SPONTANEOUS RENATURALIZATION PROCESSES OF THE
VEGETATION IN THE ABANDONED FIELDS (CENTRAL ITALY)

EDOARDO BIONDI, SIMONA CASAVECCHIA, SIMONE PESARESI

Dipartimento di Scienze Ambientali e delle Produzioni Vegetali (SAPROV) – Polytechnical
University of Marche, via Brecce Bianche I-60131 Ancona.

ABSTRACT – Some methodologies utilised for the analyses, with different scales, carried out in the
study of the renaturalisation processes that determine in the territories that are not more utilised
for agro-pastoral practices, are here described. In fact, during the last fifth teen years a progressive
process of abandonment of the hilly and mountain territories, not more economically remunerative
according to the present technological and market requests, have taken place. Therefore, in these
territories, quick recovery processes by spontaneous vegetation are developing, having a
great scientific and applicative importance, these processes caused, as result, a deep transforma-
tion of the plant landscape. These processes have been studied through the methodologies of the
phytosociological, synphytosociological and geosynphytosociological analyses in order to inter-
pret the dynamic successions and to predict the time for the recolonisation according to diachron-
ic studies associated to population dynamic analyses. To these studies are connected analyses on
the architectural model of growth of Spartium junceum, species particularly active in the vegeta-
tion recovery processes, that have been carried out in Central Italy territories. These analyses
allow a better comprehension of the role of this species.

KEY WORDS – Diachronic analysis, geosynphytosociology, plant landscape, population dynamics, veget-
etation series.

INTRODUCTION

The phenomenon of the “economic marginalization” that has progressively
affected larger areas of Italian agricultural territory since the war has become evi-
dent through the abandonment of the agro-pastoral practices that for centuries have
been the form of management for these areas. The statistical data show how in just
the central and southern regions of Italy the agricultural area in use has suffered a
reduction of around 2.1 million hectares, of which at least 1.8 million is in the hills
and mountains. The reasons for this abandonment are to be found essentially in the
changed socio-economic conditions of the Italian population, having many causes
and evident also at the community and extra-community level, that have resulted in the depopulation and the consequent loss of rurality of the Apennine population. This transformation process has led to the need to verify the "sustainability" of the affected areas, that has to be thought of both in environmental terms as much as in economic and demographic ones.

To assess the first aspect, that of the environment, it is of fundamental importance to understand what level of influence man has had on the natural ecosystems, and thus to understand the difference between the original state and the present. Such a valuation is certainly not easy to perform because of the lack of certain knowledge of the model of the potential landscape, the identification of which can be attempted through the integrated analyses of the historic series regarding the variations in space and time of environmental situations and the impact of man. It is anyway possible to put forward hypotheses that are in the majority absolutely generic, as they are mainly limited to the structure of the landscape. The scholars of the vegetation have for a long time argued over the concept of climax vegetation and therefore the potential plant landscape. It is thought anyway that the potentiality to which it is possible to refer to in concrete terms is only the actual one, that is the one that is realized or which is predictable to be realized in the near future in the territory under consideration, that having been profoundly transformed by human activities will not ever return to the original conditions (Biondi et al. 2001b).

The variations occurring in the agricultural, timbering and shepherding landscape, immediately perceptible with a simple observation (Fig. 1), allows us to discover a regenerative capacity in the natural processes that occurs on an unforeseen time-scale, significantly shorter than that hypothesised. What will be the scenario that will be reached in the hill and mountain landscapes, outside of the large centres of agricultural production, in the next few years? Will the new environmental equi-

![Figure 1 - An example of abandoned fields invaded by the shrubbery of common broom (Spartium junceum) in the hilly bioclimatic belt of the Umbria-Marche Apennines.](image-url)
libria produce better stability or, on the contrary, result in hydrogeological ruin? In what way must one intervene to guide the natural processes that are developing? To adequately answer these questions, that are only a part of those legitimately proposable, it is first of all necessary to have a solid basis of the knowledge of the processes, indispensable for carrying out the planning of the renaturalization of the landscape. Indeed, it is inconceivable not to have plans regarding such an important part of the national territory, that is so deeply involved in transformation processes. For a country with such a high population density as Italy, it is necessary to define the significance of the conservation of nature in terms of planning strategy. It is also necessary to define the role of man in the planning and reconstruction of the biological equilibria, taking into account that human activity has not always resulted in a reduction of biodiversity, but in very many circumstances has notably increased it, as with the traditional agricultural, timbering and shepherding activities. It must therefore be considered that the abandonment of such practices induces transformations that we must guide and evaluate for their true significance.

MATERIALS AND METHODS

In order to study the dynamic processes of naturalisation that are the major responsible in the transformation of the hilly and mountain plant landscape, the analysis were carried out through the approaches that are described below.

a. Phytosociological, synphytosociological and geosynphyosociological approaches
   They consist in the application of the Braun-Blanquet method in the study of the plant communities and the integrated methodologies for the individuation of the vegetation series and the description of the landscape models (Géhu & Rivas-Martínez, 1981; Biondi, 1995, 1996; Géhu, 1988; Rivas-Martínez, 1987; Blasi et al., 2001; Theurillat, 1992).

The phytosociological investigations performed on the abandoned territories have led to the individuation of integrated dynamic models of the landscape, the interpretation of the plant landscape for the individuation of the landscape units (geosigmetas) and the recognition of the role of the most active species in terms of the vegetation recovery.

b. diachronic analyses
   This kind of analysis was carried out through the utilisation of several series of old air photographs belonging to different period in order to observe the transformation of the landscape in time and to evaluate the time necessary for the establishment of the succeeding phases and the modalities of colonisation, allowing the interpretation of the environmental response to the processes of abandonment and the prediction of its evolution (Biondi et al., 2000).

c. Autoecological studies
   These studies were conducted on the interpretation and the description of the architectural models of growth (Oldeman, 1979, 1990; Champagnat, 1947) and the mechanism of recolonisation (Ballerini et al., 2002) carried out by some species, such as Spartium junceum, that are particularly active in these process-
es. Moreover, population dynamics studies, carried out on permanent plot occupied by shrub population (*Juniperus oxycedrus*, *J. communis* and *Spartium junceum*) for the evaluation of space occupancy and their evolution in the time. This allows to imagine various future scenarios that are not at present known (Baldoni *et al*., 2004).

d. plant landscape maps

The maps of the plant landscape were realised with the support of GIS methodologies which allows, at the same time, to insert all the information in an archival system of the GIS data for the production of a database that can be queried. The “plant association” attribute is assigned to each polygon that comes from the field phytosociological analyses. In this way, a computer-based vegetation map is obtained with different details according to the scale (Biondi *et al*., 2005).

