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Phytosociological study of the acidophilous deciduous oak woods with *Ilex aquifolium* of Sicily

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Abstract
We present here a phytosociological study with ecological considerations of some formations with a prevalence of *Quercus pubescens* s. l. and *Ilex aquifolium* that occur on siliceous ground in the Madonie and Peloritani Mountains of Sicily. On the basis of this study, these formations have been attributed to two new associations: *Ilici aquifolii-Quercetum leptobalani* and *Conopodio capillifolii-Quercetum congestae*, within the order *Quercetalia pubescenti-petraeae*, which is already represented by other associations in Sicily.

Key words: forest vegetation, *Quercetalia pubescenti-petraeae*, Madonie, Peloritani, Sicily.

Riassunto
Viene presentato lo studio fitosociologico, con riferimenti di tipo ecologico, di alcune formazioni a dominanza di specie del gruppo di *Quercus pubescens* s. l. e *Ilex aquifolium*, insediate su terreni silicei delle Madonie e dei Peloritani in Sicilia. Lo studio ha permesso di attribuirli a due nuove associazioni: *Ilici aquifolii-Quercetum leptobalani* e *Conopodio capillifolii-Quercetum congestae,* riferite all'ordine *Quercetalia pubescenti-petraeae*, già individuato per la Sicilia da altre associazioni.

Parole chiave: vegetazione forestale, *Quercetalia pubescenti-petraeae*, Madonie, Peloritani, Sicilia.

Introduction

For the deciduous oak woods of Sicily, the occurrence of *Ilex aquifolium* has been noted for the formations of *Quercus austrotyrrenica* of the association *Ilici-Quercetum austrotyrrenicae* (Brullo, 1984), and for the turkey oak formations of the association *Ilici-Quercetum cerridis* (Raimondo *et al*., 2009). However, there are no references relative to the occurrence of *Ilex aquifolium* in the oak associations that can be referred to the cycle of the downy oak (Brullo *et al*., 1999), except for some references to preliminary observations of this type of wood (Maniscalco & Raimondo, 2003; Maniscalco & Cavarretta, 2003, Schicchi *et al.*, 2006; Maniscalco *et al.*, 2008). The study presented here provides an analysis of both the phytosociological and ecological aspects for the mesophilous downy oak formations with holly found on the Madonie and Peloritani Mountains (Fig. 1), comparing them with the associations of *Quercus congesta* and *Q. leptobalanos* described for Sicily. For the formations of *Quercus congesta* and *Ilex aquifolium* examined here, two new associations are proposed, named as *Ilici aquifolii-Quercetum leptobalani* and *Conopodio capillifolii-Quercetum congestae*, respectively, both of which are referred to the order *Quercetalia pubescenti-petraeae*.

Materials and methods

The phytosociological relevées were carried out according to the method of Braun-Blanquet (1964). For the nomenclature of the taxa cited, reference has been made to Giardina *et al.* (2007), as well as to recent monographs describing some taxa, among which there is Brullo *et al.* (1999), which refers to the polymorphic group of the downy oak. The phytosociological relevées relative to the two forest formations found on the Madonie (Table 1) and Peloritani (Table 2) Mountains have been compared with the relevées for the associations with *Quercus congesta* and *Q. leptobalanos* that are known for Sicily, through multivariate analyses using the Syn-Tax 2000 software (Podani, 2001). To obtain a comparison at a phytogeographical level, the relevées for the association *Erico arboreae-Quercetum congestae* (Tab. 5) are also included; this Aspromonte association is also mesophilous, with downy oak and holly. A classification dendrogram has been constructed from the original Table of 75 relevées as a total of 245 species and infraspecies taxa (Fig. 2), using the UPGMA algorithm and the coefficient of chord distance, based on the presence/ absence of the taxa.

For the ecological aspects of the phytocoenoses examined, climate, geolithological and some pedological data are considered. For the climate characteristics, the data reported by Duro *et al.* (1996) were used; moreover, through ombrothermic diagrams, estimates have been made of the length of the dry summer period of the various climate stations. Due to the low number of meteorological stations in the

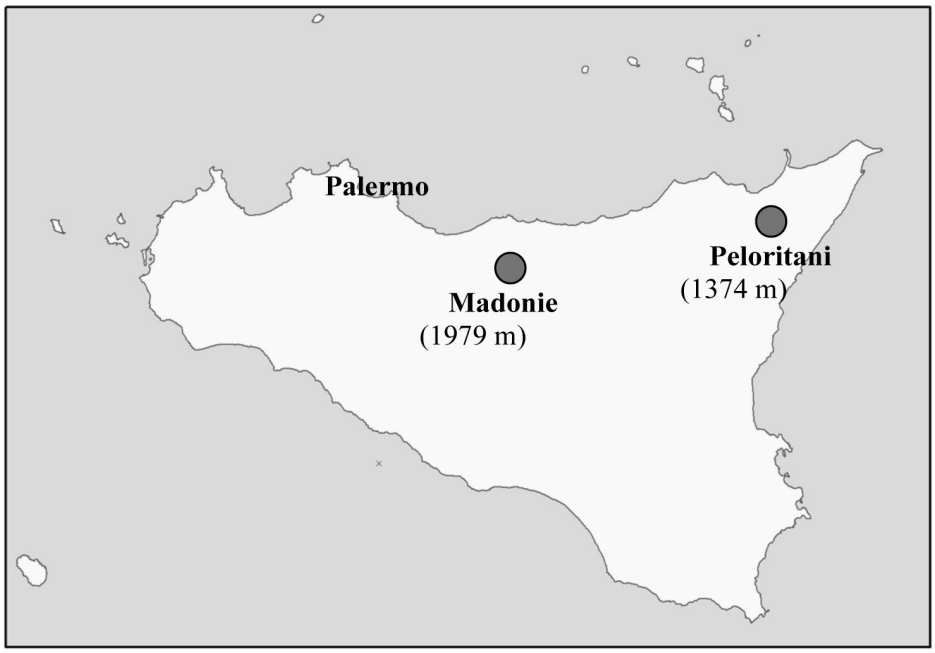


Fig. 1 – The study area location

mountain areas under study, further recent data were used from the Hydrographic Services of the Sicily Region (Servizio Idrografico della Regione Siciliana), from pluviometric stations that have been functioning over the last 20 years. The thermopluviometric data were handled according to the method of Rivas-Martínez & Loidi Arregui (1999). For the biotopes examined, as the specific climate data are not available in many cases, estimates have been made on the basis of data collected by the sampling stations in the adjoining territories. In this way, a Table has been constructed that reports for each mountain system: the meteorological stations involved, the bioclimate, and other climate data (Table 3).

For the synecological aspects for the two new associations, ecograms have been drawn up, according to the method of Pignatti & Bona (2007). These consider the Ellenberg indices, and show the values of six ecological factors: light, temperature, continental situation, water, and soil pH and nutrients Pignatti *et al.* (2005). Moreover, these ecograms are compared with two other ecograms, one in relation to an association of *Quercus leptobalanos* (*Quercetalia ilicis*) and a second of *Q. congesta* (*Quercetalia pubescenti-petraeae*). Together with the ecograms, we also illustrate the relative biological and chorological spectra (Figs. 3 and 4).

