

A phytosociological study of the *Ostrya carpinifolia* Scop. woods in Sardinia (Italy)

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Abstract

It is here presented a phytosociological study about the *Ostrya carpinifolia* Scop. woods of Sardinia, defining them in synphytosociological, synecological and synchronological terms. The analysis of this vegetation allowed the identification of a new association, named *Cyclamino repandi-Ostryetum carpinifoliae*. Within this association, three subassociations can be identified, the presence of which depends on the pedoclimatic conditions, the floristic composition and the synchronology. The typical subassociation, which can be found in the eastern Tacchi-region, has been named *paeonietosum morisii*, while the subassociation *galietosum scabri* is characteristic of the western part of such region, and the subassociation *fraxinetosum orni* is localised in the southern part of the Golfo di Orosei.

From the synphytosociological point of view, these coenoses represent the head of mesophilous special series, characterising of the subhumid and humid mesomediterranean bioclimatic belts in chain contact with the carbonatic climatophilous main series of Sardinia.

At to the syntaxonomy, we propose to include the above-mentioned formations within the suballiance *Paeonio morisii-Quercenion ichnusae* and alliance *Pino calabrica-Quercion congestae*, referred to the order *Quercetalia pubescenti-petraeae* and to the class *Quercu roboris-Fageteta sylvaticae*.

Key words: *Ostrya carpinifolia*, *Paeonio morisii-Quercenion ichnusae*, phanerophytic vegetation, phytosociology, *Quercu roboris-Fageteta sylvaticae*, Sardinia, synchronology.

Riassunto

Gli autori riportano i risultati dello studio relativo alle cenosi boschive di *Ostrya carpinifolia* Scop. in Sardegna, definendole dal punto di vista fitosociologico, sinfitosociologico, sinecologico e sincronologico.

L'analisi della vegetazione ha permesso di discriminare una nuova associazione denominata *Cyclamino repandi-Ostryetum carpinifoliae*. All'interno della suddetta associazione vengono riconosciute tre subassociazioni che si vicariano in funzione delle condizioni pedoclimatiche, della composizione floristica e della sincronologia. La subassociazione tipica viene denominata *paeonietosum morisii*, si rinviene nella regione orientale dei Tacchi, mentre la subassociazione *galietosum scabri* è caratteristica della porzione occidentale e la subassociazione *fraxinetosum orni* è localizzata nella porzione meridionale del Golfo di Orosei.

Da un punto di vista sinfitosociologico le cenosi rinvenute rappresentano le teste di serie speciali mesofile, in contatto catenale con le serie principali climatofile carbonatiche della Sardegna, caratteristiche dei piani bioclimatici mesomediterraneo subumido e umido.

A livello sintassonomico, si propone l'inquadramento delle suddette formazioni nella suballeanza del *Paeonio morisii-Quercenion ichnusae* e nell'alleanza del *Pino calabrica-Quercion congestae*, riferite all'ordine *Quercetalia pubescenti-petraeae* e alla classe *Quercu roboris-Fageteta sylvaticae*.

Parole chiave: fitosociologia, *Ostrya carpinifolia*, *Paeonio morisii-Quercenion ichnusae*, *Quercu roboris-Fageteta sylvaticae*, Sardegna, sincronologia, vegetazione fanerofitica.

Introduction

The first author who has recorded the occurrence of the hop hornbeam in Sardinia was Piazza: he mentioned *Carpinus Ostrya* L. in his manuscript without specifying the localities where it was found. The manuscript dates back to the second half of the 1700s and it was posthumously published by Terracciano (1914).

In 1827, Moris reported on *Carpinus Betulus* Linn. "in sylvis Arcidano" and later in *Flora Sardo*a (Moris, 1837), he put this name in synonymy with *Ostrya carpinifolia* Scop., although without defining precisely the distribution of the species. Since then, many authors confirmed the occurrence of such species (Parlatore,

1867; Barbey, 1885; Fiori, 1927; Tutin *et al.*, 1964; Pignatti, 1982, Camarda & Valsecchi, 1983; Tutin *et al.*, 1993), although they never specified its distribution on the island. Only Boni (1994) and Loi & Lai (2001) indicated that the species occurs in the area of Montarbu di Seui and in other surrounding areas.

