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THE JUNIPERUS OXYCEDRUS SSP. OXYCEDRUS SCRUB COMMUNITIES OF TUSCAN SERPENTINE SOILS

Abstract - The scrub communities, dominated by *Juniperus oxycedrus* ssp. *oxycedrus*, of the serpentine (ultramafic) outcrops of Tuscany, were described from the phytosociological point of view. These scrub communities are to be considered the most natural vegetation type of xeric slops of serpentine outcrops. The Tuscan serpentine endemics grow in the canopy gaps or in the less evolved stages of these scrub communities. The most typical aspects of these coenoses were describes as a new association, named *Carici humilis - Juniperetum oxycedri*, and belonging to the *Quercion ilicis*. The more evolved stages of these communities, transitioning towards the Mediterranean evergreen forest, were also sampled and typically forest species were found.

Key words - Central Italy, *Juniperus oxycedrus* ssp. *oxycedrus*, phytosociology, ultramafic soils.

Riassunto - *Le comunità arbustive a* Juniperus oxycedrus *ssp.* oxycedrus *delle serpentine della Toscana*. Vengono descritte, dal punto di vista fitosociologico, le cenosi arbustive dominate da *Juniperus oxycedrus* ssp. *oxycedrus*, degli affioramenti di serpentine (ultramafiti) della Toscana. Queste cenosi arbustive sono da considerare la tipologia vegetazionale più naturale dei versanti xerici delle serpentine e ospitano, nelle radure o negli stadi meno evoluti, anche gli endemismi serpentinicoli. Gli aspetti tipici sono stati descritti come una nuova associazione, denominata *Carici humilis - Juniperetum oxycedri*, inquadrata nel *Quercion ilicis*. Sono stati anche rilevati gli aspetti più evoluti, di transizione verso la foresta sempreverde mediterranea, che ospitano molte specie propriamente forestali.

Parole chiave - Italia centrale, fitosociologia, *Juniperus oxycedrus* ssp. *oxycedrus*, suoli ultramafici.

INTRODUCTION

Because of their chemical and physical properties, serpentine (ultramafic) soils host a distinctive flora and vegetation. These soils typically contain high concentrations of heavy metals such as nickel, chromium, cobalt, and manganese, low concentrations of nutrients and a large excess of magnesium over calcium; moreover these soils are shallow, well drained and prone to erosion (Brooks, 1987; Baker *et al.*, 1992; Roberts & Proctor, 1992). However, large variations exist in the soil features of the different sites. Proctor & Nagy (1992) suggested that the factors controlling ultramafic flora might differ from site to site. Ultramafic rocks outcrop in many sites of Tuscany, Italy, and their flora and vegetation have been widely studied by botanists and ecologists (see Vergnano Gambi, 1992; Chiarucci *et al.*, 1998). The most typical plant community in Tuscan serpentine soils is a garigue, described as the *Armerio-Alyssetum bertoloni* association, characterised by low ground cover and many endemic plants, and occurring over all ultramafic outcrops of Tuscany (Arrigoni *et al.*, 1983; Chiarucci *et al.*, 1995). Tall scrub or woodland plant communities have also been reported and are widespread in some sites (Messeri, 1936; Pichi-Sermolli, 1948; Marchiori & Tornadore Marchiori, 1977; Chiarucci, 1994; Chiarucci *et al.*, 1998). Chiarucci *et al.* (1998) claimed that the *Juniperus oxycedrus* ssp. *oxycedrus* scrub communities represent probably the most evolved natural vegetation type on xeric slopes of the westernmost ultramafic outcrops of Tuscany and that their dynamics, towards closed and structured woodland communities, is prevented by nutrient deficiency and periodic reversions due to special stress factors such as drought. These juniper scrub communities were never described from a phytosociological point of view.
The aim of the present paper is to describe, from a phytosociological point of view, the *Juniperus oxycedrus* ssp. *oxycedrus* scrub communities of Tuscan serpentine soils.