For the geolithological data, reference has been made to Bigi *et al*. (1991) and Lentini & Vezzani (1974). In all of the areas where the phytosociological relevées were taken, the pH was also measured.

Finally, a syntaxonomic scheme is proposed that includes all of the associations of downy oak defined for Sicily, including the two associations proposed here.

Description of the areas

On the island of Sicily, two mesophilous and acidophilous formations were found of *Quercus sp. pl.* (referring to the cycle of the downy oak) with holly: on the Madonie and Peloritani Mountains.

Madonie

The biotopes of the Madonie are more significant due to their spread and the richness of the species and the environment, and they include in particular the area between Pizzo di Corco (1,357 m) and the Vicaretto locality, and the isolated areas near the Gonato Valley, along the eastern slopes of Pizzo Stefano (1,578 m). Their geolithological aspects are based on terrain of Numidian Flysch. As described by Schicchi *et al.* (2006), the tree belt of these forest communities is characterised by *Quercus congesta*, with which there are associated: *Q. leptobalanos* and *Q. dalechampii.* Among the other forest species, there are: *Quercus ilex*, *Acer campestre* and *Fraxinus ornus*, as well as frequent examples of *Ilex aquifolium*, both as trees and shrubs. The floristic cortège is characterised by an abundance of elements of the class *Querco-Fagetea*, in which elements of both the order *Quercetalia pubescenti-petraeae* and the order *Fagetalia sylvaticae* are well represented. Among these last, *Ilex*

Tab. 1 - *Ilici aquifolii-Quercetum leptobalani* ass. nova

Rel. n.	1	2	3	4	5	6	7	8	Frequency
Tree height (m)	7,5	14	16	14	13	13	12	12	
Coverage (%)	100	100	100	100	100	100	100	100	
Slope (°)	5	10	2	10	10	10	10	15	
Aspect	E	N-NO	N-NO	N-NE	NO	N	N	NO	
Altitude (m)	985	1080	1105	1160	1170	1175	1180	1180	
Surface (m²)	200	300	400	250	400	300	300	200	
Charact. and diff. sp. of the ass.									
Quercus leptobalanos Guss.	2	2	2	2	3	2	2	1	V
Ilex aquifolium L.	1	2	5	4	5	4	3	.	V
Charact. sp. of the all. *Quercion congestae*									
Quercus congesta C. Presl	3	3	3	3	3	2	3	3	V
Quercus dalechampii Ten.	2	1	2	2	2	3	2	3	V
Symphytum gussonei F. W. Schultz	+	+	.	+	1	1	.	.	IV
Charact. sp. of the order *Quercetalia pubescenti-petraeae*									
Melittis melissophyllum subsp. *albida* (Guss.) P. W. Ball.	.	1	+	+	1	1	+	1	V
Tamus communis L.	+	+	+	+	+	+	1	.	V
Viola alba subsp. *dehnhardtii* (Ten.) W. Becker	+	+	.	+	+	+	+	1	V
Poa sylvicola Guss.	1	+	.	+	1	.	1	1	IV
Oenanthe pimpinelloides L.	1	.	.	.	+	.	+	+	III
Asperula laevigata L.	+	+	.	.	.	.	.	.	II
Clinopodium vulgare subsp. *orientale* Bothmer	+	+	.	.	.	.	.	.	II
Teucrium scorodonia subsp. *crenatifolium* (Guss.) Arcang.	.	.	.	.	+	.	.	+	II
Acer monspessulanum L.	.	.	2	.	.	.	.	.	I
Buglossoides purpurocaerulea (L.) I. M. Johnst.	.	.	.	.	.	.	.	+	I
Crepis leontodontoides All.	.	.	.	.	.	.	+	.	I
Euonymus europaeus L.	.	+	.	.	.	.	.	.	I
Fraxinus ornus L.	.	.	.	+	.	.	.	.	I
Luzula forsteri (Sm.) DC.	.	+	.	.	.	.	.	.	I
Echinops ritro subsp. *siculus* (Strobl) Greuter	.	.	.	.	.	.	+	.	I
Sorbus torminalis (L.) Crantz	.	+	.	.	.	.	.	.	I
Trasgr. sp. of the all. *Doronico-Fagion* and the order *Fagetalia sylvaticae*									
Lamium flexuosum Ten.	+	+	.	+	1	2	1	.	IV
Daphne laureola L.	+	.	+	+	+	.	+	1	IV
Polystichum setiferum (Forssk.) T. Moore ex Woynar	.	+	.	+	+	1	+	.	IV
Geranium versicolor L.	.	1	+	2	+	2	.	.	IV
Luzula sylvatica subsp. *sicula* (Parl.) K. Richt.	.	.	.	1	1	1	1	+	IV
Lathyrus venetus (Mill.) Wohlf.	.	+	.	+	1	1	.	1	IV
Anemone apennina L.	.	+	.	1	+	+	+	.	IV
Melica uniflora Retz.	1	1	.	.	+	1	.	+	IV
Anthriscus nemorosa (M. Bieb.) Spreng.	+	.	.	.	.	+	2	1	III
Aremonia agrimonoides (L.) DC.	.	.	.	.	+	+	+	+	III
Neottia nidus-avis (L.) L. C. Rich.	.	+	.	.	+	+	.	+	III
Potentilla micrantha Ramond ex DC.	.	+	.	+	.	+	+	.	III
Primula acaulis (L.) L.	.	.	.	+	+	+	+	.	III
Allium pendulinum Ten.	.	.	.	+	.	+	1	.	II
Doronicum orientale Hoffm.	.	.	.	.	+	+	1	.	II
Brachypodium sylvaticum (Huds.) P. Beauv.	+	.	.	1	.	.	.	+	II
Galium rotundifolium L.	.	+	.	+	+	.	.	.	II
Sanicula europaea L.	.	1	2	.	.	.	.	.	II
Allium ursinum subsp. *ucrainicum* Kleopow & Oxner	.	.	2	.	.	.	.	.	I
Euphorbia meuselii Raimondo & Mazzola	.	+	.	.	.	.	.	.	I
Charact. sp. of the class *Querco-Fagetea*									
Hedera helix L.	+	1	+	+	1	+	1	.	V
Rubus hirtus Waldst. & Kit. s.l.	+	.	.	+	+	1	1	+	IV
Acer campestre L.	.	+	.	.	.	1	.	.	II
Geum urbanum L.	+	.	.	.	.	.	+	.	II
Athyrium filix-foemina (L.) Roth	.	.	1	.	.	.	.	.	I
Viola odorata L.	+	.	.	.	.	.	.	.	I
Malus sylvestris Mill.	.	.	.	.	+	.	.	.	I
Rubus canescens DC.	.	.	.	.	+	.	.	.	I
Trasgr. sp. of the class *Quercetea ilicis*									
Ruscus aculeatus L.	1	1	+	+	1	1	1	+	V
Rubia peregrina L.	+	+	+	+	+	+	+	+	V
Quercus ilex L.	3	3	1	.	1	2	3	2	V
Thalictrum calabricum Spreng.	1	1	.	+	1	2	1	2	V
Cyclamen repandum Sm.	+	+	.	+	+	1	1	.	IV
Lonicera etrusca Santi	.	.	.	+	.	1	.	.	II
Quercus virgiliana (Ten.) Ten.	.	2	.	.	.	.	.	.	I
Carex distachya Desf.	.	.	.	.	.	.	1	.	I
Other species									
Pteridium aquilinum (L.) Kuhn	1	+	1	1	+	.	+	+	V
Ranunculus bulbosus subsp. *aleae* (Willk.) Rouy & Foucaud	+	.	.	.	+	1	+	.	III
Trifolium pratense subsp. *semipurpureum* (Strobl) Pignatti	+	.	.	.	+	.	+	+	III
Arrhenatherum elatius (L.) P. Beauv. ex J & C. Presl	.	.	.	.	+	.	+	1	II
Allium subhirsutum L.	1	.	.	.	.	.	.	+	II
Cachrys ferulacea (L.) Calest.	.	.	.	.	+	.	+	.	II
Crataegus monogyna Jacq.	.	.	.	.	.	.	+	+	II
Lapsana communis L.	.	.	+	.	.	.	+	.	II
Paeonia mascula subsp. *russoi* (Biv.) Cullen & Heywood	.	.	.	.	+	.	+	.	II
Prunus spinosa L.	+	+	.	.	.	.	.	.	II
Geranium robertianum L.	.	+	+	.	.	.	.	.	II
Rosa canina L. s.l.	.	.	.	.	.	.	+	+	II