From the phytosociological point of view, to date any author described the hop hornbeam vegetation of Sardinia in a systematic way, but for Arrigoni *et al.* (1996), who in describing the vegetation of the "Azienda Forestale Uatzo" (Central Sardinia), mentioned *Ostrya carpinifolia* in two samples referred to *Asplenio onopteridi-Quercetum ilicis* (Br.-Bl.) Rivas-Martínez 1975 and in the type-sample of *Oenanthe*

pimpinelloidis-Castanetum sativae Arrigoni & Marras 1990 *quercetosum pubescentis* Arrigoni, Di Tommaso, Camarda & Satta 1996.

In Corsica as well, Gamisans (1999) just described two *faciès* with *Ostrya carpinifolia* in the subregion of Castagniccia (North-East Corsica), the first one attributed to *Oenantho-Quercetum pubescentis* Boyer *et al.* (1983) and the second one to *Digitalo-Castanetum* Gamisans (1975) 1977.

There are thus no certain data on the distribution and the phytosociological behaviour of these species. For this reason, we decided to undertake a research on the hop hornbeam woods of Sardinia, by means of a multidisciplinary approach including phytogeographic, phytosociological, bioclimatic and pedological investigations.

Materials and Methods

For the vegetation analysis, 18 phytosociological samples were taken according to the method of the sigmatist school of Zurich-Montpellier (Braun-Blanquet, 1951), together with five pedological profiles. The soils were classified according to the U.S.D.A. Soil Taxonomy (Soil Survey Staff, 1998), and the humus forms according to those proposed by Green *et al.* (1993). For the taxonomic classification, the following sources were used: Med-Checklist (Greuter *et al.*, 1984-89), *Atlas Florae Europaeae* (Jalas & Suominen, 1972-1994; Jalas *et al.*, 1996), *Flora Europaea* (Tutin *et al.*, 1964-80; 1993) and *Flora d'Italia* (Pignatti, *op. cit.*), while for the author abbreviations, those of Brummit & Powell (1992) were followed. The syntaxonomic classification has been given according to the third edition of the Phytosociological Nomenclature Code (Weber *et al.*, 2000).

The biological form was verified directly in the field and denoted according to the categories reported in Pignatti (*op. cit.*), based on the classification of Raunkiaer (1934). As to the chorological form, reference was also made to "Le piante endemiche della Sardegna" (Arrigoni *et al.*, 1977-1991), as well as to the monographs used for the taxonomic nomenclature. To simplify the final reading of data, the chorological categories have been grouped in macroforms, according to the proposal of Mossa & Bacchetta (1998).

Bioclimatic analysis is realized in according to Rivas-Martínez *et al.* (1999; 2002a), starting with reference to the thermopluviometric stations scattered in the surveyed territory. The results permitted a classification of macrobioclimate, bioclimate, bioclimatic levels and

their horizons for all coenosis.

All the data were processed by multivariate analysis. starting from the phytosociological samples, a matrix of 18 samples by 59 species was constructed. The ordinal scale indices have been transformed according to Van der Maarel (1979) and Noest *et al.* (1989). This matrix was subjected to a cluster hierarchical classification (Fig. 2), by applying the mean linkage as agglomeration criterion and the percentage difference as resemblance coefficient a quantitative data (package SYN-TAX 5.1; Podani, 1997). Moreover a pca-scatter diagram according to the first two axes has been performed on the same data set and following an ordering (Fig. 3) according to pca (CANOCO 4.0; Ter braak, 1998).