STUDY AREAS AND VEGETATION SAMPLING

Three of the largest ultramafic areas in Tuscany were selected as study sites (Fig. 1): 1) the hills near Livorno (A); 2) the Cecina Valley and surrounding areas (B); 3) the Murlo area (C). These areas represent the westernmost serpentine sites in Tuscany, where the garigues belong to the *Armerio-Alyssetum bertoloni* subass. *euphorbietosum spinosae*. The easternmost serpentine sites, in which climate showed less Mediterranean features, are characterised by garigues

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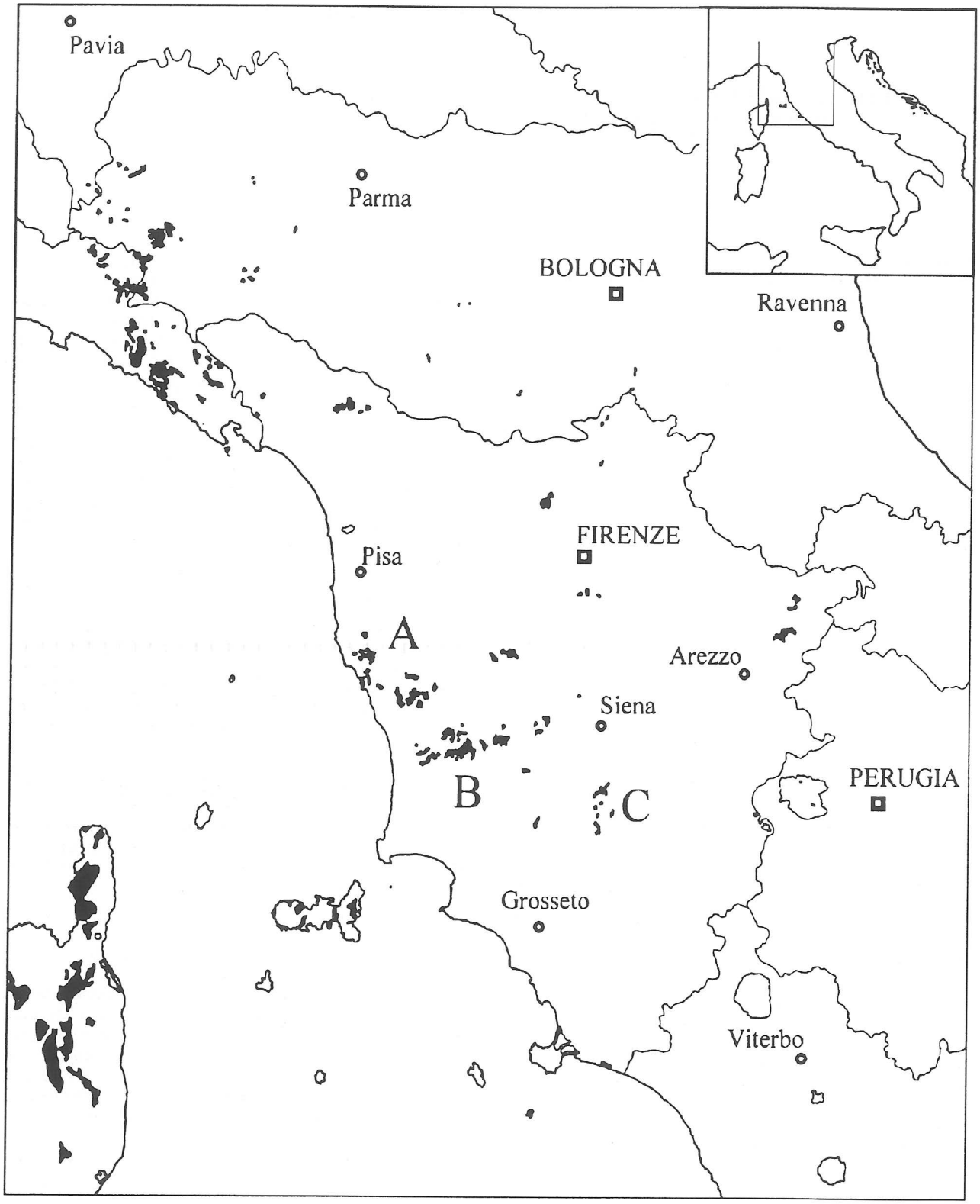

Fig. 1 - Distribution of the ultramafic outcrops of Corsica and central-northern Italy with evidenced the study sites. A: Livorno hills, B: Cecina Valley and surrounding areas, C: Murlo area.