RESULTS AND DISCUSSION

*Phytosociological, synphytosociological and geosynphytosociological investigations*

The phytosociological investigations performed on the abandoned territories have led to the individuation of integrated dynamic models of the landscape that in some cases have also considered the time necessary for the establishment of the succeeding phases, allowing the interpretation of the environmental response to the processes of abandonment and the prediction of its evolution. The role of the most active species in terms of the vegetational recovery has also been noted and emphasised through investigations of the demographic and autoecological aspects.

In recent years, research into the dynamism of the vegetation has been added to that of the so-called classical phytosociology. While the latter represents the first level of analysis of the vegetation that is focused on the recognition of the associations, the former belongs specifically to the integrated phytosociology, or sin-phytosociology that has resulted in the definition of the series (or sigmetum) of vegetation. This is made up of the collection of all the associations (communities) linked by dynamic connections that occur in a homogeneous space with the same vegetation potentialities: the “tessella” or “tessera”, which represents the starting biogeographical/environmental unit of the mosaic making up the vegetal landscape. The investigations at this last level of analysis are achieved through the phytosociology of the landscape, or the geosinphytosociology, within which the vegetation series make up self-repeating groups in a homogeneous territory for geomorphological, climatic and vegetational characteristics. These groups are termed the geosigmeta within which a climatophilous series and at least two climatophilous series can be determined. The first grows on the soil that only receives water from precipitation, while the edaphophilous series can be edapho-hygrophilous, on the land with a greater availability of water, and edapho-xerophilous, that is found in particularly dry situations with respect to the average conditions of the area (Géhu & Rivas-Martinez, 1981; Biondi, 1995; Géhu, 1988; Rivas-Martinez, 1987; Theurillat, 1992). The model is a simple one of a valley where on its defining slopes there is the climatophilous series, while in the areas where there is no soil or where the soil has been eroded to uncover the rocks, the edapho-xerophilous series is established; on the
other hand, in the central area at the base of the valley, where the water courses run and where the substratum is anyway more humid with respect to the other areas, the edapho-hygrophilous series can be found. With the integration between the dynamic series of vegetation and soil or biomass typologies, complex units of the vegetal landscape are found (Fig. 2) that make up integrated models of great predictive value (Biondi, 1995; 1996; Biondi et al., 1999; Venanzoni & Kwietkowski, 1996).

In the vegetation series, the number of associations of which it is made can vary notably either for the natural conditions or for the effect of the type of management used. It is indeed man that through the use of the territory determines the major presence of the vegetal community inside the vegetation series. In this, as a function of the human influence, it is possible to recognize: more or less natural communities, like the woods; stable semi-natural communities, like for example the perennial grasslands that maintain the same characteristics as long as they are managed in the same way; or unstable, or of brief duration and rapid evolution, semi-natural communities, like the weeds in the fields.

The landscape interpretations expressed by the sygygma and geosygygma are based upon these concepts. They constitute dynamic models with a high ecological value as they are defined through the statistical combination of species that repeat themselves in the territory with respect to the environmental characteristics represented by the interaction of the ecological factors to which the communities are sensitive. From the distribution of the vegetal associations it is consequently possible to recognize zones homogeneous for a complex of physico-chemical, biological and anthropic factors, that taken together outline a hyperspace, constituting the ecological niche of the community, defined by the needs of the plant population present in the territory.
This logical route, essentially deductive, has been validated by recent researches through statistical correlations between floristic compositions of a community and quantitative analytical data, of the pedalogical and biomass factors, that have resulted in the quantification of the concept of ecological valency of associations and in the description of the coenoclines on the basis of which the vegetation series are distributed in the geosigmetum composition (Biondi & Zuccarello, 2000; Zuccarello et al., 1999; Andreucci et al., 2000; Biondi et al., 2001a).

Phytosociological research in the study of the vegetation of Central Italy has allowed the individuation of the main series present that have been analysed in detail, especially in some areas for which the institution of parks and natural reserves has allowed and requested particularly detailed studies.

The landscape of the Marche hills, outside of the Apennines, in the Provinces of Ancona (Biondi & Allegrezza, 1996) and Ascoli Piceno (Allegrezza et al., 2006), as for example in the area of Offagna (Fig. 3), is mainly made up of deposits of very fine material, the pelites, of the Plio-Pleistocene, rich in clay minerals that alternate with pelitic-arenaceous, arenaceous-pelitic and sandy-conglomerate bodies.

In the summit areas of the same hills there are present, however, banks of sand, more or less cemented, and sometimes conglomerates that can reach a thickness of more than 20 m (Fig. 4).

The plant landscape is directly correlateable with the substrata characteristics. In this way, on the highest sectors of the hills there are good conditions of drainage that result in drought in some periods of the year. Under these conditions the edapho-xerophilous series of the downy oak grows, called Roso sempervirentis-Querco pubescensis sigmetum. For this reason, as is apparent in the photograph of the Municipality of Offagna (Fig. 3), the medieval towns, the villas and the buildings were built mainly in this area, as the rock is sufficiently stable and appropriate for the support of their foundations. On the sides of the hills in which the clays prevail, the more humid substratum allows the growth of the climatophilous series of the hop hornbeam, called Asparago acutifolli-Ostryo carpinifoliae sigmetum.
This is the area in which the appropriate soils prevail for the agriculture that is prevented only where the slope is excessive. On the sides in which the arenaceous-pelitic formations emerge, instead the Turkey oak series of *Lonicero xylostei-Querco cerridis* signetum grows. Finally, in the fall lines and along the ditches, with the constantly wet substratum, the edapho-hygrophilous series of the elm *Symphyto bulbosi-Ulmo minoris* signetum is found (Fig. 5).
In the hilly bioclimatic belt of the Umbria-Marche Apennines, the most representative vegetation series are those of the downy oak (*Peucedano cervariae-Querco pubescentis* sigmetum), that is found mainly in the hilly areas connecting the marly-arenaceous formations, and that of the hop hornbeam (*Scutellario columnae-Ostryo carpinifoliae* sigmetum) present on the calcareous sides of the ridges.

