	.	.	.	3	+
<i>Gaudinia fragilis</i>	.	+	.	1	1	.	.
<i>Stipa capensis</i>	.	+	.	.	.	4	.
<i>Galactites elegans</i>	.	+	1	.	.	.	.
Companions:							
<i>Romulea columnae</i>	2	1	+	+	+	+	1
<i>Lotus edulis</i>	1	.	+	.	1	1	.
<i>Serapias vomeracea</i>	1	2	+	+	+	.	.
<i>Trifolium angustifolium</i>	.	+	.	1	.	+	.
<i>Sherardia arvensis</i>	+	+	.	+	.	.	.

Other species: Companions: *Daucus gingidium*, *Hypericum perforatum* and *Hyoseris radiata* +, *Calamintha nepeta* 1, in 1; *Daucus gingidium* +, *Pallenis spinosa* 1, *Plantago lanceolata* 2, *Calamintha nepeta* 3, in 2; *Asteriscus spinosus* and *Medicago polymorpha* +, in 3; *Calendula arvensis* and *Plantago lanceolata* +, *Vulpia muralis* 2, *Rostraria cristata* 3, in 4; *Lagurus ovatus* +, *Erodium laciniatum* 2, *Cynodon dactylon* 3, in 5; *Petrorhagia dubia* and *Linum bienne* +, *Vulpia muralis* and *Serapias parviflora* 1, in 6; *Serapias parviflora*, *Medicago hispida* and *Hypericum perforatum* +, *Cichorium intybus* 2, *Cynodon dactylon* 4, in 7.

Localities: 1, 2, 5-7: Monte Guardia; 3, 4: Piano Incenso.

Table 5  
*Brassica fruticulosae-Brachypodietum retusi* ass. nova hoc loco  
 (*Echio-Galactinion, Brometalia rubenti-tectori, Stellarietea mediae*)

	230	210	70	30	60	110
Altitude (m.a.s.l.)	230	210	70	30	60	110
Slope (°)	0	5	10	0	5	25
Area (m <sup>2</sup> )	10	35	30	40	40	40
Cover (%)	90	100	100	100	100	100
Exposure	-	NE	SE	-	NE	E
Relevés Number	1	2	3	4	5	6
Assoc. characteristics:						
<i>Brachypodium retusum</i>	3	5	2	1	3	+
<i>Brassica fruticulosa</i>	3	2	1	2	2	3
<i>Silene bellidifolia</i>	+	+	1	1	+	.
Al. characteristics:						
<i>Bromus madritensis</i>	3	.	+	.	2	2
<i>Lotus edulis</i>	.	+	+	2	1	.
<i>Galactites elegans</i>	.	.	2	1	1	.
<i>Gaudinia fragilis</i>	.	.	3	.	.	.
Ord. characteristics:						
<i>Reichardia picroides</i>	2	1	1	+	2	+
<i>Hordeum murinum leporinum</i>	+	.	+	+	.	.
<i>Vulpia ciliata</i>	.	.	1	.	.	.
<i>Stipa capensis</i>	.	+	.	.	.	.
Cl. characteristics:						
<i>Avena barbata</i>	1	+	3	2	1	1
<i>Anagallis arvensis</i>	.	+	+	+	1	+
<i>Geranium dissectum</i>	.	+	.	3	+	.
<i>Rumex pulcher</i>	+	.	+	.	+	.
Companions:						
<i>Plantago lanceolata</i>	+	+	1	1	3	+
<i>Vicia sativa</i>	+	2	.	1	+	+
<i>Dittrichia viscosa</i>	.	+	1	1	.	+
<i>Hyoseris radiata</i>	.	1	1	+	1	.
<i>Sherardia arvensis</i>	+	+	+	1	.	.
<i>Linum bienne</i>	.	.	.	+	1	+
<i>Medicago polymorfa</i>	.	.	+	.	+	2
<i>Daucus gingidium</i>	.	+	.	1	1	.
<i>Euphorbia paralias</i>	1	+	.	.	+	.
<i>Lagurus ovatus</i>	3	3	.	+	.	.