Tab. 2 - *Conopodio capillifolii-Quercetum congestae* ass. nova

Rel. n.	1	2	3	4	5	6	
Tree height (m)	14	14	10	10	10	7	
Coverage (%)	100	100	100	100	100	95	
Slope (°)	30	30	30	35	35	35	
Aspect	E	N	N-NE	N	NO	N	
Altitude (m)	1050	1030	1060	1060	1080	1010	
Surface (m²)	300	300	250	250	250	400	Frequency
Charact. sp. of the ass. and of the all.							
Quercus congesta C. Presl	5	4	5	5	4	4	V
Conopodium capillifolium (Guss.) Boiss.	+	+	+	+	.	+	V
Charact. sp. of the order *Quercetalia pubescenti-petraeae*							
Luzula forsteri (Sm.) DC.	+	1	1	1	1	+	V
Clinopodium vulgare subsp. *orientale* Bothmer	+	+	1	1	1	+	V
Viola alba subsp. *dehnhardtii* (Ten.) W. Becker	.	+	2	1	1	+	V
Crepis leontodontoides All.	+	+	+	+	.	.	IV
Poa sylvicola Guss.	+	+	.	.	.	+	III
Asperula laevigata L.	.	.	+	.	+	.	II
Castanea sativa Mill.	+	1	.	.	.	.	II
Fraxinus ornus L.	.	.	.	+	.	+	II
Ostrya carpinifolia Scop.	.	.	.	.	.	1	I
Drymochloa drymeia (Mertens & W. D. J. Koch) Holub	.	.	.	.	+	.	I
Tamus communis L.	+	.	.	.	.	.	I
Teucrium scorodonia subsp. *crenatifolium* (Guss.) Arcang.	.	.	.	+	.	.	I
Trasgr. sp. of the all. *Doronico-Fagion* and the order *Fagetalia sylvaticae*							
Aremonia agrimonoides (L.) DC.	2	2	2	1	1	1	V
Galium rotundifolium L.	+	.	+	.	+	1	IV
Brachypodium sylvaticum (Huds.) P. Beauv.	1	1	.	1	+	.	IV
Euphorbia meuselii Raimondo & Mazzola	.	.	+	.	+	+	III
Geranium versicolor L.	.	1	1	.	.	1	III
Ilex aquifolium L.	.	.	+	3	1	.	III
Festuca heterophylla Lam.	.	.	1	1	+	.	III
Doronicum orientale Hoffm.	+	+	.	.	.	.	II
Allium pendulinum Ten.	+	.	.	.	.	+	II
Polystichum setiferum (Forssk.) T. Moore ex Woynar	.	.	.	.	+	1	II
Acer obtusatum Waldst. & Kit.	.	.	.	.	.	2	I
Aquilegia vulgaris L.	.	.	.	.	.	+	I
Lamium flexuosum Ten.	.	+	.	.	.	.	I
Luzula sylvatica subsp. *sicula* (Parl.) K. Richt.	.	.	.	.	+	.	I
Polygonatum gussonei Parl.	.	.	.	+	.	.	I
Potentilla micrantha Ramond ex DC.	.	.	.	.	+	.	I
Primula acaulis (L.) L.	.	.	.	+	.	.	I
Saxifraga rotundifolia L.	.	.	.	+	.	.	I
Charact. sp. of the class *Querco-Fagetea*							
Viola reichenbachiana Jord. ex Boreau	.	1	1	1	1	1	V
Geum urbanum L.	+	.	+	+	+	+	V
Malus sylvestris Mill.	.	.	1	1	.	1	III
Cyclamen hederifolium Aiton	.	.	.	+	.	.	I
Hedera helix L.	.	.	.	.	+	.	I
Trasgr. sp. of the class *Quercetea ilicis*							
Erica arborea L.	+	1	1	1	1	2	V
Quercus ilex L.	+	2	+	+	2	+	V
Cyclamen repandum Sm.	2	.	1	1	1	1	V
Thalictrum calabricum Spreng.	+	1	3	2	1	.	V
Arisarum vulgare Targ.-Tozz.	.	+	.	.	.	.	I
Dryopteris pallida (Bory) C. Chr. ex Maire & Petitm.	.	.	.	.	+	.	I
Lonicera etrusca Santi	.	.	.	.	.	+	I
Other species							
Pteridium aquilinum (L.) Kuhn	3	2	3	1	1	1	V
Trifolium pratense subsp. *semipurpureum* (Strobl) Pignatti	+	+	1	1	+	+	V
Ranunculus bulbosus subsp. *aleae* (Willk.) Rouy & Foucaud	+	+	+	+	+	+	V
Silene italica subsp. *sicula* (Ucria) Jeanm.	+	+	+	+	+	+	V
Stellaria gr. *media* (L.) Vill.	+	+	+	+	+	+	V
Hypochoeris laevigata (L.) Ces., Passer. & Gibelli	+	+	+	1	+	.	V
Crataegus monogyna Jacq.	+	+	1	1	.	.	IV
Galium aparine L.	+	.	+	.	+	+	IV
Geranium lucidum L.	+	+	+	.	.	+	IV
Dactylis glomerata subsp. *hispanica* (Roth) Nyman	.	.	1	1	1	.	III
Bellis margaritaefolia Huter	+	+	1	.	.	.	III
Cynosurus cristatus L.	.	.	+	+	.	+	III
Hieracium cfr. *crinitum* Sm.	+	.	+	.	+	.	III
Sedum amplexicaule subsp. *tenuifolium* (Sm.) Greuter	+	+	+	.	.	.	III
Thapsia garganica L.	+	.	.	+	+	.	III
Arum italicum Mill.	+	+	.	.	.	.	II
Geranium robertianum L.	.	.	+	.	+	.	II
Cytisus villosus Pourr.	.	+	.	+	.	.	II
Asphodelus ramosus L.	1	.	.	+	.	.	II
Silene latifolia Poir.	1	+	.	.	.	.	II
Myosotis arvensis Hill	1	+	.	.	.	.	II
Cynosurus effusus Link	.	.	.	.	+	+	II
Rhagadiolus stellatus (L.) Gaertn.	+	.	.	.	.	+	II