The downy oak series in this area has recently been further defined following the investigations conducted in the woods dominated by this species present in the Central Apennines (AlLEGREZZA et al., 2002) that has allowed their inclusion in the association *Peucedano cervariae-Quercetum pubescentis* and at the same time to specify that the thermophilous association *Roso sempervirentis-Quercetum pubescentis* in the Umbria-Marche Apennines is found only in a few areas of the calcareous ridges, in the hottest aspects on the drained soils.

The leading association is the *Peucedano cervariae-Quercetum pubescentis* that includes the relatively mesophilous oak woods present on the marly-arenaceous, marly and clay-marly soils of the hilly heights of the region, mainly in the internal sectors of the Marche synclinorium, part of the temperate bioclimate, hilly bioclimatic belt and ombrotype from humid to sub-humid. Within the association there is the thermophilous subassociation *ruscetosum aculeati*.

The hop hornbeam series refers to the wood of the association *Scutellario columnae-Ostryetum carpinifoliae* with which two main xerophilous grasslands are linked, those spread on the steep slopes, and the semi-mesophilous distributed on the slightly sloping surfaces (Fig. 6). The dry grasslands belong to the association *Asperulo purpureae-Brometum erecti* while the semi-mesophilous to the association

---

**Figure 6** - Climatophilous series of hop hornbeam that develops in the hilly bioclimatic belt or the calcareous area of the Umbria-Marche Apennines (from Ballelli & Biondi, 1982 redrawn).
Brizo mediae-Brometum erecti. The vegetation mantle that surrounds the woods is made up of formations of the common broom (Spartium junceum) and Coronilla emerus of the association Spartio juncei-Cytisetum sessilifolii. This is present in two aspects, of which one is cooler, extremely close to the woods, and the other heliophilous and pioneer, that invades the fields and the abundant grasslands. The first is composed by Cytisus sessilifolius, Coronilla emerus ssp. emeroides, Spartium junceum and Lonicera etrusca. The pioneer and heliophilous aspects have however different configurations, depending upon the dominant species. In particular, in the cooler areas, placed at higher levels, it is Cytisus sessilifolius that dominates, in contrast in the hotter areas, with soil-poor and rock-rich substrata, Cotinus coggygria and Juniperus oxycedrus are widespread, while the broom is common on the relatively deeper soils.

Particularly meaningful is the role of shrub communities. The evolutionary dynamism of the vegetation linked to the abandonment is most evident in the spreading of high grasses and shrubs that invade the grasslands and fields that are no longer cultivated. This dynamic process takes its origins from an ecosctal space, positioned between the forest and the grassland, that is occupied by an intricate vegetation of shrubs and vines, the mantle preceded by herbaceous formations, the vegetation edge. Both of these phytocoenoses spread when the anthropic activities come to an end, invading the grasslands. The study of this type of vegetation, introduced by Tüxen (1952), for the aspects regarding the shrub vegetation, and by Dierschke, (1974) for those of the herbaceous vegetation, have definitively opened the road to the phytosociology of the landscape, allowing the realization of interpretative models of the dynamics of the vegetation.

Regarding the Italian shrub vegetation, the syntaxonomic revision of the associations of mantles described for the national territory has recently been completed (Poldini et al., 2002). The methodology used is based upon a comparison of the phytosociological tables produced for the Italian territory brought together in one unique matrix of synthetic columns, together with those coming from various European countries, that were then classified using the “similarity ratio” index and the method of complete linkage (Podani, 1993). Once the differential species of the Italian phytocoenoses had been individuated, the same classification operation was repeated with the matrix reduced to the Italian columns only (Fig. 7), to which was applied the theory of the “Fuzzy set” (Feoli & Zuccarello, 1986; 1991; Biondi et al. 2004) that has allowed the interpretation of the level of belonging of the columns to the diverse groups or syntaxa. It has thus been possible to define the revised syntaxonomic description of the Italian shrub vegetation (Table 1).

For the hill areas of Central Italy the pioneer herbaceous plant that is one of the first that spreads after the abandonment, becoming of quantitative importance also at the landscape level, is Brachypodium rupestre. This cespitose grass, provided with long underground runners, results in more or less circular groupings in the initial phases of the colonisation, that then grow and merge forming dense carpets that end up completely covering the terrain abandoned by the agro-pastoral activities (Fig. 8).

This process represents the spreading of the forest edge of vegetation. This stage is followed by the spreading of a shrubbery formation: a vegetation structure with its own morphological and floristic characteristics, dominated by different shrubs, depending upon the climatic and edaphic conditions (Biondi et al., 1988).
Figure 7 - Classification of the 69 Italian associations of mantle (*Rhamno-Prunetea*).


Figure 8 - Picture of an agricultural hilly territory, on the calcareous ridge of the Umbria-Marche Apennines, with various stages of abandonment and recovery of the vegetation. In the upper part, there are remnants of wood, preceded by edges of mantles, and on the slope there are post-cultivation grasslands of *Brachypodium rupestre* (light area in the photograph) and of *Helichrysum italicum* (in grey) that are distributed on the basis of the micromorphology of the slope. In the less steep areas (at the bottom) the terrain is still being cultivated.

In the Marche hill areas there is mainly the common broom (*Spartium junceum*) or the red juniper (*Juniperus oxycedrus*), but sometimes also *Coronilla emerus* or *Cytisus sessilifolius*. 
The shrubs that take over the zones previously colonised by Brachypodium rupestre arise from the vegetation mantle that spreads to occupy the grassland when the anthropic activities cease (Fig. 9). The species that spread and colonise the abandoned terrain are obviously the more heliophilous ones and also the less water-demanding. The shrubbery, while gaining structure, favours in turn the conditions for the establishment of the less demanding pioneer wood plants, such as the flowering ash (Fraxinus ornus), the hop hornbeam (Ostrya carpinifolia) and the downy oak (Quercus pubescens).

Diachronic analyses of the vegetation recovery processes on the abandoned fields

There have been analyses of the Apennine territories occupied by the hop hornbeam series (Biondi et al., 2000) with the aim of identifying the phases of the dynamic processes that are found during the succession, for the definition of the times and the dynamics of the most active populations in the processes of recovery (Biondi, 1990; Canullo, 1992, 1993; Canullo et al., 1992; Ballerini et al., 2000; Ballerini & Biondi, 2002; Ballerini et al., 2002).

This research has been realised in the "permanent areas of study" chosen in a way so as to represent diverse periods of agricultural activity abandonment, and therefore of different naturalisation. The field studies in this area have been integrated with diachronic analyses, obtained through interpretation of past aerial photographs from the years of 1956, 1978 and 1990 (Fig. 10).