Other species: Companions: *Calamintha nepeta* +, *Lobularia maritima*, *Petrorhagia dubia*, *Serapias vomeracea* and *Valeriana-lla microcarpa* 1, in 1; *Serapias vomeracea*, *Cerastium glomeratum*, *Calamintha nepeta*, *Silene vulgaris* and *Trifolium pratense* +, *Thapsia garganica* 1, in 2; *Dactylis glomerata* subsp. *hispanica* and *Centaurium erythraea* +, *Hyparrhenia hirta* and *Trifolium angustifolium* 2, in 3; *Ampelodesmos mauritanicus*, *Linum bienne* and *Lobularia maritima* +, *Cerastium glomeratum* 2, *Foeniculum vulgare* 3, in 4; *Hyparrhenia hirta*, *Ampelodesmos mauritanicus*, *Asteriscus spinosus* and *Helichrysum italicum* +, *Linum bienne* 1, in 5; *Linum bienne* +, in 6.

Localities: 1 and 2: Monte Guardia; 3: Monte Pagliaro; 4: Conti; 5: Guarini; *holotypus assoc.*; 6: Tre Venti.

***Erico-Quercetum ilicis quercetosum virgilianae***  
*subass. nova hoc loco* (Tab. 1, *holotypus rel.* 6)

*Synecology and structure*: the community is an acidophilus forest with *Quercus ilex* and deciduous trees, like *Quercus virgiliana* and *Sorbus domestica*.

*Syndynamics*: the *Erico-Quercetum ilicis quercetosum virgilianae* is presently the most advanced vegetation of the north-facing hill slopes and the colluvial sites of the Ponza island. As regressive dynamic stages there are the mantles of the *Calicotomo villosae-Rubetum ulmifolii*, the bush-forest of

the *Erico-Arbutetum unedonis*, and the garrigue vegetation and grasslands which settles as the former successional stages of the *Erico-Quercetum ilicis* serie.

*Synchorology*: the subassociation occurs in Ponza in small and isolated patches occupying the northern slopes of Mount Guardia and some narrow valleys. The present abandon of the cultivations is believed to lead rapidly to the reconstruction of wood areas with deciduous oaks, when fires incidence would be reduced at the same time, starting from isolated individuals of chestnut oak, domestic sorbs and chestnut trees on the side of the terracings. This subassociation is similar to the *Erico-Quercetum virgiliana* which is described for Sicily, Calabria and the Eolian islands (BRULLO & MARCENÒ, 1985, SIGNORIELLO, 1984, BRULLO & al., 1996, MAIORCA & SPAMPINATO, 1999, BRULLO & al., 2001).

***Erico arboreae-Arbutetum unedonis* Molinier 1937 (Tab. 6)**

*Synecology and structure*: this high (2-3 m), shrubby vegetation dominated by the presence of *Erica arborea*, *Arbutus unedo* and *Myrtus communis* develops on north-facing slopes and on colluvial seawards benches, sheltered from the prevailing winds. Among the woody most mature formations, this bushland represents the most widespread coenosis.

*Syndynamics*: the *Erico arboreae-Arbutetum unedonis* is the closest stage to the woodland of *Erico-Quercetum ilicis quercetosum virgiliana* of the *Quercenion virgiliana* serie.

*Synchorology*: in Italy, this type of vegetation is present in the Tyrrhenian coastal zone (BRULLO & al., 2001). In Ponza, it is particularly abundant on the north-facing sides of Capo Bosco (the toponym is quite suggestive of the potential vegetation of this area) and Campo Inglese.

***Calicotomo villosae-Rubetum ulmifolii* ass. nova hoc loco (Tab. 7, holotypus rel. 5)**

*Synecology and structure*: it is a mantle formation with thorny shrubs, frequent in the impluvia and the colluvia, mainly north-facing, and on the bottom of the alluvial valley.

Physiognomic leading species are *Rubus ulmifolius* and *Spartium junceum* together with the characteristic species *Calicotome villosa*. Other differential species of the association are *Asparagus acutifolius*

and *Hedera helix*. The group of species of the *Pruno-Rubenion* and *Pruno-Rubion* (see BLASI & al., 2002a) is well represented. The association is forming the mantle of deciduous acidophilous Mediterranean oak forests. The high frequency of *Arundo donax* and *Prunus spinosa* has clearly an anthropic origin. The former is used to realize wind breaking bushes and as a vineyard support, while the latter is used as a rootstock for fruit-bearing species of the genus *Prunus*.

*Syndynamics*: the *Calicotomo villosae-Rubetum ulmifolii* is specific to Ponza where it forms a mesophilous mantle with ruderal-nitrophilous species of the deciduous residual woods on the island.