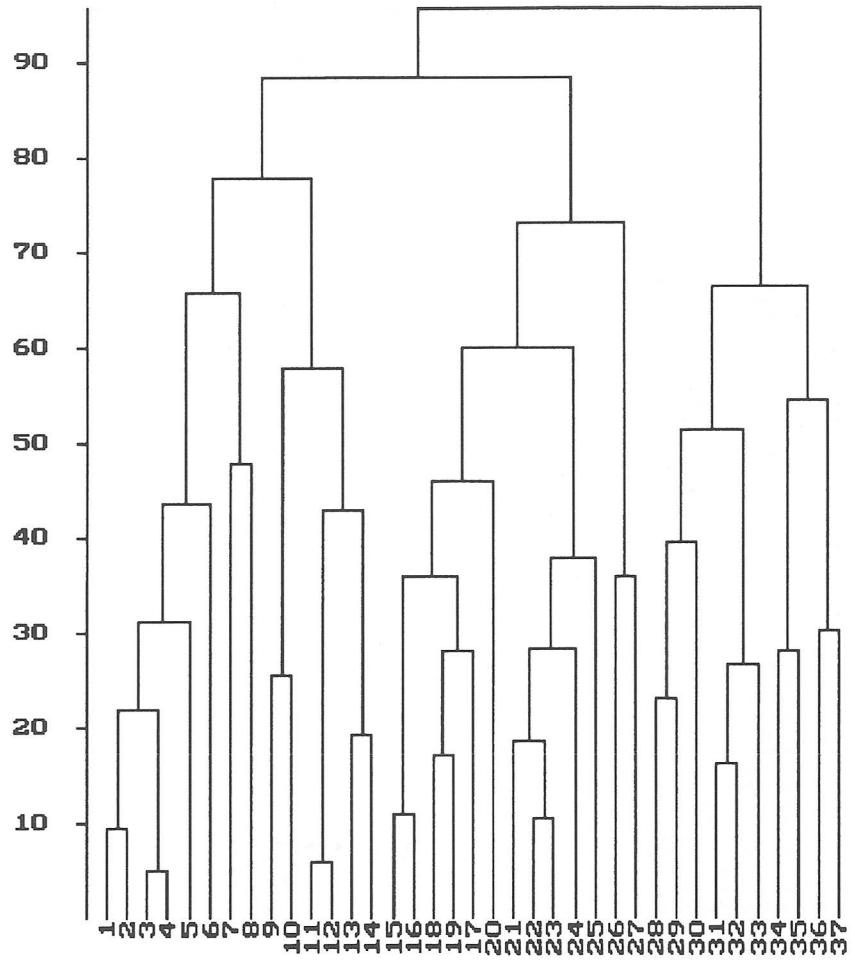

Fig. 2 - Dendrogram showing the classification of plots.

belonging to the *Armerio-Alyssetum bertoloni* subass. *typicum* (Chiarucci *et al.*, 1995) and by the scarcity of *Juniper oxycedrus* ssp. *oxycedrus* scrub communities (Chiarucci *et al.*, 1998). Thereafter we did not sample these eastermost serpentine areas.

In each area some plots, representing all the main stages of the juniper scrub communities were sampled according to the method of Braun-Blanquet (1964).

In order to obtain floristically homogeneous groups of plots, the data matrix was submitted to cluster analysis with the Minimum Variance Clustering as agglomerative criterion, applied to a matrix based on the Euclidean Distance. Cluster analysis was performed by the program package Syn-Tax 5.1 (Podani, 1994). The Braun-Blanquet values were trasformed according to Van der Maarel (1979).

Plant nomenclature follows Pignatti (1982) for most species, Chiarucci *et al.* (1995) for serpentinophytes and Moraldo (1986) for the genus Stipa.