Results

The present study lets to confirm the occurrence of *Ostrya carpinifolia* within the territories of Montarbu di Seui and the revealed three new cites (Fig. 1) in the areas

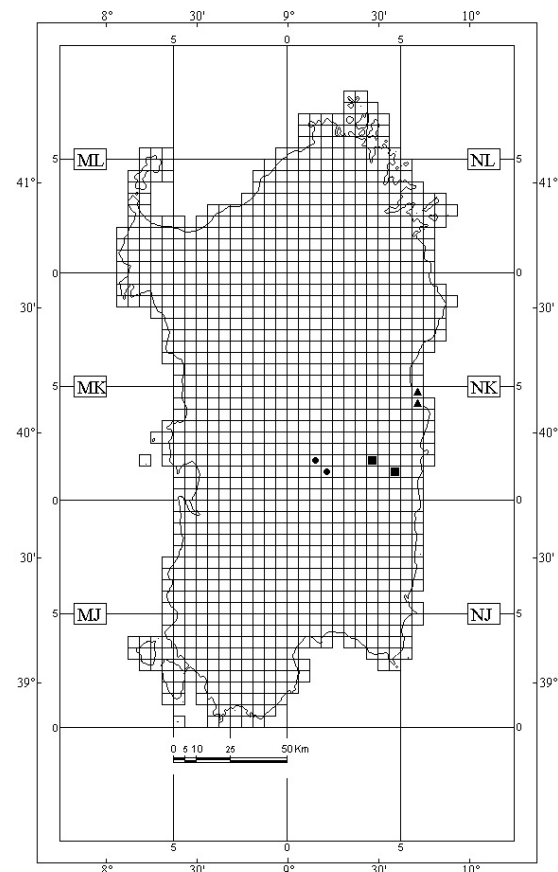


Fig. 1 - Distribution range of *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova (*paeonietosum morisii* subass. nova = ■; *galletosum scabri* subass. nova = ●; *fraxinetosum orni* subass. nova = ▲)

of Ispuligidenie in the Golfo di Orosei (Baunei, NU), Osini (NU) and Laconi (NU).

The multivariate analysis, together with the floristic-sociological investigation, lets to identify an association, within which it is possible to distinguish three main groups (A, B and C) that can be differentiated at the

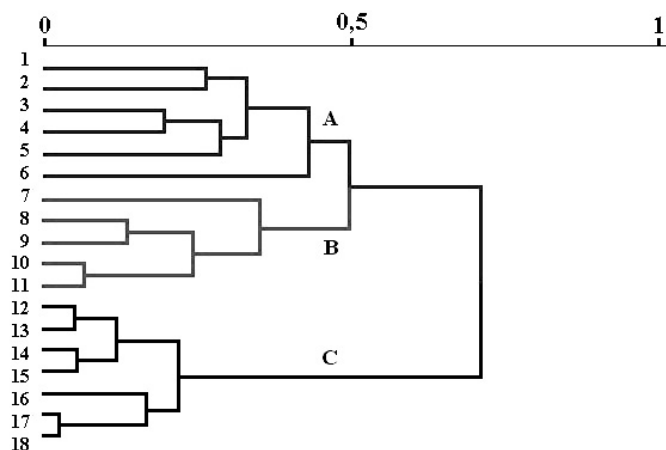


Fig. 2 - Cluster hierarchical classification, applying mean linkage and percentage difference to the quantitative data (A=*Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *paeonietosum morisii* subass. nova; B=*Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *galietosum scabri* subass. nova; C= *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *fraxinetosum orni* subass. nova)