**GEOSIGMETA OF THE ALLUVIAL VALLEY**

The alluvial valleys of Ponza and Santa Maria are the most strongly man-transformed environmental unit of the island with houses, streets and gardens. Presently, only small fragments of the potential woody meso-hydric vegetation remain, mainly in the marginal areas of the dwellings and in the gardens. Macchia covers about 15% of the series area, vineyards and secondary grasslands around 20%, the rest being occupied by artificial areas (see map of the vegetation series and Figure 1).

***Fraxino angustifoliae-Ulmenion minoris* Rivas-Martínez 1975 (fragments)**

*Synecology and structure*: The residual elements of the original vegetation are composed by few specimen of *Fraxinus angustifolia* subsp. *oxycarpa*, *Quercus virgiliana*, *Ulmus minor*, *Populus nigra* which can be referred to fragments of the Mediterranean humid wood communities of the *Fraxino angustifoliae-Ulmenion minoris* (RIVAS-MARTÍNEZ, 1975; PEDROTTI & GAFTA, 1996). This suballiance represents the syntaxonomic reference of the mature stage that would potentially occupy the bottom of the island valley.

*Syndynamics*: Fraxinus woods are mainly replaced by fragments of *Ulmus minor* community, that would correspond to the secondary community of the *Allio triquetri-Ulmetum minoris*, described for the alluvial areas of north-western Sardinia (FILIGHEDDU & al., 1999). The meso-hygrophilous communities make catenal contacts with the *Quercenion virgiliana* serie along the peripheral parts of the bottom of

Table 6  
*Erico arboreae-Arbutetum unedonis* Molinier 1937 (1-5)  
 (*Ericion arboreae*, *Pistacio-Rhamnetalia alaterni*, *Quercetea ilicis*)  
*Erico arboreae-Juniperetum phoeniceae* De Marco, Dinelli & Caneva 1985 (6,7)  
 (*Oleo-Ceratonion*, *Pistacio-Rhamnetalia alaterni*, *Quercetea ilicis*)

Altitude (m.a.s.l.)	115	15	100	40	40	70	20
Slope (°)	30	25	20	30	15	20	5
Area (m <sup>2</sup> )	60	90	70	50	60	60	70
Cover (%)	100	100	90	100	100	100	100
Exposure	N	N	NW	NW	N	N	W
Relèves N.	1	2	3	4	5	6	7
<i>Erico arboreae-Arbutetum-unedonis:</i>							
<i>Erica arborea</i>	4	4	4	5	5	3	2
<i>Arbutus unedo</i>	2	4	+	5	.	.	.
<i>Pulicaria odora</i>	1	1	+	.	+	1	.
<i>Erico arboreae-Juniperetum phoeniceae:</i>							
<i>Juniperus phoenicea</i>	.	.	.	.	.	4	3
<i>Arisarum vulgare</i>	.	+	.	.	1	+	+
<i>Daphne sericea</i>	.	.	1	.	.	2	.
<i>Euphorbia dendroides</i>	.	.	.	.	.	1	.
<i>Pistacio-Rhamnetalia alaterni:</i>							
<i>Myrtus communis</i>	2	2	1	1	2	2	+
<i>Pistacia lentiscus</i>	1	+	1	.	+	+	+
<i>Teucrium flavum</i>	2	1	+	.	.	1	.
<i>Rhamnus alaternus</i>	1	.	.	.	.	1	1
<i>Prasium majus</i>	.	+	+	.	.	+	.
<i>Quercetea ilicis:</i>							
<i>Phillyrea latifolia</i>	1	1	+	2	+	3	2
<i>Lonicera implexa</i>	2	1	2	1	1	+	1
<i>Asparagus acutifolius</i>	1	+	+	+	+	+	+
<i>Rubia peregrina</i>	2	1	+	+	+	+	+
<i>Phillyrea angustifolia</i>	+	1	2	.	2	1	+
<i>Smilax aspera</i>	2	+	.	+	.	.	+
<i>Clematis flammula</i>	1	+	.	+	.	.	+
<i>Asplenium onopteris</i>	.	.	+	.	+	.	+
<i>Carex flacca</i>	.	+	.	.	.	1	.
<i>Hedera helix</i>	.	+	.	+	.	.	.
<i>Viburnum tinus</i>	3	2	.	.	.	.	.
<i>Quercus ilex</i>	.	.	.	.	.	.	+
<i>Quercus virgiliana</i>	.	.	.	.	2	.	.
Companions:							
<i>Erica multiflora</i>	2	1	+	.	.	1	1
<i>Brachypodium retusum</i>	2	1	1	.	1	.	1
<i>Spartium junceum</i>	2	1	2	2	+	.	.
<i>Briza maxima</i>	.	+	.	+	.	+	+
<i>Genista thyrrena</i>	.	2	1	.	.	1	2
<i>Rubus ulmifolius</i>	.	+	+	.	+	.	1
<i>Umbilicus rupestris</i>	.	.	+	.	+	+	.
<i>Hypochaeris glabra</i>	.	.	+	.	+	+	.