RESULTS AND DISCUSSION

Three main clusters can be recognised in the dendrogram (Figure 2). The first group of plots (plots 1-10 in Table 1) were sampled in open juniper scrub communities, dominated by *Juniperus oxycedrus* ssp. *oxycedrus*, with a significant presence of other Mediterranean evergreen species (*Phillyrea latifolia*, *Erica arborea*, *Erica scoparia*, *Quercus ilex*, *Arbutus un-*

Table 1 - Phytosociological table of the *Juniperus oxycedrus* ssp. *oxycedrus* scrub communities of Tuscan serpentine soils. Plots 11-24: *Carici humilis - Juniperetum oxycedri* ass. nov. (type relève 17). Species found in only one plot, with their abundance value: Plot 3: *Asplenium onopteris* f. *serpentinii* (r); Plot 6: *Arenaria serpyllifolia* (+), *Cheilanthes marantae* (r), *Sedum rupestre* ssp. *rupestre* (+); Plot 10: *Anthyllis vulneraria* ssp. *praepropera* (+); Plot 16: *Iris chamaeiris* (+); Plot 17: *Centaurea nigra* (+); Plot 18: *Cytisus decumbens* (+), *Prasium majus* (r); Plot 22: *Cytisophyllum sessilifolius* (+); Plot 23: *Osyris alba* (+); Plot 26: *Brachypodium ramosum* (1); Plot 27: *Rubus ulmifolius* (+); Plot 28: *Centaurium erythraea* (r); Plot 30: *Euphorbia nicaeensis* ssp. *prostrata* (+); Plot 32: *Polygonatum odoratum* (r), *Rosa sempervirens* (r), *Melittis melyssophyllum* (r); Plot 34: *Hieracium virgaurea* (+), *Sorbus torminalis* (r), *Solidago virgaurea* (r); Plot 35: *Taxus baccata* (2); Plot 36: *Spartium junceum* (+); Plot 37: *Staehelina dubia* (+).