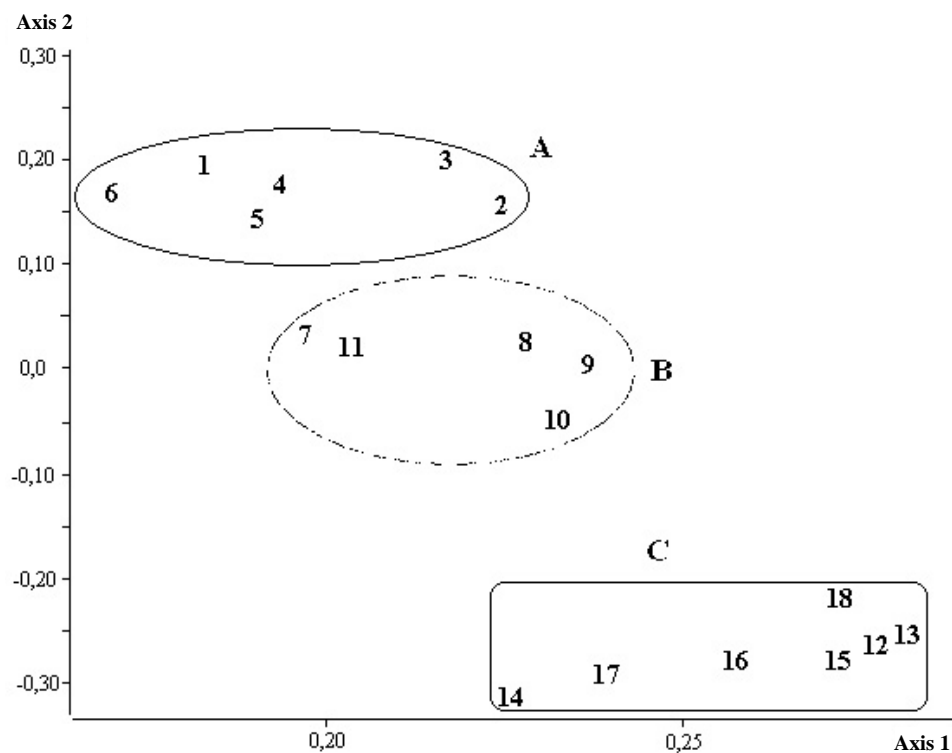


Fig. 3 - PCA scatter diagram (A=*Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *paeonietosum morisii* subass. nova; B=*Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *galietosum scabri* subass. nova; C= *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *fraxinetosum orni* subass. nova)

level of subassociations from the floristic, structural and ecological points of view. There are here reported the diagnosis of the *syntaxa*, the phytosociological table with the samples listed according to the results of the multivariate analysis (Tab. 1), a map of the distribution of the coenoses (Fig. 1), and the profiles of the soils associated with each of the described subassociations (Fig. 4, 5 and 6).

CYCLAMINO REPANDI-OSTRYETUM CARPINIFOLIAE ass. nova hoc loco (holotypus ass.: rel. 3, Tab. 1)

paeonietosum morisii subass. nova hoc loco (holotypus subass.: rel. 3, Tab. 1)

Tab. 1, rels. 1-6

Pedological profile 1 (Fig. 4)

SYNONYMS: Any previously described *syntaxon* for Sardinia and the surrounding territories has been found to which the association at issue and the relative typical subassociation can be referred.

STRUCTURE: Mesoforests on overage 16 to 20 m high, dominated by deciduous broad-leaved trees, and secondarily by lauriphylls and sclerophylls with a sparse shrubby layer and an open herbaceous layer mainly formed by scapose or caespitose hemicryptophytes and rhizomatose geophytes.

Tab. 1 - Phytosociological table of *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova

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CHARACTER TAXA: *Ostrya carpinifolia* and *Cyclamen repandum*.

DIFFERENTIAL TAXA OF THE SUBASSOCIATION: *Acer monspessulanum*, *Paeonia morisii*, *Hieracium oliastreae* and *Aquilegia nugorensis*.

HIGH FREQUENCY TAXA: *Taxus baccata*, *Quercus ilex*, *Ilex aquifolium*, *Viola alba* ssp. *dehnhardtii*, *Hedera helix* ssp. *helix*, *Clematis vitalba*, *Ruscus aculeatus*, *Polystichum setiferum* and *Brachypodium sylvaticum*.