Other species: Companions: *Cistus salvifolius* 1, in 1; *Cistus salvifolius* and *Anagallis arvensis* +, in 2; *Lavandula stoechas*, *Rosmarinus officinalis* and *Micromeria graeca* +, *Thymelaea hirsuta* 1, in 3; *Lavandula stoechas*, *Brassica fruticulosa*, *Fumaria capreolata*, *Papaver setigerum*, *Silene gallica*, *Reichardia picroides*, *Avena barbata*, *Cynosurus echinatus*, *Gaudinia fragilis*, *Galactites elegans* and *Artemisia arborescens* +, in 4; *Carex divulsa*, *Brassica fruticulosa*, *Fumaria capreolata*, *Parietaria diffusa*, *Ficus carica* and *Olea europaea* +, in 5; *Calicotome villosa* and *Daucus gingidium* +, in 6; *Carex divulsa*, *Arundo donax* and *Helichrysum italicum* +, in 7.

Localities: 1 and 2: Campo Inglese; 3: Capo Bosco; 4: Conti; 5: Linguana; 6: Montagnella; 7: Lucia Rosa.



the alluvial valley, settled again by the *Erico-Genistetum thyrrhenae* and the *Calicotomo-Rubetum ulmifolii*.

#### GEOSIGMETUM OF THE SANDY SHORES

***Salsola kali-Cakiletum aegyptiacae*** Costa & Mansanet 1981

*Synecology and structure:* on the sandy heaps mixed with organic matters of remains of seaweeds and sea phanerogamae deposited by wave motion, fragmentary populations of psammophilous vegetation composed by few pioneer terophytes with succulent habitus are located, among them *Cakile maritima*, *Euphorbia peplis*, *Euphorbia paralias*, *Salsola kali*.

*Syndynamic:* since there are no real sandy back shores on the Ponza island, apart from the contact with the fragments of the *Echinophoro spinosae-Elytrigietum juncei*, the catenal sequences of psammophilous vegetation are absent.

*Synchorology:* the association is distributed in the whole Mediterranean region (GÉHU & BIONDI, 1994); in Ponza it is fragmentarily present on the beaches of S. Antonio (nearby the port), Giancos, Frontone and Feola bay.

***Echinophoro spinosae-Elytrigietum juncei*** Géhu 1988 corr. Géhu 1996

*Synecology and structure:* there are fragments of perennial psammophilous vegetation, represented by *Elytrigia juncea*, *Medicago marina*, *Echinophora spinosa*, *Pancratium maritimum*, *Glaucium flavum*, *Eryngium maritimum*. The short stretches of beach extending nearby the built-up area of Ponza are polluted by nitrophilous and ruderal species and particularly impoverished as for characteristic and companion species.

*Synchorology:* an association distributed in the whole Mediterranean region (GÉHU & BIONDI, 1994); in Ponza it is present on the beaches of S. Antonio and Giancos.

#### GEOSIGMETUM OF THE SEA CLIFFS AND GEOSIGMETUM OF THE DEBRIS CONES BELOW THE SEA CLIFFS

***Oleo-Euphorbietum dendroidis*** Trinajstić 1973 (Tab. 2)

*Synecology and structure:* it is a termophilous garrigue with *Euphorbia dendroides*, which can form

a primary community in the steep sea-facing sites while characterises a secondary communities on the abandoned terracings, submitted to an intensive insolation and run through by frequent fires, the *Oleo-Euphorbietum dendroidis* variant with *Cistus monseliensis*.