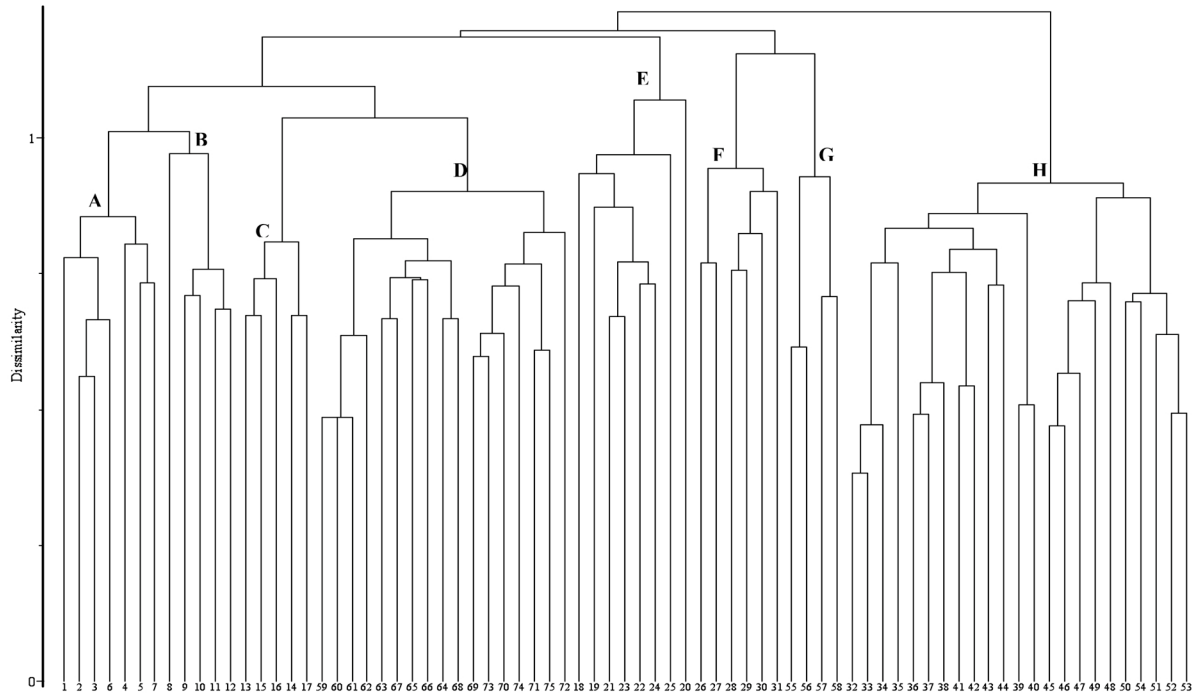


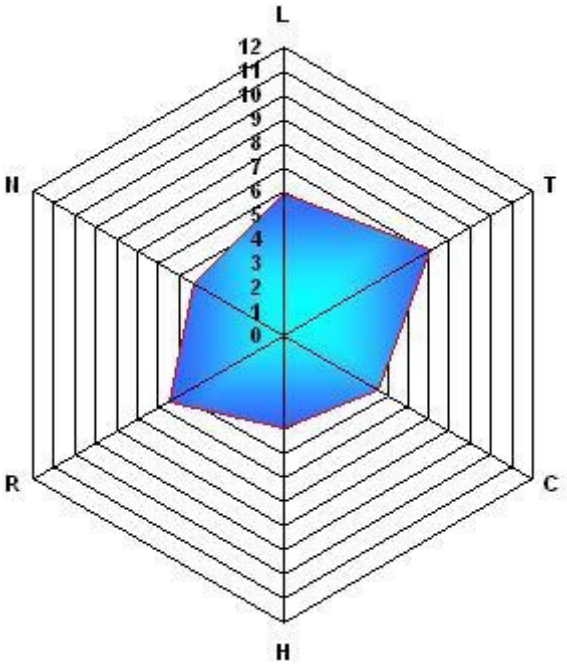
Fig. 2 – Relevées dendogram
Legend: A. *Festuco heterophillae-Quercetum congestae*; B. *Arabido-Quercetum congestae*; C. *Vicio elegantis-Quercetum congestae*; D. *Quercetum leptobalani*; E. *Ilici aquifolii-Quercetum leptobalani*; F. *Conopodio capillifolii-Quercetum congestae*; G. *Erico arboreae-Quercetum congestae*; H. *Agropyro panormitani-Quercetum congestae*.

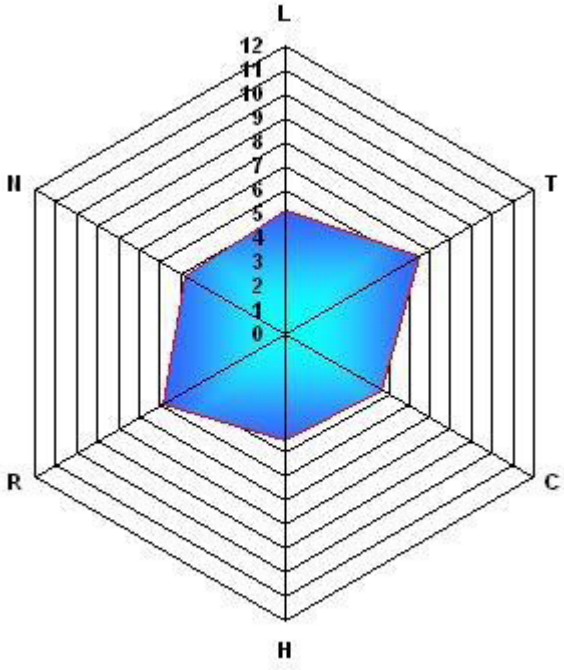
Mountain	Weather Station	Prov.	a.o. P, T	Basin	m	dry months	rain days	T (°C)	R (mm)	Ic	It, Itc	Io	Ios4	BIOCLIMATE	
														thermotype	ombrotype
Madonie	**Castelbuono** ***	PA	58, .	Pollina	423	-	77	**16,4**	**798,4**	-	-	4,06	-	*upper thermomediterranean	lower subhumid
	Cefalù	PA	60, 53	Pollina, Lascari	30	4,4	74	**18,8**	**693,3**	14,1	434	3,06	0,71	lower thermomediterranean	upper dry
	Collesano ***	PA	58, .	Roccella	460	-	80	**16,3**	**931,8**	-	-	4,76	-	*lower mesomediterranean	lower subhumid
	Petralia Sottana	PA	60, 59	Imera meridionale	930	3,8	90	**13,3**	**809,9**	18,3	232	5,04	0,91	upper mesomediterranean	upper subhumid
	Piano Formaggio ****	PA	9, .	Pollina	1210	-	-	**11,7**	**1208,3**	-	-	8,6	-	*lower supramediterranean	lower humid
Peloritani	**Alì Terme** **	ME	24, .	Fiumedinisi, C. Peloro	7	4,5	73	**18,4**	**711,6**	14,7	-	3,22	0,65	*lower thermomediterranean	upper dry
	Antillo	ME	58, 3	Agrò	480	2,9	87	**15,9**	**1415,4**	17,1	339	7,21	1,3	lower mesomediterranean	lower humid
	Casalvecchio Siculo **	ME	56, .	Agrò	400	3,4	80	**16,3**	**1004,6**	15,9	-	5,14	0,91	*upepr thermomediterranean	upper subhumid
	Ganzirri	ME	49, 32	Fiumedinisi, C. Peloro	12	3,7	81	**18**	**830,2**	13,8	416	3,84	1	lower thermomediterranean	lower subhumid
	Gualtieri Sicaminò **	ME	17, .	Muto	80	3,3	86	**18**	**1074,4**	14,9	-	4,97	1,12	*lower thermomediterranean	upper subhumid
	Milazzo **	ME	45, .	Muto, Mela	2	4,5	73	**18,5**	**648,8**	14,6	-	2,92	0,83	*lower thermomediterranean	upper dry
	S. Lucia del Mela **	ME	51, .	Muto, Mela	280	3,7	70	**16,9**	**841,1**	15,5	-	4,15	0,99	*upper thermomediterranean	lower subhumid