	Plot n.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37
	Altitude (m)	395	315	470	320	310	280	250	240	420	430	500	300	480	350	270	325	305	360	375	450	380	380	370	430	320	320	250	410	270	315	400	420	450	150	380	365	445
	Aspect	SSE	ESE	SW	SW	SSE	SW	SW	SW	NW	SW	W	W	SE	S	SSE	SSE	S	SE	NW	SE	NW	NW	SW	SE	SW	NNE	SSE	E	NW	N	S	N	NE	N	NW	NE	SSE
	Slope (°)	15	25	25	35	15	20	25	25	15	17	5	30	5	20	30	20	25	30	10	35	15	15	30	12	40	20	25	26	30	37	10	20	5	5	10	30	20
	Total vegetation cover (%)	80	80	90	90	80	70	60	80	70	70	90	100	90	95	90	70	90	90	90	85	100	100	90	90	75	85	90	85	90	95	100	95	95	100	95	90	90
	Tree layer cover (%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	10	10	15	15	20	20	10	15	10
	Shrub layer cover (%)	80	65	90	70	70	65	30	70	50	60	70	80	80	80	85	50	95	80	75	75	90	90	85	95	80	85	85	90	85	75	95	95	95	100	95	75	80
	Shrub layer height (m)	3	2	3	2.5	1.2	1.5	2.5	2.5	2.5	2.5	1.5	3.5	3.2	2.5	2.5	1.2	2.5	2	2	3	3	2.5	3	2.5	2.5	2.5	2	3	3	2.5	2	2.2	2.5	3	3	3.5	2.5
	Field layer cover (%)	5	25	15	80	20	25	35	25	40	30	20	20	20	10	2	20	15	40	50	20	10	20	2	2	1	3	10	1	25	50	40	20					
	Sampling surface (m2)	100	100	100	100	100	100	100	100	100	100	90	100	80	100	100	100	100	100	100	100	100	150	100	100	100	100	100	100	100	100	100	100	100	100	110	100	100
	Carici humilis-Juniperetum oxycedri																																					
b	*Juniperus oxycedrus* L. ssp. *oxycedrus*	3	4	2	3	3	3	2	2	2	3	3	3	3	3	1	3	4	2	4	3	3	3	3	3	+	1	2	3	2	1	2	2	2	1	3	3	3
c	*Carex humilis*	.	.	.	.	.	.	+	1	+	.	1	1	1	1	2	1	1	.	2	2	1	.	1	1	.	.	.	.	.	.	1	2	+	2	r	.	.
b	*Myrtus communis*	.	.	.	.	.	.	.	.	.	.	2	2	1	1	1	2	3	2	.	.	2	2	2	1	.	+	.	.	.	.	.	.	.	.	.	.	1	.
b	*Pistacia lentiscus*	.	.	.	.	.	.	.	.	+	.	+	.	+	.	+	+	.	2	.	.	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
b	*Rhamnus alaternus*	.	.	.	.	.	.	.	.	.	.	1	1	1	+	.	.	2	1	.	.	1	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
	Armerio denticulatae-Alyssetum bertoloni	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Galium corrudifolioum*	+	1	+	+	+	+	+	+	+	+	.	.	.	.	.	1	1	+	+	+	.	.	.	.	.	.	+	.	+	+	r	r	.	.	.	+	+
c	*Trinia glauca*	+	r	1	.	+	+	.	+	+	1	.	.	.	.	.	r	+	+	+	.	r	.	+	r	.	.	.	.	.	+	.	.	.	.	.	+	.
c	*Festuca robustifolia*	1	1	1	+	+	1	2	1	1	1	.	.	.	.	.	.	1	.	1	1	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	1	.
c	*Festuca inops*	1	1	1	1	1	1	2	1	.	1	.	.	+	+	.	1	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Dorycnium hirsutum*	+	r	.	.	r	.	+	+	+	+	.	+	.	.	+	.	.	r	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	+	+
c	*Centaurea aplolepa* ssp. *carueliana*	r	+	.	.	r	r	1	1	1	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+
c	*Thymus acicularis* var. *ophioliticus*	.	+	.	+	+	1	1	+	+	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+
c	*Stachys recta* ssp. *serpentini*	+	1	.	+	+	r	+	1	.	.	.	.	.	.	.	r	r	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Potentilla hirta*	+	+	.	.	.	.	+	+	+	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Plantago holosteum*	.	.	.	.	.	+	1	+	1	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.
c	*Linum trigynum*	.	r	.	+	r	r	.	.	.	+	.	.	.	.	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Helichrysum italicum* ssp. *italicum*	.	+	.	+	+	+	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Alyssum bertolonii*	.	+	.	.	.	+	1	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
c	*Dianthus sylvestris* ssp. *longicaulis*	.	.	.	.	r	r	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
c	*Hieracium piloselloides*	r	.	.	.	.	.	.	+	1	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
c	*Teucrium montanum*	.	r	.	.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
c	*Euphorbia spinosa* ssp. *spinosa*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	1
c	*Convolvulus cantabrica*	.	.	.	.	r	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Viburno tini-Quercetum ilicis ericetosum arboreae	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
b	*Phillyrea latifolia*	2	2	3	2	2	2	1	2	1	2	2	2	1	2	1	1	.	2	2	2	2	2	2	2	2	2	2	3	2	1	4	2	3	1	+	1	1
b	*Quercus ilex*	3	2	4	2	2	.	1	1	2	2	2	2	.	.	2	2	1	3	1	2	2	2	2	2	3	3	3	3	3	3	2	3	3	3	2	2	2
b	*Erica arborea*	2	1	1	1	2	2	+	1	.	+	2	2	2	2	2	1	2	2	1	1	.	.	2	1	+	1	2	2	1	2	1	1	2	1	1	.	2
b	*Arbutus unedo*	1	1	2	.	+	.	+	2	1	1	1	2	1	1	3	1	1	1	+	.	.	.	2	2	+	1	1	2	3	2	4	2	3	1	3	3	2
b	*Erica scoparia*	2	2	.	.	.	.	1	2	+	.	1	1	.	.	1	.	2	.	2	2	2	2	3	3	1	2	2	1	1	1	1	1	.	+	1	2	2
b	*Smilax aspera*	+	.	.	.	.	.	+	1	+	.	.	1	+	.	+	.	+	+	.	2	1	1	1	.	.	.	1	+	1	+	2	+	+	+	+	+	+