*Syndynamics:* the association is directly in contact with the coastal subhalophilous associations on rocks of rhyolitic lava, cliffs and drift areas at the bottom of the coastal slopes, where it is in catenal contact with the primary community of the *Erico-Genistetum tyrrhenae*. The alien *Opuntia ficus-barbarica* is also quite frequent in these sites.

As a secondary community, it colonises the old terracings slopes where, in many cases, the loss of the ground occurred, due to the decay of the terraces and the recurring fires. The mingling with elements of the *Erico-Genistetum tyrrhenae*, towards which this association tends to evolve, is frequent in these sites.

*Synchorology:* on the basis of the floristic-coenological variations of the *Oleo-Euphorbietum dendroidis*, GÉHU & BIONDI (1997) would refer these coenoses to the Italian-Sardinian group. This group can be interpreted as a race of the widespread association *Oleo-Euphorbietum dendroidis*, which was found in different sites from the Balears islands to the Egean coasts (BLASI & al., 2000b). This race is placed in Sicily and in the smaller islands of Italy; it is rarer in Sardinia and on the peninsula coasts, it rises in the Adriatic up to the Gargano and in the Tyrrhenian up to the Circeo, much rarely further up in the north (PIGNATTI, 1998). In Ponza, some primary stations are in the sea drift cones mainly around the Mount Guardia.

***Erico arboreae-Juniperetum phoeniceae*** De Marco, Dinelli & Caneva 1985 (Tab. 6)

*Synecology and structure:* it is a high, multistratified shrubland containing tree-height specimen of *Juniperus phoenicea*, in the transition area between the cliffs and the *Quercus ilex* community series, on colluvial, fresh and quite acidic soils. It holds also the rare *Daphne sericea*, which is physiognomically much more important in the close Aurunci mountains (DI PIETRO, 2001).

*Syndynamics:* it is a mature stage of which only residual strips, extremely narrow, are left on the island; the regressive stages are composed by the secondary *Oleo-Euphorbietum dendroidis* and by the macchia of the *Erico-Genistetum tyrrhenae*.



Table 8  
*Crithmo-Limonietum pontii* Bartolo, Brullo & Signorello 1989 (1-3)  
 (Crithmo-Station, Crithmo-Staticetalia, Crithmo-Staticetea)  
*Senecioni-Helichrysetum littorei* Barbagallo, Brullo & Signorello 1983 (4-6)  
*Anthyllido-Helichrysetum littorei* Brullo & De Marco 1989 (7-9)  
 (Helichrysetalia italici, Helichryso-Crucianelletea)

Altitude (m.a.s.l.)	3	25	7	30	2	3	15	30	5
Slope (°)	20	40	10	25	40	45	40	45	20
Area (m <sup>2</sup> )	30	25	25	60	20	30	40	50	25
Cover (%)	40	40	35	60	70	60	95	80	50
Exposure	N	E	SE	SE	E	E	N	N	E
Relevés N.	1	2	3	4	5	6	7	8	9
<i>Crithmo-Limonietum pontii:</i>									
<i>Limonium pontium</i> var. <i>pontium</i>	1	1	1	.	+	.	.	.	.
<i>Crithmo-Station, Crithmo-Staticetalia, Crithmo-Staticetea:</i>									
<i>Crithmum maritimum</i>	2	2	2	2	.	.	+	+	.
<i>Reichardia picroides</i>	+	+	+	.	.	.	.	+	.
<i>Lotus cytisoides</i>	+	.	+	.	.	.	+	+	.
<i>Plantago macrorhiza</i>	.	+	.	.	.	.	.	.	.
<i>Senecioni-Helichrysetum littorei:</i>									
<i>Helichrysum littoreum</i>	1	+	+	4	4	3	2	2	2
<i>Senecio cineraria</i> subsp. <i>bicolor</i>	+	+	.	1	+	1	+	.	.
<i>Anthyllido-Helichrysetum littorei:</i>									
<i>Anthyllis barba-jovis</i>	.	.	.	1	.	.	3	4	2
<i>Helichrysetalia, Helichryso-Crucianelletea:</i>									
<i>Daucus gingidium</i>	2	.	+	1	1	+	1	2	+
<i>Matthiola incana</i>	+	+	.	+	+	+	+	+	.
<i>Senecio leucanthemifolius</i>	1	.	.	.	.	.	+	+	.
<i>Thymelaea hirsuta</i>	.	.	.	.	.	.	.	.	+
Companions:									
<i>Brachypodium retusum</i>	.	+	.	1	1	+	1	.	+
<i>Dactylis glomerata</i>	.	+	+	.	+	.	+	+	.
<i>Genista thyrrena</i>	.	.	+	.	3	3	1	.	.
<i>Dittrichia viscosa</i>	.	.	.	.	1	.	1	+	.