It has thus been possible to map the agro-vegetational variation across these years. With this system, it has been possible to quantify the time necessary for the growth of the different dynamic successions that follow different routes depending upon the particular conditions determined by the anthropic activities.

The first part of the diachronic vegetation analyses has allowed the estimation of the time needed for the change from the vegetation infesting the fields to the grassland, of the association Asperulo purpureae-Brometum erecti, making clear also
Figure 10 - Aerial photographs of the area under consideration in the diachronic analyses of the vegetal landscape (in the Locality of Case Meloni, in the Municipality of Fabriano). The top photograph, taken in 1956, shows the area as completely cultivated; in the next, taken in 1978, there is evidence of abandonment and the recovery of the wood on the grazed areas outside of the agricultural zones. In the final photograph, of 1990, the major part of the fields have been abandoned and taken over by the post-cultivation grasslands and by the shrubbery.

through which *facies* the process is realized. The starting situation is represented by the community infesting the cultivation, mainly made up of terophytes belonging to the alliances *Fumario-Euphorbion* (vineyards) and *Caucaoidion lappulae* (seeded and
uncultivated for 1-2 years). Already after 3-4 years from the abandonment, the massive presence of the hemicyrptophytes and geophytes of the order Agropyretalia repens determine the assignment of the vegetation to this latter syntaxon. This condition in the more humid situations can last even for 10 years, before then evolving towards the facies of Brachypodium rupestre of the grassland, of the class Festuco-Brometea, while in the drier situations the evolution towards a facies of Helichrysum italicum can be seen instead. In both cases, in around 40 years the vegetation evolves towards the grassland of the association Asperulo purpureae-Brometum erecti.

The diachronic analyses of the vegetation have also allowed the valuation of the speed and models of expansion of the woods of the association Scutellario columnae-Ostryetum carpinifolii and of the shrubs of the association Spartio juncet-Cytisetum sessilifolii. In the situations in which the evolutive process originates through the dissemination from individuals of forest species, the tree vegetation grows directly on the uncultivated fields constituting, in the first phases, the shrub stage of the secondary succession that evolves towards the wood. This process happens frequently enough in the areas examined, favoured by the depth of the soil of the more-or-less terraced fields.

The forestal or pre-forestal species that have the biggest part in the recolonisation are: Fraxinus ornus, the seeds of which cover distances of many metres from the mother plant; and Quercus pubescens, the acorns of which fall up to a few metres outside the projection of the foliage; meanwhile in the more favourable situations Ostrya carpinifolia also participates in the recolonisation. This process can occur according to the schemes of advancement represented by the frontal and dispersive models. In the frontal model, the dissemination of forestal species starts from a wood front bordering the uncultivated field.

The colonisation by the phanerophytes stops for a number of years a few metres from the edge of the wood because of the absence of vegetative propagation and the long time interval needed for the fruiting of the pioneering plant. The phanerophytes can grow together with the shrubs of the mantle, but prevail on these while they grow, while the species of the mantle establish themselves at the edges of the newly formed pre-wood and advance frontally towards the grasslands (Fig. 11). In the dispersive model the dispersion of seeds comes about from isolated trees; the colonisation on the part of the wood stops for a number of years a few metres away from the disseminating plants and then restarts when the new individuals fruit (Canullo, 1993). The woods that arise from this model constitute pioneering facies within which the nemoral species are little represented (Fig. 12).

The advancement of the wood, over the interval of observation (35 years) was limited to a few metres in the case of Quercus pubescens (ballistic dissemination) while distances of up to 20 m had been reached in the case of Fraxinus ornus and Ostrya carpinifolia (anemochorous dissemination).

In other situations, that in the Apennines are definitely the most frequent as they involve terrain with reduced quantities of soil that is not terraced, the colonisation of the uncultivated fields is carried out by the species of the vegetation mantles, and in particular by Spartium junceum that in the pedoclimatic context that characterises the area under study is the most spread of the pioneering shrubs (Fig. 1). This situation is highly relevant, so much so that it characterises the present-day hill and sub-mountain landscape of the Central Apennines. The process occurs according to
the frontal and nucleation models. The frontal model consists of the ecotonal protrusion of the mantle, that takes over the grassland forming a shrubbery of *Spartium junceum* (according to the dynamic scheme shown in Fig. 9) that spreads mainly by seed and proceeds at a speed of around 2-3 metres/year thanks to the precocity of the fruiting of *Spartium junceum* (Bioni *et al.*, 1997; Bioni *et al.*, 2005)

The trailing edge of the shrubbery, the oldest, is characterised by the regression of the broom that leaves space for the entry of other shrub species of the class *Rhamno-Prunetea*, allowing therefore a better structuring of the vegetation of the mantle. Moreover, other shrub species and some pioneering trees are able to grow under the close cover formed by the broom, exploiting the pedogenic evolution and the humidity of the substratum. Later, the trees take over from the broom plants that survive for a few years, even if dominated, but losing the capacity for maturation of
their fruits. The most active forestal species is *Fraxinus ornus*, that is advantaged by its capacity of anemochorous dissemination. A progressive time and space sequence therefore arises between grassland, shrubbery, mantle, pre-wood and wood that determines the fast recovery of the forestal vegetation. In the model for nucleation, the colonisation by *Spartium junceum* occurs through centrifugal expansion originating from isolated individuals (Fig. 13), as well as by frontal advance starting from the edge of the wood.

It is therefore possible to predict that analogous seed dispersal mechanisms will determine the presence in the area of forestal species such as *Fraxinus ornus*, *Quercus pubescens* and *Ostrya carpinifolia* that will later take over, while the population of broom will collapse partly because it becomes old and partly because it is shadowed by the trees.
Figure 13 - Nucleation model starting from broom bushes (years: 1956, 1978 & 1990); C = cultivated, P = grassland, S = Spartium junceum (from Biondi et al. 1997).

The pedological study, carried out in the same area, has shown that the vegetation of the recently abandoned fields grows on Entisols (Xerorthents Type) with an Ap C profile not much different from the soils still under cultivation. In parallel, with the evolution of the vegetation towards the wood, without modifying appreciably their own physical characteristics (particularly their structure) as the dynamic evolutive processes settle in, the soils demonstrate again a diagnostic alteration horizon of profile type A Bw C. The increase in the thickness of the solum and its enrichment in organic substance and clay, along with everything that these variations bring at the level of other fundamental characteristics of the soil (cation exchange and useful water capacities), allow these same soils to be classified as part of the Inceptisols (Xerochrepts Type) (Biondi et al., 1997; Biondi et al., 2005).