b	*Fraxinus ornus*	+	.	+	.	1	.	.	.	.	1	+	+	.	.	.	.	.	.	1	2	1	1	2	2	.	.	.	.	.	.	1	2	2	2	2	1	1
c	*Rubia peregrina*	1	.	1	.	.	.	.	.	1	.	.	.	.	.	+	.	+	+	.	+	.	r	+	.	.	.	1	+	2	.	+	+	+	+	.	+	Z
b	*Lonicera implexa*	+	+	+	.	.	.	.	+	+	+	r	.	.	.	.	+	+	1	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.
b	*Viburnum tinus*	+	.	+	.	.	.	.	.	.	.	1	2	+	1	+	+	.	.	.	+	.	.	1	.	.	+	.	.	.	+	.	r	r	.	1	.	.
c	*Cyclamen repandum*	.	r	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	.	.	.	.	.	+	+	+	.	+	1	1	2	1	1	.	.
c	*Carex flacca Schreber*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	+	+	+	+	+	.	.	.	.	.	.	1
c	*Stachys officinalis*	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	+	+	+	r	+	.
b	*Ruscus aculeatus*	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	1	.	.	.	.	.	.	.	+	+	+	1	.	.
b	*Clematis flammula*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
	Other species	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Bromus erectus*	1	2	1	4	2	2	1	3	+	+	+	+	1	1	.	2	2	2	2	2	+	+	+	+	.	.	.	+	1	3	.	.	.	.	.	3	2
b	*Cistus salvifolius*	2	1	+	1	3	2	2	2	1	1	.	.	1	.	.	1	.	1	1	.	.	.	+	1	.	+	.	+	.	1	.	.	.	.	.	+	+
b	*Genista januensis*	1	1	+	+	1	+	1	.	.	1	.	.	.	.	.	+	+	r	+	+	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.
c	*Brachypodium rupestre*	.	.	1	.	.	.	.	.	.	.	r	.	.	.	+	.	1	2	.	.	.	.	.	.	.	1	.	1	.	.	2	1	+	1	1	2	2
b	*Asparagus acutifolius*	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	+	r	+	.	.	+	+	.	.	.	.	.	.	+	.	.	.	r	.	.	.	.
c	*Vincetoxicum hirundinaria*	.	.	.	.	.	.	+	.	.	.	r	.	r	.	.	.	+	r	+	.	.	.	+	.	.	.	.	.	.	.	.	r	.	.	.	.	.
b	*Cistus creticus* ssp. *eriocephalus*	.	.	+	.	.	.	.	.	1	1	.	.	.	.	+	1	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Anthericum liliago*	.	r	.	.	.	r	.	.	.	.	.	.	.	.	.	r	r	r	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	+	.
b	*Genista pilosa*	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	1	+
c	*Tanacetum achilleae*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.
c	*Asperula cynanchica*	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r
c	*Hedera helix*	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.
c	*Polygala flavescens*	r	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
b	*Lonicera caprifolium*	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
c	*Knautia arvensis*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
c	*Dactylis hispanica*	.	1	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Filipendula vulgaris*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.
c	*Serratula tinctoria*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.
c	*Viola alba* ssp. *dehnhardtii*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	.
b	*Quercus pubescens*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	1
b	*Sorbus aria*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	2	+	.
c	*Cytinus hypocistis*	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	r	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Centaurium pulchellum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Echium vulgare*	.	r	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Herniaria glabra*	.	.	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Hieracium pilosella*	r	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Lotus corniculatus*	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
c	*Centaurea triunfetti*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	r	.	.	.
b	*Ligustrum vulgare*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.
b	*Cytisus villosus*	+	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Carex hallerana*	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Linum tenuifolium*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Scabiosa columbaria*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Cuscuta epithymum*	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Iberis umbellata*	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Allium sphaerocephalon*	.	.	.	+	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Silene paradoxa*	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
c	*Hypochoeris achyrophorus*	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
c	*Sanguisorba minor*	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.
c	*Tamus communis*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.
c	*Brachypodium sylvaticum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
c	*Koeleria splendens*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
c	*Danthonia alpina*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	2