Other species: Companions: *Spartium junceum* and *Euphorbia dendroides* +, *Pistacia lentiscus* and *Trifolium angustifolium* 1, *Melilotus indicus* 3, in 4; *Spartium junceum*, *Rosmarinus officinalis* and *Hyparrhenia hirta* +, *Erica multiflora* 1, in 5; *Cerastium glomeratum* +, in 6; *Erica multiflora* 1, in 7.

Localities: 1, 7 and 8: Chiaia di Luna; 2 and 4: Faro; 3: Frontone; 5, 6 and 9: Cala Core; 7 and 8: Chiaia di Luna.

*Synchorology*: it was described in Sardinia, but its distribution area includes probably also the smaller volcanic islands of the Tyrrhenian sea, where it became very rare due to the deforestation. In Ponza it can be found in the western coast between Lucia Rosa rocks and Beppe Antonio cape.

*Crithmo-Limonietum pontii* Bartolo, Brullo & Signorello 1989 (Tab. 8)

*Synecology and structure*: on the rhyolitic cliffs, only periodically exposed to the direct action of the sea spray, there is a halo-rupicolous vegetation with scarce cover (20-40%) characterized by *Crithmum mariti-*

*mum* and *Limonium pontium* var. *pontium* (endemic species of the Pontine islands). On the contrary, the vegetation finds it difficult to set up permanently on the hyaloclastitic, very easily erodible sub-vertical walls.

*Syndynamics*: generally, this pioneer community develops catenal contacts with the sub-halophilous coenoses of the *Helichrysetalia italici*, with the shrub communities of the *Pistacio-Rhamnetalia alaterni* and the *Erico-Genistetum tyrrhenae*.

*Synchorology*: an endemic association of the Pontine islands; due to its ecological characteristics it can be considered as a geographical vicarious of the *Crithmo-Limonietum inarimensis* of the close Ischia island (BARTOLO & al., 1989).

**Senecioni-Helichrysetum li torei** Barbagallo, Brullo & Signorello 1983 (Tab. 8)

*Synecology and structure:* this vegetation with sub-halophilous chamaephytes occupies a rather discontinuous belt all around the island. It is a formation structurally more complex than the previous one, with almost continuous covering (70-80%), which settles both on the rocks scarcely covered by a thinnest layer of lithosol (as on the walls of Gavi), and on the landslide and the drift cones yet not completely stabilized (as on the SW side of the Mount Guardia). It is mostly developed in not excessively steep places. It is a pioneer formation, characterized by the chamaephytes *Helichrysum li toreum* and *Senecio cineraria* subsp. *bicolor*. Not much frequent, *Senecio leucanthemifolius* is sometimes abundant like on the high cliffs facing the Lucia Rosa rocks, characterizing the association physiognomy.

*Syndynamics:* the *Senecioni-Helichrysetum litorei* forms a transition zone interposed between the associations with *Crithmum* and *Limonium* species and the coastal scrub which is represented by formations of the *Oleo-Ceratonion*, the *Calicotomo-Genistion*, or the *Cisto-Ericion*.

*Synchorology:* this association is also present on carbonatic lithologies besides on volcanic substrata; it may be found on the Eolian Islands, the Sorrentina peninsula, Capri, Ischia, the other Pontine islands and in the Circeo National Park (FILESI & al., 1998).

**Anthyllido-Helichrysetum litorei** Bruno & De Marco 1989 (Tab. 8)

*Synecology and structure:* it is a vegetation showing its optimum in the highest side of the cliffs (BIONDI, 1999). The most significant species of these rocky places is *Anthyllis barba-jovis*, a nanophanerophyte with a clearly pioneer nature, showing a high abundance only in correspondence with rocky walls directly influenced by the marine agents (BRULLO & DE MARCO, 1989.)

*Syndynamics:* the *Anthyllido-Helichrysetum litorei* is in close catenal contact with the *Crithmo-Limonietum* and the *Senecioni-Helichrysetum* which can occupy the area below.