Autoecological studies: the broom

From the studies carried out, it has been seen that the most common mechanism of recolonisation of the shrub vegetation on abandoned fields and grasslands in the Umbria-Marche Apennines occurs by frontal advance of the vegetation mantle (Biondi et al., 1997; Biondi et al., 2005). In this process, the broom plays an essential role in the heliophylic phase of spreading of the pioneering shrubbery. For this reason, it is considered a necessity to undertake the autoecological study of this species in precise terms, with the first analysis being that of the knowledge of the architectural model (Ballerini et al., 2002). This is in order to understand how the broom manages to cover the terrain, and therefore to interpret the structure as a function of the intra- and inter-species competition that accompanies the dynamics of the population.
To construct an architectural model (according to Oldeman, 1990) of *Spartium junceum* the growth unit (g.u.) was analysed, i.e., the axial growth starting from a bud in a single continuous period of growth, which includes also the sylleptic branching (Lauri, 1991) that derives from ready lateral buds that are able to grow in the same cycle of growth in which they were formed without an intervening rest or winter dormancy period.

Three different types of shoots can be individuated (Fig. 14), known as “categories”:

a) *main shoots* - originating from buds that have been through the winter period (proleptic shoots; Oldeman, 1979);
b) *stipular shoots* - produced from ready lateral buds, not visible to the naked eye and positioned at the base of the shoots in a dorsal (external) position and protected by the persistent part of the leaf stem from the axil of which the main shoot grew;
c) *sylleptic shoots* - produced along the axis of any vigorous shoot, in distal positions with respect to those stipular, by the ready lateral buds at the axil of the persistent part of the leaf stem of the newly formed nodes (anticipated shoots; Champagnat, 1947).

The study of the architectural model of the broom has involved investigations into the phylotaxis, into the budding and into the differences between the buds as a function of the type of branch and the growth of the shoots, both as total growth and speed of elongation, in plants of different ages. In this way, the characterisation of the growth of the aerial parts has been achieved, demonstrating some adaptive advantages of the model. It has been shown that the young individuals specialise in the lengthening of the branches rather than a higher rate of budding that could dilute their resources across too many centres for growth, while this behaviour can be necessary for an increase in the competitiveness towards the herbaceous plants in the first phases of the colonisation of abandoned terrain.

![Figure 14](image-url) - An example of the complex growth unit (g.u.) of *Spartium junceum* that shows all three categories of branches: primary (a), basal secondary (b), sylleptic (c) (from Ballerini et al., 2002).
Under these conditions, the broom takes on a slender architectonic form and an ovoid foliage. In contrast, the adult or scenescent individuals preferentially form a high number of branches with respect to their lengthening, which becomes uniform across the different categories.

In this way, the plant tends to obtain upon maturity a spread architectonic form with an external corona of short flowering branches and an internal cavity growing through the years (Ballerini et al., 2002). With the numerical data obtained from the study of the architectonic model, it has been possible to realize a programme that simulates the growth of the broom (Neri & D’Onofrio, 2002) (Fig. 15).

The demographic studies of populations of *Spartium junceum* have been performed in a permanent area situated in the Alto Esino through a census of individuals in 1994, with a following check on the data in 2000. The permanent area is set up in a way that allows an analysis of the processes of frontal advance of the mantle within the hop hornbeam series.

The permanent area is situated on the eastern aspects of Serra Santa mountain (1423 m), which is part of the Umbria-Marche Apennine ridge, in the Locality of Vallemonici, in the Municipality of Fabriano (Province of Ancona). It is made up of 8 squares, each with 6 m sides, positioned consecutively on a colluvium following

**Figure 15** - Graphical simulation of the growth of a broom individual: front view (top) and view from the top (bottom) (from Onofri & Neri, 2002).
the line of maximum slope. The average altitude is 755 m; the exposure of the slope is towards the North-East. The squares are denominated by a letter from A (uphill) to H (downhill); they have been arranged in such a way as to include a succession of vegetation, including the edge of the wood of *Ostrya carpinifolia* (in the higher part), shrubbery structures dominated by *Spartium junceum*, to the herbaceous structures of *Bromus erectus* (in the lower part).

In the permanent area phenological and population dynamics analyses have been performed.

The phenological investigation was carried out in the vegetative season of 1994 and included the entire population of *Spartium junceum* in the permanent area. Graphs have been constructed of the phenological data (Fig. 16).

The production of the leaves proceeds from the end of February to the middle of August. In the first cycle, a strong decrease in leaf production is noted from the mid-

![Phenology: vegetative phases](image1)

![Phenology: reproductive phases](image2)

**Figure 16** - Phenological diagram of the vegetative phases (top) and of the reproductive phases (bottom) of *Spartium junceum* (from Ballerini et al., 2000).
dle of June, as in this period the sexually mature plants cease leaf production to form the floral raceme. The foliation phase, with respect to both the first and the second cycles, suddenly stopped in mid-August. By the end of August anyway, the majority of the plants have completely lost their leaves, a peculiar characteristic of this species being the brief persistence of the leaves on the plant.

The production of flower buds starts around the middle of April. The complete flowering period is made up of two cycles, partly overlapping, and is very long: within the population, plants in this phenological stage have been found from the middle of May to the first ten days of September. The seed dispersion occurs rather quickly, as the mature legume opens soon and allows them to fall.

The second cycle of bud opening occurs in only 54.3% of the plants that begin new leaf production, while very few reach the second flowering (9.8%). It was not possible to follow distinctly the two phases of the maturation of the fruit in this population.

From the data available it is anyway possible to conclude that, with respect to the reproduction capacity of the species, the contribution of the second cycle is very little.

Concerning the dynamics of the population of broom at the end of the vegetative season of 2000, there were 77 plants in the area, against the 81 of 1994 (Ballerini et al., 2000; Ballerini & Biondi, 2002). This was caused by a strong regression of the population in the entire first half of the area – that closer to the wood – that was not compensated for by the its expansion in the lower part, as this was still managed as grazed grasslands. This resulted in an increase in the average age of the broom plants in the permanent area, in the 6 years that had passed, which increased appreciably from 10.8 to 14.5 years (Fig 17). The cause of this phenomenon is to be found in the above-mentioned impediment to colonisation arising from grazing that had strongly limited the development of the population.