Tab. 3 - Mountain, pluviometric station, province, rainfalls (R) and temperature (T), basin, height, dry months in summer time, raining days each year, average annual temperature, average annual rainfalls; bioclimate and index calculated following Rivas-Martínez & Loidi Arregui (1999).
(*) theoretic thermotype;
(**) T from Duro & al. (1996);
(***) T theoretic;
(****) T theoretic and R from period 1985-1998.

aquifolium has an important role within these vegetal formations, showing its potential also in its arboreal form. Although species of the class *Quercetea ilicis* are present, they are little represented, however. The pH was between 5.5 and 6.9.

Where the slopes are less steep, a local facies was found (rel. 3, Table 1) in which *Ilex aquifolium* reaches large sizes. These aspects of the vegetation are of great naturistic and landscape interest. Along the north-western slopes of Pizzo di Corco at around 1,150 m,





Quercetum leptobalani

L	6,1
T	7,1
C	4,5
H	3,7
R	5,4
N	4,2

CHOROTYPE	%
Endem.	4,3
Steno-Med.	32,5
Euri-Med.	17,7
Med.-Mont.	7,8
Eurasiat.	26,8
Atl.	3,3
Boreal	4,7
Multizon.	3,0

LIFE FORM	%
T	1,9
G	11,5
H	45,9
CH	4,0
NP	9,1
P	27,6

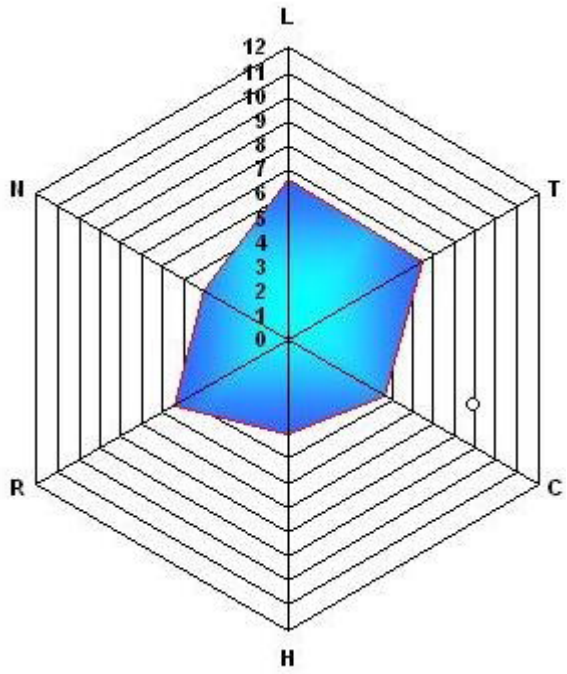
Ilici aquifolii-Quercetum leptobalani

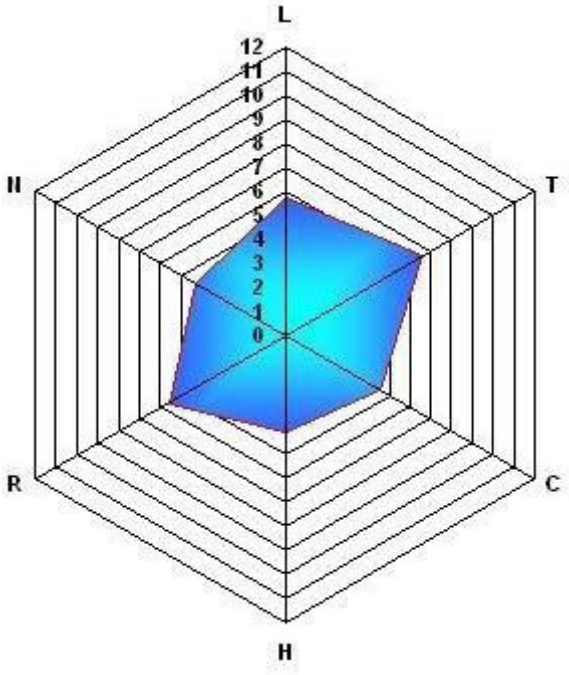
L	5,1
T	6,4
C	4,6
H	4,4
R	5,8
N	4,8

CHOROTYPE	%
Endem.	2,7
Steno-Med.	17,1
Euri-Med.	20,7
Med.-Mont.	8,2
Eurasiat.	33,4
Atl.	3,9
Orof.-SEur.	3,5
Boreal	5,4
Multizon.	5,1

LIFE FORM	%
T	1,6
G	23,8
H	40,4
CH	4,7
NP	3,9
P	25,7

Fig. 3 – Echogram, Chorotypes and Life form of *Quercetum leptobalani* and *Ilici-Quercetum leptobalani*.





Agropyro panormitani-Quercetum congestae

L	**6,6**
T	**6,3**
C	**4,5**
H	**3,9**
R	**5,5**
N	**4,0**

CHOROTYPE	%
Endem.	**1,6**
Steno-Med.	**6,7**
Euri-Med.	**16,4**
Med.-Mont.	**18,3**
Eurasiat.	**33,9**
Atl.	**3,7**
Orof.-SEur.	**3,7**
Boreal	**9,0**
Multizon.	**5,3**

LIFE FORM	%
T	**6,5**
G	**12,5**
H	**57,5**
CH	**3,6**
NP	**3,9**
P	**16,0**

Conopodio capillifolii-Quercetum congestae

L	**5,7**
T	**6,6**
C	**4,5**
H	**4,1**
R	**5,6**
N	**4,3**

CHOROTYPE	%
Endem.	**1,0**
Steno-Med.	**25,8**
Euri-Med.	**16,8**
Med.-Mont.	**12,0**
Eurasiat.	**23,0**
Orof.-SEur.	**2,4**
Boreal	**11,9**
Multizon.	**7,2**

LIFE FORM	%
T	**12,0**
G	**17,2**
H	**47,9**
CH	**4,3**
NP	**0,5**
P	**18,2**

Fig. 4 – Echogram, Chorotypes and Life form of *Agropyro-Quercetum congestae* and *Conopodio-Quercetum congestae*.

and again within the wood, there is a large fall line in which there are hydro-hygrophilous elements that are of great phytogeographical and ecological interest (Schicchi *et al.*, 2006).