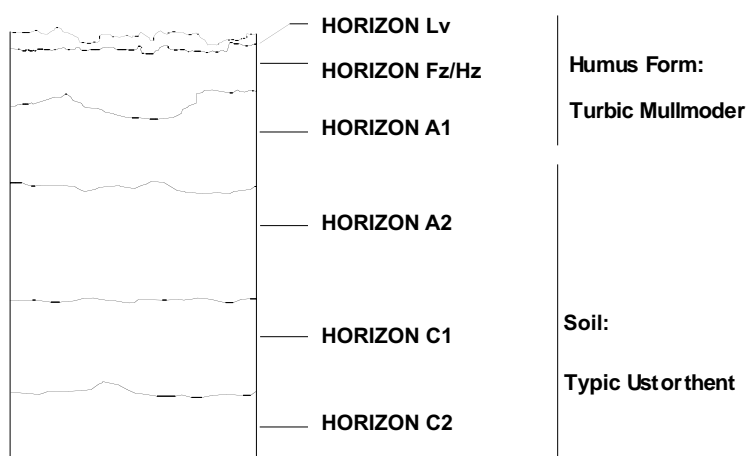
SYNECOLOGY: Mesophilous woods found between 945 and 1160 m of altitude on carbonatic substrata derived from Mesozoic limestone of the Triassic era. They generally as well detritus layers and slope deposits, sometimes silicified, preferably N-facing and from 15° to 45° sloping. The soils on which they grow are deep from subalkaline to neutral, with a skeleton from 8% to 70%, well drained and with high humification rate. The organic horizons are up to 9 cm deep, have sharp limits and an Lv-Fz/Hz sequence and are classified as Turbic Mullmoder. The inorganic horizons are in most cases more than 50 cm deep, with an A₁-A₂-C₁-C₂ sequence and are classified as Typic Ustorthent. From the bioclimatic point of view, they are found in a mediterranean pluvisesonal oceanic contest, in thermotypic and ombrotypic conditions between the upper mesomediterranean lower humid and the lower suprasediterranean upper humid, the former being the optimal bioclimate.

SYNDYNAMICS: These woods represent the head of the mesomediterranean upper humid, calcicole, mesophilous special series of Central Sardinia. The degradation

layers attributable to the *Pruno-Rubion ulmifolii* O. Bolòs 1954, while the herbaceous edges are generally made of semi-shaded perennial phorb communities that can be included in the class *Trifolio-Geranietea* Müller 1962. The chain contacts are with the meso-suprasediterranean, calcicole, climatophilous mesoforests of *Acero monspessulani-Quercu ilicis sigmetum* and with the suprasediterranean edaphoxerophilous microforests of *Junipero nanae sigmetum*.

SYNCHOROLOGY: Coenosis endemic to Central-Eastern Sardinia, found only in the eastern Tacchi-region (Fig. 1). Widely diffuse on Monte Tonneri (Seui – NU) and on Tacco di Osini (NU). Particularly abundant in the following resorts: Sa Scala 'e sa Marra, Fundu de Tonneri, Muragessa and Accu Ermolinus in the municipality of Seui (NU) and in Pizzu 'e Taccu in the municipality of Osini (NU). The high occurrence of species endemic to the Tacchi-region confirms that this subassociation is endemic.

VARIABILITY: The coenosis has little variability, usually induced by the post human exploitation of these woods. Coppicing lasted until a few years ago, limiting greatly the development of this association and often favouring the penetration of edge-species. In the places where rain-water flows, even if only temporarily, the coenosis becomes enriched in many mesohygrophilous endemic taxa, such as: *Hypericum hircinum* ssp. *hircinum*, *Carex microcarpa*, *Borago pygmaea* and *Euphorbia amygdaloides* ssp. *arbuscula*.



**CYCLAMINO REPANDI-OSTRYETUM
CARPINIFOLIAE ass. nova**

galietosum scabri subass. nova hoc loco
(holotypus subass.: rel. 9, Tab. 1)

Tab. 1, rels. 7-11

Pedological profile 2 (Fig. 5)

STRUCTURE: Micro-mesoforests on overage from 8 to 12 m high, dominated by deciduous broad-leaved trees and secondarily by lauriphylls and sclerophylls, with a fairly thick shrubby layer and an herbaceous layer mainly formed by geophytes and hemicryptophytes.

DIFFERENTIAL TAXA OF THE SUBASSOCIATION: *Galium scabrum*, *Tamus communis*, *Malus sylvestris*, *Monotropa hypopitys* and *Digitalis purpurea* var. *gyspergerae*.