Concerning the broom, it was verified that in around 20 years the population reaches its maximum expansion. Later, the competition between the individuals becomes very strong, a decrease in their number is seen, and they tend towards a distribution of a uniform type (evident above all in square D). This phase, that we can define as stable, can be maintained for a long time as the population remains almost constant.

The situation changes when the broom shrubbery is reached by the pre-forest species, and in particular by the flowering ash. This species succeeds indeed in establishing itself even under the dense cover formed by the broom, corresponding to the stabilisation phase of the final population. Then the flowering ash individuals show greater growth than the broom and take on a dominant position.

At the end of the vegetative season of the year 2000, the reduction in the plants of the broom population, from 81 to 77, was caused by the strong decrease suffered by the population in the whole of the first half of the permanent area. This decrease in individuals was not compensated for by the expansion of the population in the lower areas of the slope, because in this area the grazing prevented the settling of new individuals.

In the year 2000, the broom disappeared completely from square A, with a decrease in number in squares B, C and D (Fig. 18) and a small increase in squares E and F were noted, while the population expanded considerably in squares G and H. In square B the individuals of Spartium junceum, a particularly heliophilous species, can survive only in the few spaces that are not covered by the flowering
FIGURE 17 - Comparison between the pyramids of age in the population of *Spartium junceum* with reference to the situation in 1994 (top) and in 2000 (bottom).

FIGURE 18 - Variations of density in the populations under consideration between 1994 and 2000: the letters of the alphabet along the X-axis indicate the squares and the permanent area of study (from Ballerini & Biondi, 2002).
ash, and they assume a distribution (D) of the contagious type. The distribution in squares C, D and E is of the random type, but the values of D increase with respect to 1994; indeed, at that time the values close to zero indicated a distribution tending towards uniformity, typical of the mature population. In 2000, the distribution is even more random, as the species does not survive in the areas overshadowed by the flowering ash.

The area of maximum density moves about 6 m, passing from square F to square G. The broom remains dominant in squares F and G where it reaches an 81% coverage. This is the maximum coverage value that this species reaches: in square D in 1994, while in 2000 the same value occurs a good 18 m down the slope.

The average age of the broom population over these 6 years went from 10.8 to 14.5 years, indicative of an overall aging of the population that could not colonise the grassland because of the grazing present in square H.

From the histograms in Figure 18, it is possible to see that in 1994 the density of the flowering ash individuals decreased from the wood towards the grassland, while in 2000, a drastic fall in the density values in the first three squares is noted. Evidently, the intra-species competition between the growing flowering ashes is very strong in the first three squares, so much so that the population, having overcome the phases of colonisation, stabilisation and spreading, can be considered to be at the limit of its expansion even though the single individuals have not yet reached their maximum growth. The situation in the central squares D and E was substantially stable.

In Figure 19, it can be seen that the pattern of the coverage of the flowering ash has an inverse relationship with the variation in the density in the two periods under consideration: also in 2000, the coverage is maximal near the wood and diminishes moving towards the grassland. The values seen in 2000 are therefore higher as the individuals, although overall decreased in the area (from 81 in 1994 to 53 in 2000), reach a dominant position up to the level of square E, forming a typical pre-wood belt.

Moreover, the data of 2000 confirm the hypothesis that the flowering ash is able to grow under the cover of broom and that it can even be favoured by this condition, probably because of the microclimate conditions that occur. Indeed, outside of the shrubbery it is not possible to find situations so important for the development of the flowering ash population. It appears, however, that the excessive coverage of broom does not allow the ingress of the flowering ash into squares F and G, into which it will probably successfully spread once the intra-species competition of the broom population causes the death of individuals during the phase of population decrease.

The other shrub and tree species under consideration (Fig. 18 and Fig 19) enter into the vegetational context much more slowly; indeed, because of this the structuring of the pre-forest and wood stages need a longer time, which cannot as yet be predicted. It is anyway interesting to note that the total number of these species and their coverage in squares A, B, C and D was growing between 1994 and 2000, indicating that the pre-wood, still made up mainly by *Fraxinus ornus*, is beginning to structure itself in a more complex form, more similar to the wood. In this dynamic process the role of the hop hornbeam, the species that dominates the wood in contact with the permanent area, is still limited. Evidently the ecological characteristics are not yet at their best for the growth of this species that, under the observed conditions, demonstrates itself to be rather demanding.
The results of the pedological surveys carried out in 1994 (Ballerini et al., 2002) demonstrate how moving from the high part to the lower part of the slope, the overall depth of the soil increases because of evident previous colluvial phenomena, while that of the most superficial layer decreases. This correlates with the content of organic substance that is particularly more abundant in the higher part of the slope, in relation to the presence of the wood and of the shrubbery. The degree of overall evolution of the soil, the depth and the characteristics of the superficial layer are very similar between the soil of the wood and that within the shrubbery, while these are different from those of the grassland, the soil of which is less evolved.

The shrubbery can therefore have a positive role under the environmental conditions considered, as this vegetation structure proves very efficiency for hydrogeological protection. It is able to protect the soil from erosion even in situations of notable slope; it favours pedological evolution, as well as creating microclimate conditions of benefit to the growth of the pre-forest species.
From these investigations it can be seen how projects of wood management can be organised, more linked with the ecological characteristics of the areas and with the plants that naturally characterise them. Indeed, under the climatic conditions of the territory in which the investigations were carried out the vegetation reacts quickly enough to the abandonment of anthropic activities, without leaving space for the erosive processes to set in through the succession of the vegetation structures (grasslands and shrubbery) to effectively protect the soil. Under these conditions it is thought that wood management must be mainly orientated towards favouring the development of the natural models of occupation of the territory on the part of the natural autochthonous vegetation.

*Plant landscape maps*

It deals with synphytosociological maps where the landscape units, individuated on the basis of the geomorphological and bioclimatic characteristics of the mapped territory, have been put in evidence and delimited.

These maps have been realised through the GIS methodologies that have the vantage of being extremely more precise than the previous ones because the polygons delimiting the different vegetation types are drawn directly on the video over the digital and georeferenced orthophoto.

Furthermore, these maps are associated to a relational database, thus to each polygon corresponds a series of tables linked each other by a common key, where several attributes such as: the patch surface, vegetation physiognomy, plant association, the vegetation series to which the association belongs, the plant landscape unit, utilisation and so on, have been included. The geodatabase can be updated in real time and easily queried in order to obtain several representations of different themes and statistical information through the possible crossjoins among tables.