edo). The small shrub *Genista januensis* was also very abundant. Shrub canopy was not closed and, therefore, the field layer was dense and rich, being characterised both by typical garigue species (*Alyssum bertoloni*, *Centaurea aplolepa* ssp. *carueliana*, *Galium corrudifolium*, *Stachys recta* ssp. *serpentini*, *Thymus striatus* var. *ophioliticus*, *Trinia glauca*, *Dianthus sylvestris* ssp. *longicaulis*, *Galium corrudifolium*, *Dorycnium hirsutum*, *Helichrysum italicum*, *Potentilla hirta*, *Linum trigynum*) and xerophilous perennial grasses (*Festuca inops*, *F. robustifolia*, *Bromus erectus*). This group of plots can be considered as a transitional stage between the garigue and true juniper scrub communities or a mixed vegetation types and therefore it was not typified from a phytosociological point of view.

The plots of the second group (plots 11-24) were sampled in denser juniper scrub communities, in which *Juniperus oxycedrus* ssp. *oxycedrus*, together with the Mediterranean evergreen species (*Quercus ilex*, *Arbutus unedo*, *Phillyrea latifolia*, *Erica arborea*, *Erica scoparia*) formed a closed canopy. Other shrub species were abundant in this group (*Myrtus communis*, *Lonicera implexa*, *Rhamnus alaternus*, *Viburnum tinus*). *Genista januensis* was also frequent in this group. Field layer was reduced both in cover and richness, because of the higher shrub cover, *Bromus erectus* and *Carex humilis* being the most abundant species. The garigue species and the xerophilous graminoids were almost totally absent, being partly replaced by *Brachypodium rupestre* and *Rubia peregrina*. The vegetation of these group has not yet described from a phytosociological point of view. The good floristic characterisation the of this group of plots, well differentiated with respect to the garigues (Chiarucci *et al.*, 1995) and the other groups of relevés reported in table 1, make it possible to identify a new association, named *Carici humilis - Juniperetum oxycedri*. This association can be characterised by *J. oxycedrus* ssp. *oxycedrus*, *Myrtus communis*, *Pistacia lentiscus*, *Rhamnus alaternus* and in the field layer *Carex humilis*. Because of the high presence - and abundance - of the evergreen species of the *Quercion ilicis* this new association can be reffered to this alliance.

The third group of plots (plots 25-37) were sampled in more evolved scrub communities in which *Viburnum tinus*, *Cyclamen repandum* and *Fraxinus ornus* were frequent and abundant, suggesting that this scrub communities are structurally and floristically evolved and represent a transitional stage towards true *Quercus ilex* woods. Because of the abundance of *Erica scoparia* and *E. arborea* the closed scrublands of this group represent a intermediate stage between the *Carici humilis -Juniperetum oxycedri* and the *Viburno-Quercetum ilicis* (Br.-Bl. 1936) Rivas-Martinez 1974 subass. *ericetosum* Mol. 1936. This latter association was reported by many authors along the southern coast of Tuscany (Pignatti & Pignatti, 1968; Arrigoni *et al.*, 1985; De Dominicis *et al.*, 1988) and on ultramafic soils of Tuscany (Marchiori & Tornadore Marchiori, 1977; Chiarucci, 1994, Chiarucci *et al.*, 1998).

CONCLUSION

From the present paper emerged that the juniper scrub communities recently recognised as one of the more evolved natural plant communities of Tuscan ultramafic soils, can be described as a new association, named *Carici humilis-Juniperetum oxycedri*. Because of the abundance of species characteristic of the *Quercion ilicis*, this new association was collocated in this alliance. According to Chiarucci *et al.* (1998) the *Juniperus oxycedrus* ssp. *oxycedrus* scrub communities represent the most evolved natural vegetation type on the xeric slopes and their successional dynamics, towards closed and structured woodland communities, is prevented by nutrient deficiency and periodic reversions caused by special stress factors such as drought. Drought stress may be the driving force for creating gaps in the canopy of this vegetation type which can be occupied by xerophile heliophile plants, such as the serpentine endemics.

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