Fig. 4 - Pedological profile of *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *paeonietosum morisii* subass. nova

HIGH FREQUENCY TAXA: *Phillyrea latifolia*, *Viburnum tinus*, *Rubus ulmifolius* and *Sanicula europaea*.

SYNECOLOGY: Mesophilous woods found between 700 and 975 m a.s.l. on carbonatic substrata derived from travertines. They generally dwell many-layered travertine deposits, preferring northern or western exposures and sloping an angles between 5° and 40°. The soils on which they grow vary from alkaline to subalkaline, up to 90 to 100 cm deep, with a skeleton from 5% to 20%, slow drainage in the deepest horizons, having a low humification rate. The organic horizons are up to 5 cm deep, have sharp limits and an Ln/Lv-Fz-Hz sequence, and are classified as Calcic Mullmoder. The inorganic horizons are in most cases more than 50 cm deep, with a A-Bkm-BkC-C sequence, and are classified as Petrocalcic Calciustept. From the bioclimatic point of view, they are found in a mediterranean pluvisessional oceanic contest, in thermotypic and ombrotypic conditions between the upper mesomediterranean upper subhumid and the upper mesomediterranean lower humid, the latter being the optimal bioclimate.

SYNDYNAMICS: These woods represent the head of the upper mesomediterranean humid, calcicole, mesophilous special series of Central Sardinia. The degradation layers are attributable to the *Pruno-Rubion ulmifolii*, while the herbaceous edges are generally made of perennial grasses and therophytes that form coenosis which can be included in the class *Trifolio-Geranietea*. The chain contact are with the mesomediterranean, edaphic indifferent, climatophilous microforests of *Prasio majoris-Quercus ilicis sigmetum* and with the mesomediterranean, edaphoxerophilous, microforests

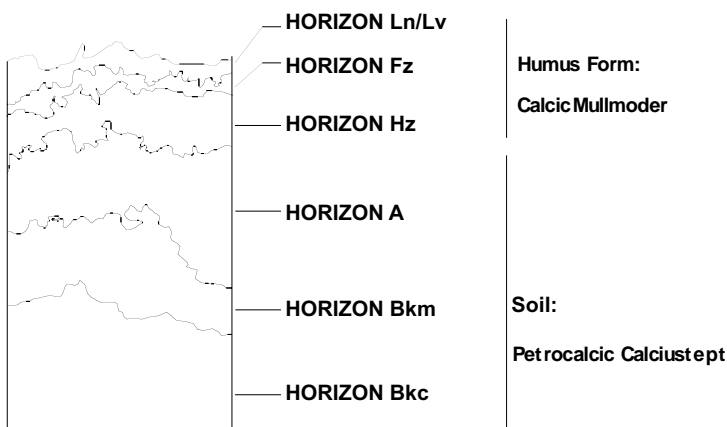


Fig. 5 - Pedological profile of *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *galietosum scabri* subass. nova

of *Pistacio lentisci-Junipero oxycedri sigmetum*.

SYNCHOROLOGY: Coenosis endemic to Sardinia, currently found only in the Tacchi-region, especially in the western part (Fig. 1). Widely diffuse in the Sarcidano area and in particular in Laconi (NU). It occurs the following resorts: Lattinazzu, Tanca di Cuccuru and Funtana Taone in the municipality of Laconi (NU), it also occurs in the travertine zones along the valley floors and at the foothill of Monte Tonneri (Seui – NU). In comparison with the typical subassociation, this one is poorer in endemics exclusive of the Tacchi-region, and for this reason it may be possibly found also in other areas of Sardinia.

VARIABILITY: The coenosis as a little variability, usually linked to the typology of the travertine substrata. When these are many-layered, gently sloping and water-filled during most of the year, and in particular the forests are more dense and very rich in mesohygrophilic species. In the past, these formations have also been heavily cut, both for the quick recovery and rapid growth of the hop hornbeam, especially in the areas at the valley bottoms that are rich in water.