*Synchorology:* the *Anthyllido-Helichrysetum litorei* occurs on the Sorrentine coast, Capri, Ischia (BIONDI, 1999) and the Pontine islands of the western group. *Anthyllis barba-jovis* is quite rare in the close

Circeo National Park, while it occurs widely in similar communities of the Ausoni and Aurunci mountains sea spurs (FILESI & al., 1998). In Ponza this coenosis can be found at Chiaia di Luna and in short stretches scattered on the east coast.

## DISCUSSION AND CONCLUSION

In the Ponza landscape, the woodland series are presently dominated by the Tyrrhenian islands' endemic macchia of the *Erico-Genistetum thyrrhenae* (about 50% of the island area). The northern hill slopes are characterised by the macchia with *Erica arborea* and the *Erico arboreae-Arbutetum unedonis* (*Quercenion virgilianae* series), while the typical *Erico-Genistetum thyrrhenae* and its subassociation *lavanduletosum stoechadis*, together with the garrigues of the *Oleo-Euphorbietum dendroidis* dominate in the *Erico-Quercetum ilicis* series of the southern hill slopes (Fig. 1). The many persisting terracings, even though mostly obsolete, allow a fast vegetation recover after fires, unfortunately very frequent between September and October. Yet, despite a generalized abandon of cultivation, mature stages of woodland series are scarcely represented due to fires, hence the macchia still dominates the island landscape.

The most critical conditions concern the vegetation of the bottom of the alluvial valleys, where woods and mantles hardly cover 3% of the total area, while the *Erico-Genistetum thyrrhenae* reaches 16% and the remaining is occupied by buildings and vineyards.

Presently, the residual wooded areas are absolutely insufficient to maintain the forest ecosystems in ecologically efficient conditions. The juniper thicket of the *Erico-Juniperetum phoeniceae* is reduced to very small strips and risks the extinction.

On the other hand, the condition of the other plant communities is good and the originality of some floristic combinations lead to the syntaxonomical description of new associations and variants. Therefore, the natural landscape of the island shows a great variety of taxa and plant communities having phytogeographic similarities with the flora and the vegetation of the other southern Tyrrhenian volcanic islands and of west Mediterranean coasts. Hence, Ponza holds an important phytogeographic role by representing the northern limit of taxa and communi-

ties having their center of distribution in southern Italy islands.

The results of this paper, summarized in the map of the vegetation series of Ponza, can represent basic documents for land planning and biodiversity monitoring, in line with the principles of a sustainable use of natural resources.

#### SYNTAXONOMICAL SCHEME

##### QUERCETEA ILICIS Br.-Bl. ex A. & O. Bolòs 1950

*Quercetalia ilicis* Br.-Bl. ex Molinier 1934

*Erico-Quercion ilicis* Brullo, Di Martino et Marcenò 1977

*Erico-Quercetum ilicis* Brullo, Di Martino & Marcenò 1977

*Erico-Quercetum ilicis quercetosum virgilianae* subass. nova hoc loco (holotypus relevé 36, tab. 5)

*Pistacio lentisci-Rhamnetalia alaterni* Rivas- Martínez 1975

*Ericion arboreae* Rivas-Martínez (1975) 1987

*Erico arboreae-Arbutetum unedonis* Molinier 1937

*Oleo sylvestris-Ceratonion siliquae* Br.-Bl. ex Guinochet & Drouineau 1944

*Erico arboreae-Juniperetum phoeniceae* De Marco, Dine-lli & Caneva 1985

*Myrto communis-Pistacietum lentisci* (Molinier (1936) 1954) Rivas-Martínez 1975

*Oleo-Euphorbietum dendroidis* Trinajstić 1973

*Oleo-Euphorbietum dendroidis* variant with *Cistus monspeliensis*

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

*Quercetalia pubescenti-sessiliflorae* Klika 1933

*Pino-Quercion congestae* Brullo, Scelsi, Siracusa & Spampinato 1999

*Quercenion virgilianae* Blasi, Di Pietro & Filesi 2004

##### SALICI PURPUREAE-POPULETEA NIGRAE (Rivas-Martínez & Cantó ex Rivas-Martínez, Báscones, T.E. Díaz, Fernández-González & Loidi 1991) Rivas-Martínez, Fernández-González, Loidi, Lousã & Penas 2001