In Figure 20, the scheme of the relational Geodatabase is shown, where all the subjects constituting the archive and the relations among the same subjects are described. Each rectangle of the scheme represents a subject with all the correlated attributes that in the database are present as tables and in same cases as georeferenced graphic objects (maps).

---

**Figure 20** - Scheme of the relational geodatabase realised for the Marche Ecological Net Project (REM).
The biggest rectangles represent the tables directly linked to the graphic objects of the plant coverage and of the phytosociological relevées.

For the plant coverage the geometry “polygon” is utilised; this one represents a homogeneous plant coverage, in a physiognomic, physiognomic-structural and ecotonal sense (with a structural composition intermediate with respect to homogeneous typologies, such as grasslands with shrubs or with trees and so on) that is possible to find in the territory. These information are related with tables of validation of Physiognomy, structural Physiognomy and Ecotones.

The maps realised with this methodology represent instruments extremely precise for the monitoring of vegetation in time.

CONCLUSIONS

The study of the processes of spontaneous renaturalization due to the vegetation in the areas abandoned by the agro-pastoral activities have allowed the understanding of the significance that these processes have in terms of space and time. This has provided data that can have relevance in the planning of the interventions needed for the management of ecological relevance of such large areas of territory. In particular, these are thought to be significant for the recovery of the major wooded areas for which there should no longer be replanting of the types effected since the beginning of the 1900s across a large part of the Central Apennines, with the planting of non-native conifers that have caused great problems. Among these, the constitution of non-self-reproducing woods must be considered, that often at the end of their life-cycle have not arrived at an environmental condition substantially more evolved, as demonstrated by numerous examples of replanting with the Austrian Black Pine (Pinus nigra) planted around the years of 1914-1916 (Biondi & Ballelli, 1973). Another drawback is the construction of woods with a great fire risk (Biondi & Taffetani, 1989) that make the Apennine areas of Central Italy more prone to wood fires than the hilly and partly plain pre-Apennine areas, while on the basis of the climatic conditions, characterised by more rain, lower average temperatures and a reduced summer drought, and on the basis of the typologies of the natural woods, would be potentially at a reduced risk of fires. Therefore, the result is that the planting of conifers has indeed inverted the natural risk of fires in the territories under consideration. Other negative factors connected to this type of replanting are the widespread parasite attacks to which they are subjected, mainly by the processionary moth, and the inconsistence of their economic value that makes it problematic for their use as mature forest, as the costs of cutting are not covered by the returns obtained by the selling of the wood.

On the basis of the new data reported here, it is thought that the start of an experimental phase for the definition of the most appropriate intervention methodologies for the constitution of new woods is of fundamental importance. These must take into account the forest potential of the territories and respect the successive phases of the vegetation dynamics, that will have to be accelerated through the inclusion of pre-forest species and the possibility of thinning of the shrubbery when this competes too actively with the pre-forest. This experimentation will allow more natural woods to be obtained, both in terms of their constituent plants and the most stable structure of the phytocoenosis. This will allow better evolution of the soil with the reduction of erosion, and at the same time also provide a reduced risk of wood fires.
RIASSUNTO

Vengono descritte alcune metodologie di analisi impiegate, a scale diverse, per lo studio dei processi di rinaturalizzazione che si determinano nelle aree non più utilizzate per scopi agricoli e zootecnici. Infatti, negli ultimi cinquanta anni si è assistito ad un progressivo processo di abbandono delle aree collinari e soprattutto montane, non più economicamente remunerative in base alle attuali esigenze tecnologiche e di mercato. In questi territori, pertanto, stanno avvenendo veloci processi di recupero spontaneo da parte della vegetazione di notevole interesse applicativo, che portano ad un veloce cambiamento del paesaggio vegetale. Tali fenomeni sono stati indagati con i metodi dell’analisi fitosociologica, sinfitosociologica e paesaggistica per l’interpretazione dei processi dinamici e dei tempi di ricolonizzazione in base a studi di carattere diaconico associati a studi di dinamica di popolazione. A questi sono state collegate indagini sui modelli di architettura di crescita della ginestra, specie particolarmente attiva nei processi di recupero della vegetazione, sui territori dell’Italia centrale, che permettono di meglio comprendere il ruolo di questa specie.

REFERENCES

BALLERINI V. AND BIONDI E., 2002 - Dinamica di popolazioni arbustive e preforestali nell’Appennino umbro-marchigiano (Italia centrale). Fitosociologia 39(1) suppl. 2: 175-183


TABLE 1 - Syntaxonomical list of the Italian shrub vegetation (from Poldini et al., 2002).

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rhamnus prinettiana</td>
<td>Rhamnus prinettiana Turrin 1952</td>
</tr>
<tr>
<td>Prunus spinosa</td>
<td>Prunus spinosa Turrin 1952</td>
</tr>
<tr>
<td>Cytisus scoparius</td>
<td>Cytisus scoparius L. 1888</td>
</tr>
<tr>
<td></td>
<td>Gruppo di associazioni edafosereofile</td>
</tr>
</tbody>
</table>
|  | Asparagus setaceus-Oxydendrum alnus 
|  | Allegrezza, Biondi, Formica e Balaidi 1997 |
|  | Lonicera caprifolium-Cornus sanguinea 
|  | Allegrezza et al. 1997 (non Biondi, Allegrezza e Guatlin 1988) |
|  | Rhamnus prinettiana-Poaces setosa 
|  | ilex Biondi 1999 |
|  | [± Arbutus + Palmaria spinosa-christie (Pirone, Frattaroli e Corbeta, 1997)] |
|  | Campanulaceae spicigeo-menu-Poaceae-Cornus sanguinea Biondi et Catinin in Pirone et al. 2001 |
|  | Gruppo di associazioni edafosereofile |
|  | Asparagus setaceus-Cornus sanguinea Biondi e Vitadini 2002 |
|  | Lonicera caprifolium-Poaceae sanguinea Biondi, Allegrezza e Guatlin 1988 |
|  | Galio palustre-Poaces sanguinea Pedrotti 1988 |
|  | Lonicera caprifolium-Cornus sanguinea Biondi, Allegrezza e Guatlin 1988 |
|  | Caroecis silvestris-Poaces corriae Biondi, Allegrezza e Guatlin 1988 |
|  | Spireta juncea-Cornus sanguinea Biondi e Vitadini 1998 |
|  | Lonicera caprifolium-Poaces sanguinea Biondi, Allegrezza e Guatlin 1988 |
|  | Cynto sanguinea-Cornus sanguinea Biondi, Pio, Baldoni e Taffetani 1997 |
|  | Spireta juncea-Ericetum arborii Biondi e Vitadini 2002 |
|  | Spireta juncea-Poaces sanguinea Biondi, Pio, Baldoni e Taffetani 1997 |
|  | Cynto sanguinea-Poaces sanguinea Pedrotti 1988 |
|  | Gruppo di associazioni submesofile |
|  | Campanulaceae-Cistus paludinosus L. e Biondi 1998 |
|  | Lonicera caprifolium-Baranieris sanguinea Biondi e Vitadini 2002 |
|  | Cytisus spinosa-Daphnietum sericeae Di Pietro 2001 |