CYCLAMINO REPANDI-OSTRYETUM CARPINIFOLIAE ass. nova

fraxinetosum orni subass. nova hoc loco (holotypus subass.: rel. 14, Tab. 1)

Tab. 1, rels. 12-18

Pedological profile 3 (Fig. 6)

STRUCTURE: microforests on overage 7 to 12 m high, dominated by deciduous broad-leaved trees and by sclerophylls, with a medium dense shrubby layer and an almost absent herbaceous layer.

DIFFERENTIAL TAXON OF THE SUBASSOCIATION: *Fraxinus ornus*.

HIGH FREQUENCY TAXA: *Quercus ilex*, *Viburnum tinus*, *Smilax aspera* and *Rubia peregrina*.

SYNECOLOGY: Mesophilous microforests found between 200 and 520 m a.s.l., on carbonatic substrata derived from Jurassic-Cretaceous dolomitic limestones. They generally grow on paleo-rockfalls exclusively on very steep N-facing with a dip-angle between 30° to 50°. The dwelled soils are from alkaline to subalkaline, not very deep (maximum 30 cm), with a skeleton from 75% to 99%, and a rapid drainage. The organic horizons are up to 11 cm deep, have sharp limits, a Ln-Lv-Fa-Ha sequence and, can be classified as Clastic Mormoder. The inorganic horizons are in most cases less than 30 cm deep, with an A/C-C sequence, and are classified as Lithic Xerorthent.

From the bioclimatic point of view, they are found in a mediterranean pluvisessional oceanic contest, in thermotypic and ombrotypic conditions between the lower mesomediterranean lower subhumid and the upper mesomediterranean upper subhumid, the former being the optimal bioclimate.

SYNDYNAMICS: These woods represent the head of the lower mesomediterranean subhumid, calcicole, mesophilous, special series of Central-Eastern Sardinia. The degradation series is formed by shrublands referable to *Ericion arboreae* (Rivas-Martínez ex Rivas-Martínez, Costa & Izco 1986) Rivas-Martínez 1987, by garigues of *Teucrium mari* Gamisans & Muracciole 1985 and by grasslands of *Thero-Brachypodium retusi* Br.-Bl. 1925. The chain contact are with the mesomediterranean, calcicole, climatophilous microforests of *Prasio majoris-Quercus ilicis sigmetum* and with the thermomediterranean, edaphoxerophilous microforests of *Oleo sylvestris-Junipero turbinatae sigmetum*.

SYNCHOROLOGY: Coenosis currently only found in the Golfo di Orosei, mostly along the coastal trait between Cala Sisine in the north and Cala Goloritzè in the south (Fig. 1), particularly at the foot of the cliffs of Ispuligidene and Bacu Mudaloro (Baunei - NU).

VARIABILITY: The coenosis as a very little variability and bears remarkable ecological, floristic and structural differences from the above-described formations. It grows off the beaten tracks and for this reason there are only few, if any, traces of the past coppicing.

NOTES: With respect to these above-described coenoses, the low presence of elements referable to the class *Quercus roboris-Fagetea sylvaticae* Br.-Bl. et Vlieger in Vlieger 1937 should be noted, as well as a noteworthy floristic dearth, well testified by the very low (8.5) average number of species.

thy floristic dearth, well testified by the very low (8.5) average number of species.

Syntaxonomy

From the syntaxonomic point of view, the *Cyclamino repandi-Ostryetum carpinifoliae* can be ascribed to the Corso-Sardinian endemic alliance of *Paeonio morisii-Quercion ichnusae*. Indeed, most of the plants associated with the coenosis at issue are either character species of *Quercus roboris-Fagetea sylvaticae* or endemics and subendemics remarkably interesting in their phytogeography and distribution range. From a physiognomic-structural point of view, it should be emphasized that they are almost always mesoforests in which sclerophylls and lauriphylls are always subordinate with respect to the deciduous broad-leaved trees.

On the basis of these considerations, and in agreement with Rivas-Martínez *et al.* (2001; 2002a and 2002b) and the grouping proposed by Bacchetta *et al.* (2004), in the following scheme suballiance *Paeonio morisii-Quercion ichnusae* and alliance *Pino calabricae-Quercion congestae* has been included in the order *Quercetalia pubescenti-petraeae* and in the class *Quercus roboris-Fagetea sylvaticae*.