Sometimes holly is also found in the substituting shrubby aspects that are characterised by a predominance of Rosaceae shrubs of the alliance *Pruno-Rubion ulmifolii*. The further stages of substitution are rich in species of the class *Molinio-Arrhenatheretea*. These aspects of grassland vegetation should be associated with *Cynosuro-Leontodontetum siculi*. Among the species seen, there are *Anthemis arvensis* subsp. *sphacelata*, *Anthoxanthum odoratum*, *Arrhenatherum elatius*, *Briza maxima*, *Cynosurus cristatus*, *C. echinatus*, *Dactylis glomerata* subsp. *hispanica*, *Hypochoeris radicata*, *Hordeum bulbosum* subsp. *nodosum*, *Oenanthe pimpinelloides*, *Petrorhagia saxifraga*, *Pteridium aquilinum*, *Trifolium incarnatum* subsp. *molinerii* and *T. pratense* subsp. *semipurpureum*. In these environments, and in particular where species linked to excessive grazing are found, such as *Eryngium campestre*, *Scolymus grandiflorus*, *Carlina sicula* and *Asphodelus ramosus*, *Pteridium aquilinum* has an important role: within the progressive series following abandonment, it can reach total coverage and develop in height, such as to allow only the growth of trees.

Peloritani

The biotopes of the Peloritani are found mainly on the cooler slopes of the mountain area, between the peaks of Pizzo Croce (1,214 m), Pizzo Acqua Bianca (1,210 m) and Monte Cavallo (1,216 m), and they are characterised by metamorphic substrata of various natures (granitoids, gneiss, augen-gneiss, amphibolites, marble, phyllites, quartzdiorite phyllites, metarenites and metalimestones).

The tree belt of the woods under study is characterised by a dominance of *Quercus congesta*, with which there are associated: *Quercus ilex* and *Castanea sativa*. The floristic cortège is distinguished by an abundance of elements of the class *Querco-Fagetea*, and in particular of the order *Quercetalia pubescenti-petraeae*. Among the elements of this order, there are *Asperula laevigata*, *Clinopodium vulgare* subsp. *orientale*, *Crepis leontodontoides*, *Drymochloa drymeia*, *Fraxinus ornus*, *Luzula forsteri*, *Ostrya carpinifolia*, *Poa sylvicola*, *Tamus communis*, *Teucrium scorodonia* subsp. *crenatifolium* and *Viola alba* subsp. *dehnhardtii*. With regard to the class *Fagetalia sylvaticae,* there are: *Acer obtusatum*, *Allium pendulinum*, *Aquilegia vulgaris*, *Aremonia agrimonoides*, *Doronicum orientale*, *Geranium versicolor*, *Galium rotundifolium*, *Euphorbia meuselii*, *Lamium flexuosum*, *Luzula sylvatica* subsp. *sicula*, *Polygonatum gussonei* and *Ilex aquifolium*, with this last not very widespread, although in some areas it reaches tree status. For the class *Quercetea ilicis*, there are some elements present, such as: *Cyclamen repandum*, *Dryopteris pallida*, *Erica arborea*, *Lonicera etrusca*, *Quercus ilex* and *Thalictrum calabricum*. The pH values recorded are generally between 5.4 and 6.0, although close to the northern slopes of Mount Cavallo higher values were recorded, which reached 6.9, and which are indicated in Table 4 with an asterisk.

For the dynamic aspect, these oak woods are substituted by shrubby coenoses of *Erica arborea*, with which there is *Cytisus villosus*. In these aspects of the vegetation, there are sometimes also woody Rosaceae, like *Crataegus monogyna* and *Pyrus spinosa*. The shrubby aspects of the vegetation can be linked to the acidophilous and oceanic coverage of the class *Cytisetea scopario-striati*, the presence in Sicily of which was reported by Bartolo *et al.* (1994) and Brullo *et al.* (2001).

The vegetation of *Erica arborea* is now very spread on some of the slopes, and characterises a part of the vegetal landscape of the Peloritani. The next stage in the substitution is represented by the ferns of *Pteridium aquilinum*, which also cover huge swathes of this area.

Results

As shown in Figure 2 (UPGMA/chord distance), the analysis of the classification dendrogram distinguishes sharply between the downy oak associations described for the island and the two new vegetation units presented here. This dendogram highlights the separation between the more thermophilous associations referred to *Quercetalia ilicis*, which are found in a single large cluster, from the more mesophilous associations referred to *Quercetalia pubescenti-petraeae*, which are included in other clusters. In particular, there are four main clusters seen. The cluster to the left includes the associations *Festuco heterophillae-Quercetum congestae* (rel. 1-7), *Arabido-Quercetum congestae* (rel. 8-12), *Vicio elegantis-Quercetum congestae* (rel. 13-17) and *Quercetum leptobalani* (rel. 59-75). The central cluster includes the Madonie formations under study (rel. 18-25); of these, in particular for the other relevées, the facies with *Allium ursinum* and *Sanicula europaea* can be seen (rel. 20). The first of the two clusters on the right, which can be divided into two

subclusters, include the Peloritani formations under study (rel. 26-31) and those of Aspromonte of *Erico arboreae-Quercetum congestae* (rel. 55-58). This cluster therefore shows a certain affinity between these two forest communities, which presumably arises from geolithological and phytogeographical factors, since both of these communities are seen as a part of the Calabria-Peloritani Arc. Finally, the last cluster includes the Etna forest formations of *Agropyro panormitani-Quercetum congestae* (rel. 32-54).

Regarding the synecological aspect, comparing two formations of the Madonie (Fig. 3), one of *Quercetalia ilicis* and the other of *Quercetalia pubescenti-petraeae*, it can be seen that the polygon relative to the downy oak woods with holly under study has a different shape with respect to that of *Quercetum leptobalani*. This is due to the different values of the ecological factors, among which there are higher values for water (H) and nutrients (N), and lower values for light (L) and temperature (T).

Figure 4 shows a comparison of the downy oak formations examined on the Peloritani with those of Etna of *Agropyro-Quercetum congestae* (both of which are referred to *Quercetalia pubescenti-petraeae*). In this case, it can be seen that the shapes of the two polygons are substantially different due to the lower light values (L) and the higher temperature (T) and nutrient values (N) of the first of these forest communities, with respect to the second.

For the bioclimate aspects, the oak woods examined are part of the Supramediterranean thermotype, with the lower humid ombrotype for the Madonie and the upper humid ombrotype for the Peloritani (Table 4). In particular, the Peloritani formations are those that have higher precipitation, due to their particular geographic position that benefits from the influence of the humid currents coming from both the Tyrrhenian Sea and the Ionic Sea. Indeed, within Sicily, for the same altitude, this territory has the highest pluviometric values (Table 3). Moreover, among the microclimate elements of all biotopes, the presence of fog has particular relevance, which can recur also during days when the nearby coastal areas have very little cloud.

Discussion and conclusions

For the mesophilous and acidophilous downy oak woods with holly examined here, two new associations have been proposed: *Ilici aquifolii-Quercetum leptobalani* (Holotype: rel. 4, Table 1), for the formations of the Madonie – previously indicated by Maniscalco *et al.* (2008) as *Ilici aquifoliae-Quercetum congestae* – and *Conopodio capillifolii-Quercetum congestae* (Holotype: rel. 1, Table 2) for those of the Peloritani; both of these are referred to the order *Quercetalia pubescenti-petraeae* (*Querco-Fagetea*).