Berberidamen vulgaris S.B. 1950

Prunus spinosa-Prunus vulgaris Palloni e Vitadini 1995

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gruppo di associazioni edafosereofile</td>
</tr>
<tr>
<td></td>
<td>Prunus spinosa-Poaces spinosa-christie Biondi e Vitadini 2002</td>
</tr>
<tr>
<td></td>
<td>Frangula reptans-Cornus sanguinea Palloni e Vitadini 2002</td>
</tr>
<tr>
<td></td>
<td>Frangula reptans-Poaces sanguinea Palloni e Vitadini 2002</td>
</tr>
<tr>
<td></td>
<td>Frangula reptans-Poaces sanguinea Pedrotti 1988</td>
</tr>
<tr>
<td></td>
<td>[Syn: Syrinx: Frangula reptans Pedrotti e Minghetti 1994 (non Nocle 1931 ex Th. Müller 1986)]</td>
</tr>
<tr>
<td></td>
<td>Clenopathetum ulmifolii Pedrotti 1983 (non Cenomo + Rubus ulmifolii + Cenomo vulgare)</td>
</tr>
<tr>
<td></td>
<td>Rubus ulmifolii-Ligustrum vulgare Pedrotti 1989</td>
</tr>
<tr>
<td></td>
<td>Stadio a Cornus sanguinea (Palloni, Vitadini &amp; Zanatta, 2002)</td>
</tr>
<tr>
<td></td>
<td>Fiesonoma a Prunus spinosa subsp. spinosa a Prunus avia subsp. avia (Palloni, Vitadini &amp; Zanatta, 2002)</td>
</tr>
<tr>
<td></td>
<td>Gruppo di associazioni submesofile</td>
</tr>
<tr>
<td></td>
<td>Lonicera caprifolium-Rhamnetum corniculata Palloni e Vitadini 1995</td>
</tr>
<tr>
<td></td>
<td>Caroecis marcescens Laminacea Biondi, Pio, Baldoni e Taffetani 1998</td>
</tr>
<tr>
<td></td>
<td>Fiesonoma a Palmaria spinosa-christie + Ulmus minor (Palloni e Vitadini, 1995)</td>
</tr>
</tbody>
</table>

Berberidamen vulgaris ghini, Foucrot e Delclaux-Duplessin 1983

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gruppo di associazioni dell'area nord-orientale e dell'Appennino</td>
</tr>
<tr>
<td></td>
<td>Rhamnus catharticus-Lonicera corniculata Palloni e Vitadini 2002</td>
</tr>
<tr>
<td></td>
<td>Alnus viridis-Acer campestre Pedrotti 1982</td>
</tr>
<tr>
<td></td>
<td>Arbutus vaginata-Poaces spinosa Biondi e Casavecchia 2002</td>
</tr>
<tr>
<td></td>
<td>Lonicera xefostachya-Salicetum pseudoparrasii Biondi e Casavecchia 2002</td>
</tr>
<tr>
<td></td>
<td>Arbutus vaginata-Melanium fruticosum Biondi, Allegrezza e Taffetani 1990</td>
</tr>
<tr>
<td></td>
<td>Gruppo di associazioni dell'Appennino alpino</td>
</tr>
<tr>
<td></td>
<td>Lonicera caprifolium-Anthemis alpinae Podotti 1994</td>
</tr>
<tr>
<td></td>
<td>Rubus idaei-Rhamnetum fallacii Biondi et al. 1999</td>
</tr>
</tbody>
</table>

Prunus spinosa subsp. spinosa O. Bolós 1954

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Gruppo di associazioni edafosereofile</td>
</tr>
<tr>
<td></td>
<td>Lonicera caprifolium-Cornus sanguinea Biondi, Bagella, Casavecchia e Pirz 2002</td>
</tr>
<tr>
<td></td>
<td>Roso perpervennis-Rubus ulmifolii Blasi e Di Pietro e Fortini 2000</td>
</tr>
<tr>
<td></td>
<td>Lonicera caprifolium-Rubus ulmifolii L. e Biondi 1996</td>
</tr>
<tr>
<td></td>
<td>Aggi. a Palmaria spinosa-christie e Cornus sanguinea (Blas e Di Pietro, 2001)</td>
</tr>
<tr>
<td></td>
<td>Ass. a Palmaria spinosa-christie (Catinin, 1996)</td>
</tr>
<tr>
<td></td>
<td>Ass. a Spartium junceum e Rubus ulmifolius (Catinin, 1996)</td>
</tr>
<tr>
<td></td>
<td>Gruppo di associazioni edafosereofile</td>
</tr>
<tr>
<td></td>
<td>Cistus salviifolius-Rhamnetum monogynum Filippelli, Farris, Bagella e Biondi 1999</td>
</tr>
<tr>
<td></td>
<td>Vicie tenebrosa-Prunus spinosa-christie Filippelli, Farris, Bagella e Biondi 1999</td>
</tr>
<tr>
<td></td>
<td>Vinca minor-Rubus ulmifolii Biondi, Farris e Filippelli 2002</td>
</tr>
<tr>
<td></td>
<td>Crataegus monogyna-Poaces sanguinea Biondi, Farris e Filippelli 2002</td>
</tr>
<tr>
<td></td>
<td>Crataegus jucunda Brouillet e Marconett 1993</td>
</tr>
</tbody>
</table>

Salvia-Ferulare conglomer (Passarge 1895) de Foucret 1992

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Scientific Name</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frangula ulmaria-Poaces spinosa Biondi et al. 1998</td>
</tr>
<tr>
<td></td>
<td>Prunus spinosa-Cornus sanguinea Biondi e Vitadini 1995</td>
</tr>
</tbody>
</table>