QUERCUS ROBORIS-FAGETEA SYLVATICAE Br.-Bl. et Vlieger in Vlieger 1937

QUERCETALIA PUBESCENTI-PETRAEAE Klika 1933

Pino calabricae-Quercion congestae Brullo, Scelsi, Siracusa et Spampinato 1999

Paeonio morisii-Quercion ichnusae Bacchetta, Biondi, Farris, Filigheddu et Mossa 2004

Cyclamino repandi-Ostryetum carpinifoliae ass. nova

paeonietosum morisii subass. nova

galietosum scabri subass. nova

fraxinetosum orni subass. nova

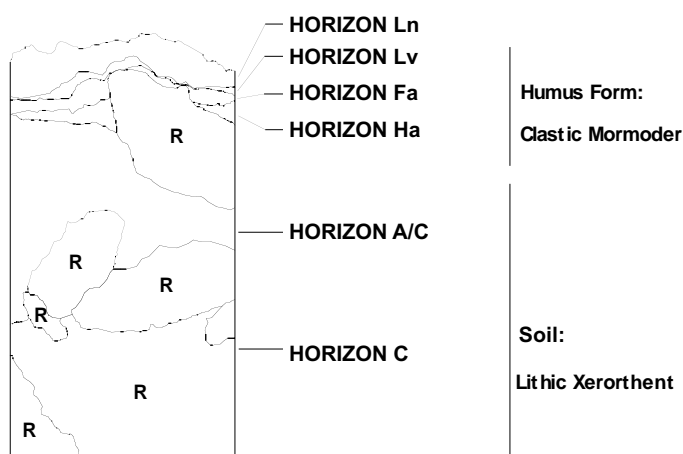


Fig. 6 - Pedological profile of *Cyclamino repandi-Ostryetum carpinifoliae* ass. nova *fraxinetosum orni* subass. nova

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Location and sampling data

Rel. 1, 2, 3, 4, 5, 7: Monte Tonneri (Seui, NU), 08.06.2001; rel. 6: Sa Scala 'e sa Marra (Seui, NU), 09.06.2001; rel. 8: Tra Funtana Taone e Latinazzu (Laconi, NU), 23.04.2002; rel. 9: Latinazzu (Laconi, NU), 11.11.1997; rel. 10, 11: Tanca di Cuccuru (Laconi, NU), 23.04.2002; rel. 12, 13, 16: Ispuligidenie (Baunei, NU), 06.07.1996; rel. 14, 15, 17: Ispuligidenie (Baunei, NU), 03.05.1997; rel. 18: Ispuligidenie (Baunei, NU), 06.09.1996.

Sporadic species

Rel. 1: *Sorbus aria* (L.) Crantz ssp. *aria* (+), *Viola riviniana* Reichb. (+), *Mycelis muralis* (L.) Dumort. (+); rel. 2: *Pteridium aquilinum* (L.) Kuhn (+); rel. 3: *Moehringia pentandra* Gay (+); rel. 6: *Cephalanthera longifolia* (L.) Fritsch (+), *Potentilla reptans* L. (+), *Vincetoxicum hirsutinaria* Medikus ssp. *contiguum* (Koch) Markgraf (+),

Mentha insularis Req. ex Gren. et Godr. ssp. *insularis* (+), *Juniperus communis* L. ssp. *nana* Syme var. *corsicana* (+); rel. 7: *Rhamnus alpina* L. ssp. *alpina* (+); rel. 8: *Silene alba* (Mill.) Krause (+); rel. 9: *Helleborus lividus* Aiton ssp. *corsicus* (Briq.) P. Fourn. (+); rel. 10: *Listera ovata* (L.) R. Br. (+); rel. 11: *Juniperus communis* L. ssp. *communis* (+); rel. 14: *Polypodium cambricum* L. ssp. *serrulatum* (Sch. ex Arcang.) Pichi-Serm. (+).