In relation to the various nemoral contingents, overall, the phytocoenosis of the Madonie (Fig. 5) appear more mesophilous and floristically more rich, with respect to that of the Peloritani (Fig. 6). The *Conopodio capillifolii-Quercetum congestae* that has developed on metamorphic substrata appears to constitute a particular vegetation expression of *Quercus congesta*, which due to the geolithological factors, can be found in Sicily exclusively on the Peloritani.

Other island formations (*Festuco heterophillae-Quercetum congestae*, *Vicio elegantis-Quercetum congestae*, *Arabido-Quercetum congestae* and *Quercetum leptobalani*, referred to *Erico-Quercion ilicis*) have a floristic cortège that is markedly more thermophilous with respect to those examined on the Madonie and the Peloritani Mountains.

With respect to *Agropyro panormitani-Quercetum congestae* of Etna (Tab. 5) – the only Sicilian downy oak association that is referred to the order *Quercetalia pubescenti-petraeae* – both *Ilici-Quercetum leptobalani* and *Conopodio-Quercetum congestae* are richer overall for their floristic aspects and appear to

MOUNTAIN	PLACE	ALTITUDE (m)	LITHOLOGY	RELEVATED PH	ASSOCIATION	BIOCLIMATE
Madonie	P. di Corco-Vicaretto, Gonato	1000-1250	Flysch numidico	5,5 – 6,9	*Ilici aquifolii-Quercetum leptobalani*	Lower Supramediterranean humid
Peloritani	P. Croce, P. Acqua Bianca, M. Cavallo	1000-1150	Metamorphitis various nature	5,4 – 6(6,9*)	*Conopodio capillifolii-Quercetum congestae*	Upper Supramediterranean humid

Tab. 4 – Oak formations with holly analyzed on the Madonie and on the Peloritani mountains.

Fig. 5 – Serre di Corco (Madonie), 1100 m. Late winter aspect of *Quercus congesta*, *Q. leptobalanos* wood and *Q. dalechampii*, in which *Q. ilex* and *Ilex aquifolium* can be found.

Fig. 6 - *Quercus congesta* wood by Pizzo Acqua Bianca (Peloritani), 1050 m.

be well characterised according to the elements of the various phytosociological contingents represented.

The oak woods of the Madonie referred to *Ilici-Quercetum leptobalani* deserve particular attention, since they are an excellent expression of the vegetation – as well as being very particular from the ecological and structural points of view – that can be included in the deciduous formations that have developed between the island forest communities of *Quercetalia ilicis* and those of the *Fagetalia* (like the beech woods and oak woods of *Ilici-Quercetum austrotyrrhenicae*). The attribution of these oak woods with holly to *Quercetalia pubescenti-petraeae* is suggested by the floristic cortège that is rich in elements of this order, and also by the presence, even though reduced, of the elements of *Quercetea ilicis*. These latter are instead practically absent from the forest communities of the *Fagetalia* mentioned above, which are typical of the higher vegetation belt. On the other hand, with regard to the elements of *Quercetalia pubescenti-petraeae,* it can be stressed that they are sporadic in the beech woods and in the downy oak woods with holly, while they become almost the only characterising elements of the floristic cortège of *Fagetalia*. The marked incidence in the oak woods of *Ilici-Quercetum leptobalani* of elements of *Fagetalia* can be related to the oceanic conditions, which together with the favourable edaphic conditions, result in an optimal situation also for the development of holly. Similar oceanic conditions at a microclimate level are seen for the Peloritani, although the soil that has evolved on metamorphic substrata is generally more permeable with respect to that of the Madonie, which has evolved on Flyschoid substrata.

Ilici aquifolii-Quercetum leptobalani has developed on the cooler slopes between 1,000 and 1,250 m, with the occasional outgrowth to lower altitudes under favourable conditions, as is seen near Gonato. This formation of deciduous oak establishes chain contact with the ilex woods of *Geranio versicoloris-Quercetum ilicis* (Maniscalco & Raimondo, 2003), seen for the same altitude belt, but developed on rocky substrata.

Conopodio capillifolii-Quercetum congestae has developed on the cooler slopes of the mountainous peaks of the Peloritani at around 1,000 to 1,150 m. Part of this formation falls within the Natural Reserve of the Fiumedinisi and Scuderi Mountain (Riserva Naturale Orientata di Fiumedinisi e Monte Scuderi; Messina), which was established recently.

Syntaxonomical scheme of oak woods *Quercus congesta* and/or *Q. leptobalanos* of Sicily

QUERCO ROBORIS-FAGETEA SYLVATICAE Br.-Bl. & Vlieg. 1937 em. Oberd. 1992
Quercetalia pubescenti-petraeae Klika 1933
Pino-Quercion congestae Brullo, Scelsi, Siracusa & Spampinato 1999
Agropyro panormitani-Quercetum congestae Brullo, Scelsi, Siracusa & Spampinato 1999
IIici aquifolii-Quercetum leptobalani ass. nova
Conopodio capillifolii-Quercetum congestae ass. nova

QUERCETEA ILICIS Br.-Bl. ex A. & O. Bolòs 1950
Quercetalia ilicis Br.-Bl. 1936 em. Rivas-Martínez 1975
Erico-Quercion ilicis Brullo, Di Martino & Marcenò 1977
Quercetum leptobalani Brullo 1984
Festuco heterophyllae-Quercetum congestae Brullo & Marcenò 1985
Arabido-Quercetum congestae Brullo & Marcenò 1985
Vicio elegantis-Quercetum congestae Brullo & Marcenò 1985

Tab. 5 - Synoptic table of *Quercus congesta* wood associations belonging to the class *Querco-Fagetea*