*Populetalia albae* Br.-Bl. ex Tchou 1948

*Populion albae* Br.-Bl. ex Tchou 1948

##### FRAXINO ANGUSTIFOLIAE-ULMENION MINORIS RIVAS-MARTÍNEZ 1975

*Allio triquetri-Ulmetum minoris* Filigheddu, Farris, Bagella & Biondi 1999

##### CISTO-LAVANDULETEA Br. -Bl. in Br.-Bl., Molinier & Wagner 1940

*Lavanduletalia stoechadis* Br.-Bl. in Br.-Bl., Molinier & Wagner 1940

*Calicotomo villosae-Genistion tyrrhenae* Biondi 1997

*Erico multiflorae-Genistetum tyrrhenae* Biondi 1997

*Erico multiflorae-Genistetum tyrrhenae* variant with *Erica arborea*

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*Erico multiflorae-Genistetum tyrrhenae lavanduletosum stoechadis* subass. nova hoc loco (holotypus relevé 10, tab. 3)

##### HELICHRYSO STOECHADIS-CRUCIANELLETEA MARITIMAE Géhu, Rivas-Martínez & Tüxen in Bon et Géhu 1973

*Helichrysetalia italici* Biondi & Géhu 1994

*Anthyllidion barbae-jovis* Brullo & De Marco 1989

*Anthyllido-Helichrysetum litorei* Brullo & De Marco 1989

*Plantagini-Thymelaecion hirsutae* Bartolo & Brullo in Bartolo, Brullo & Signorello 1992

*Senecioni-Helichrysetum littorei* Barbagallo, Brullo & Signorello 1983

##### CRITHMO-STATICETEA Br.-Bl. in Br.-Bl. Roussine & Nègre 1952

*Crithmo-Staticetalia* Molinier 1934

*Crithmo-Staticion* Molinier 1934

*Crithmo-Limonietum pontii* Bartolo, Brullo & Signorello 1989

##### CAKILETEA MARITIMAE Tüxen et Preising ex Br.-Bl. & Tüxen 1952

*Euphorbietalia peplis* Tüxen ex Oberdorfer 1952

*Euphorbion peplis* Tüxen ex Oberdorfer 1952

*Salsolo kali-Cakiletum aegyptiacae* Costa & Mansanet 1981

##### EUPHORBIO PARALIAE-AMMOPHILETEA AUSTRALIS Géhu et Géhu-Franck 1988

*Ammophiletalia* Br.-Bl. 1933

*Ammophilion australis* Br.-Bl. 1921 corr. Rivas-Martínez, Costa & Izco in Rivas-Martínez, Lousã, Díaz, Fernández-González & Costa 1990

*Echinophoro spinosae-Elytrigietum juncei* Géhu 1988 corr. Géhu 1996

##### RHAMNO CATHARTHICAE-PRUNETEA SPINOSAE Rivas Goday & Borja 1961

*Prunetalia spinosae* Tüxen 1952

*Pruno-Rubion ulmifolii* O. Bolòs 1954

*Pruno-Rubion ulmifolii* O. Bolòs 1962

*Calicotomo villosae-Rubetum ulmifolii* ass. nova hoc loco (holotypus relevé 20, tab. 8)

##### STELLARIETEA MEDIAE Tüxen, Lohmeyer & Preising ex von Rochow 1951



- Brometalia rubenti tectori* (Rivas Goday & Rivas-Martínez 1965) Rivas-Martínez & Izco 1977  
*Echio plantaginei-Galactinion tomentosae* O. Bolòs & Molinier 1969  
*Brassico fruticosae-Brachypodietum retusi* ass. nova hoc loco (holotypus relevé 49, tab. 7)
- HELIANTHEMETEA GUTTATI* (Rivas Goday 1958) Rivas Goday & Rivas-Martínez 1963 corr. Rivas-Martínez 1978  
*Helianthemetalia guttati* Br.-Bl. 1940 corr. Rivas-Martínez 1978
- ISOETO-NANOJUNCETEA* Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946  
*Isoetalia* Br.-Bl. 1936  
*Isoetion* Br.-Bl. 1936
- Helianthemion guttati* Br.-Bl. 1940 corr. Rivas-Martínez 1978  
*Trifolio cherleri-Plantaginetum bellardii* Rivas Goday 1957  
*Trifolio cherleri-Plantaginetum bellardii* variant with *Brachypodium retusum* and *Pulicaria odora*

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