Ass. n.	1	2	4	3
Rel. n.	8	6	4	23
Charact. and diff. sp. of the ass.				
Quercus leptobalanos Guss.	100	.	.	.
Rubia peregrina L.	100	.	.	.
Melittis melissophyllum subsp. *albida* (Guss.) P. W. Ball.	88	.	.	.
Symphytum gussonei F. W. Schultz	63	.	.	.
Oenanthe pimpinelloides L.	50	.	.	.
Euonymus europaeus L.	13	.	.	.
Acer monspessulanum L.	13	.	.	.
Buglossoides purpurocaerulea (L.) I. M. Johnst.	13	.	.	.
Sorbus torminalis (L.) Crantz	13	.	.	.
Echinops ritro subsp. *siculus* (Strobl) Greuter	13	.	.	.
Melica uniflora Retz.	63	.	.	.
Anemone apennina L.	63	.	.	.
Anthriscus nemorosa (M. Bieb.) Spreng.	50	.	.	.
Neottia nidus-avis (L.) L. C. Rich.	50	.	.	.
Sanicula europaea L.	25	.	.	.
Allium ursinum subsp. *ucrainicum* Kleopow & Oxner	13	.	.	.
Conopodium capillifolium (Guss.) Boiss.	.	83	.	52
Ostrya carpinifolia Scop.	.	17	.	.
Drymochloa drymeia (Mertens & W. D. J. Koch) Holub	.	17	.	.
Acer obtusatum Waldst. & Kit.	.	17	.	.
Aquilegia vulgaris L.	.	17	.	.
Polygonatum gussonei Parl.	.	17	.	.
Saxifraga rotundifolia L.	.	17	.	.
Dryopteris pallida (Bory) C. Chr. ex Maire & Petitm.	.	17	.	.
Arisarum vulgare Targ.-Tozz.	.	17	.	.
Cytisus villosus Pourr.	.	.	100	.
Epipactis helleborine (L.) Crantz	.	.	75	.
Fragaria vesca L.	.	.	75	.
Silene viridiflora L.	.	.	75	.
Aristolochia lutea Desf.	.	.	50	.
Digitalis micrantha Roth	.	.	50	.
Lactuca muralis (L.) Gaertn.	.	.	50	.
Scutellaria columnae subsp. *gussonii* (Ten.) Rech. fil.	.	.	50	.
Rumex sanguineus L.	.	.	50	.
Pulmonaria apennina Puppi & Cristofolini	.	.	25	.
Sorbus domestica L.	.	.	25	.
Arabis turrita L.	.	.	25	.
Helleborus bocconei subsp. *intermedius* (Guss.) Greuter & Burdet	.	.	25	.
Elymus panormitanum (Parl.) Tzvelev	.	.	.	100
Pinus nigra subsp. *calabrica* (Loud.) A. E. Murray	.	.	.	65
Cnidium silaifolium (Jacq.) Simonkai	.	.	.	52
Epipactis microphylla (Ehrh.) Sw.	.	.	.	26
Limodorum abortivum (L.) Sw.	.	.	.	22
Charact. sp. of the all. *Quercion congestae* and order *Quercetalia pubescenti-petraeae*				
Quercus congesta C. Presl	100	100	100	100
Poa sylvicola Guss.	75	50	100	65
Teucrium scorodonia subsp. *crenatifolium* (Guss.) Arcang.	25	17	100	.
Crepis leontodontoides All.	13	67	.	100
Quercus dalechampii Ten.	100	.	100	100
Tamus communis L.	88	17	50	.
Clinopodium vulgare subsp. *orientale* Bothmer	25	100	50	.
Luzula forsteri (Sm.) DC.	13	100	25	.
Viola alba subsp. *dehnhardtii* (Ten.) W. Becker	88	83	25	.
Fraxinus ornus L.	13	33	.	.
Asperula laevigata L.	25	33	.	.
Trasgr. Sp. Of the all. *Doronico-Fagion* and order *Fagetalia sylvaticae*				
Brachypodium sylvaticum (Huds.) P. Beauv.	38	67	100	100
Galium rotundifolium L.	38	67	25	43
Aremonia agrimonoides (L.) DC.	50	100	50	9
Geranium versicolor L.	63	67	50	.
Ilex aquifolium L.	88	50	50	.
Luzula sylvatica subsp. *sicula* (Parl.) K. Richt.	63	17	.	57
Doronicum orientale Hoffm.	38	33	.	43
Festuca heterophylla Lam.	.	50	100	74
Castanea sativa Mill.	.	33	100	26
Euphorbia meuselii Raimondo & Mazzola	13	50	.	.
Lamium flexuosum Ten.	75	17	.	.
Potentilla micrantha Ramond ex DC.	50	17	.	.
Polystichum setiferum (Forssk.) T. Moore ex Woynar	63	33	.	.
Primula acaulis (L.) L.	50	17	.	.
Allium pendulinum Ten.	38	33	.	.
Daphne laureola L.	75	.	.	96
Lathyrus venetus (Mill.) Wohlf.	63	.	.	52

Charact. sp. of the class *Querco-Fagetea*				
Hedera helix L.	100	17	25	.
Geum urbanum L.	25	83	75	.
Viola reichenbachiana Jord. ex Boreau	.	83	100	52
Malus sylvestris Mill.	13	50	.	.
Rubus hirtus Waldst. & Kit. s. l.	63	.	.	.
Acer campestre L.	25	.	.	.
Rubus canescens DC.	13	.	.	.
Athyrium filix-foemina (L.) Roth	13	.	.	.
Viola odorata L.	13	.	.	.
Cyclamen hederifolium Aiton	.	17	.	.
Lathyrus pratensis L.	.	.	.	100
Milium montianum Parl.	.	.	.	13
Trasgr. sp. of the class *Quercetea ilicis*				
Quercus ilex L.	88	100	100	.
Carex distachya Desf.	13	.	25	52
Thalictrum calabricum Spreng.	88	83	.	.
Cyclamen repandum Sm.	75	83	.	.
Lonicera etrusca Santi	25	17	.	.
Ruscus aculeatus L.	100	.	25	.
Erica arborea L.	.	100	100	.
Quercus virgiliana (Ten.) Ten.	13	.	.	.
Pulicaria odora (L.) Rchb.	.	.	25	.
Rosa sempervirens L.	.	.	.	22

1 - *Ilici aquifolii-Quercetum leptobalani* ass. nova
2 - *Conopodio capillifolii-Quercetum congestae* ass. nova
3 - *Agropyro panormitani-Quercetum congestae* Brullo, Scelsi, Siracusa & Spampinato 1999.
4 - *Erico arboreae-Quercetum congestae* Brullo, Scelsi & Spampinato 2001.

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Appendix

Tab. 1 - *Ilici aquifolii-Quercetum leptobalani*
Locations and dates of the relevées.
Rel. 1: Gonato, 11-7-2004; rels. 2, 3, 4, 5, 6, 7: Serre di Corco-Vicaretto, 20-6-2004; rel. 8: Serre di Corco-Vicaretto, 10-7-2004.

Sporadic species.
Rel. 1: *Asphodelus ramosus* L.: +, *Calamintha nepeta* (L.) Savi: +; *Cynosurus cristatus* L.: +, *Dactylis glomerata* subsp. *hispanica* (Roth) Nyman: +, *Silene latifolia* Poir.: +, *Lolium perenne* L.: +, *Trifolium campestre* Schreb.: +; rel. 3: *Salix pedicellata* Desf.: 1, *Equisetum* sp.: +, *Hypericum hircinum* subsp. *majus* (Aiton) N. Robson: +; rel. 5: *Hordeum bulbosum* subsp. *nodosum* (L.) B. R. Baum: +, *Hypochoeris laevigata* (L.) Ces., Passer. & Gibelli: +, *Rumex thyrsoides* Desf.: +; rel. 8: *Silene italica* subsp. *sicula* (Ucria) Jeanm.: +, *Hypochoeris radicata* L.: +, *Silene vulgaris* (Moench.) Garcke s.l.: +.

Tab. 2 - *Conopodio capillifolii-Quercetum congestae*
Locations and dates of the relevées.
Rels. 1, 2: Pizzo Acqua Bianca-Monte Cavallo, 15-5-2005; rels. 3, 4, 5: Pizzo Acqua Bianca-Monte Cavallo, 23-6-2002; rel. 6: Pizzo Croce-Pizzo Acqua Bianca, 4-6-2005.

Sporadic species.
Rel. 1: *Cynosurus echinatus* L.: +, *Sherardia arvensis* L.: +; rel. 2: *Achillea ligustica* All.: +, *Silene vulgaris* (Moench.) Garcke s.l.: +, *Rosa canina* L. s.l.: +, *Geranium dissectum* L.: +; rel. 5: *Anthoxanthum odoratum* L.: +, *Aristolochia sicula* Tineo: +; rel. 6: *Rubus* sp.: +.