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VEGETATION, SOIL AND PEDOFAUNA AS PROXY TO UNDERSTAND ECOLOGY OF *OSTRYA CARPINIFOLIA* FORESTS IN EUROPE

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"In nature there are no rewards or punishments; there are consequences. "
(Horace Annesley Vachell)

…alla mia mamma.

Abstract

Having identified the *Ostrya carpinifolia* forests as one of the most widespread forest types in the Apennines-Balkan bio-geographical region and having highlighted the shortage of studies, and the lack of inclusion of these coenoses in the habitats described at European level, the main purpose of the Ph.D research project, summarized in this work, was to provide useful data to understand the ecological value, the dynamics, the potentiality and the threats of these coenoses. In order to provide an image as complete as possible, the project was articulated into three key points. (I) The analysis of the dynamics related to traditional coppice management, its modification and abandonment, useful to identify the optimum duration of the rotation and the ecological effects of the abandonment, carried out through the in-depth study of coenoses during different moments of the rotations examined and after a decades of abandonment in the Apennines areas. (II) The investigation of the effects of ecological isolation on these coenoses, useful in establishing the ecological value of the existing isolated coenoses, the current dynamics and the identification of a minimal area of intervention, carried out by in-depth study of the residual *Ostrya carpinifolia* woods present in the territory of the Marche region. (III) A preliminary census of these forest formations along the Italian and Balkan territories, carried out by collecting floristic-vegetational, pedological, structural and management data of these coenoses at the whole geographic distribution range. The main result of this large data collection campaign is the creation of datasets related to the ecological and management characteristics, regarding the entire distribution area and all the different management phases. The interpolation and reworking of these data allow to increase the understanding of these forest formations, making it possible to interpret dynamics and evaluate the real ecological value characterizing the *Ostrya carpinifolia* forests. These aspects are still difficult to deal with, given the data presently available in literature, but fundamental to build dynamic forecast models. Models necessary for the drafting of real useful management and landscaping plans. The studies carried out and here reported show how these formations, commonly labelled as not very interesting under the ecological point of view, are instead characterized by a particularly rich flora, a very lively dynamism and highlight a strong resilience. Therefore, these coenoses should not be interpreted as transitory or recovery phases of more "mature" coenoses, but real stable semi-natural forest formations very rich in terms of biodiversity, now threatened by widespread abandonment, exactly like the secondary prairies habitats.

Keywords: *Ostrya carpinifolia*; Forest management; Coppice; Abandonment, Flora; Vegetation; Soil; Pedofauna; Landscape; Biodiversity.

Riassunto

Identificati i boschi di *Ostrya carpinifolia* come una delle formazioni forestali più diffuse e caratteristiche della regione biogeografica Appennino-Balcanica e rilevata la carenza di studi e dati nonché la mancata inclusione di queste cenosi tra gli Habitat descritti a livello Europeo, lo scopo principale del progetto di ricerca sviluppato durante il dottorato e riassunto in questo lavoro, è stato quello di fornire dati utili per comprendere il valore ecologico, la dinamica, le potenzialità e le minacce di queste cenosi. Al fine di fornire un quadro il più completo possibile, il progetto è stato articolato in tre punti chiave. (I) L'analisi delle dinamiche relative alla gestione tradizionale del ceduo, la sua modifica e il suo abbandono. Fondamentale per definire la durata ottimale del turno e gli effetti ecologici dell'abbandono, è condotta attraverso lo studio approfondito delle cenosi in diversi momenti del turno e successivamente all'abbandono gestionale, nelle aree appenniniche. (II) Lo studio degli effetti dell'isolamento ecologico su queste cenosi. Utile per delineare il valore ecologico delle cenosi isolate esistenti, le dinamiche attuali e l'individuazione di un'area minima di intervento; condotto mediante uno studio approfondito dei boschi residui di *Ostrya carpinifolia* presenti nel territorio della regione Marche. (III) Il censimento preliminare di queste formazioni sul territorio Italiano e Balcanico, imperniato sulla raccolta di dati floristico-vegetazionali, pedologici, strutturali e gestionali di queste cenosi a scala di areale. Il risultato principale di questa ampia campagna di raccolta dati è la creazione di set di dati relativi alle caratteristiche ecologiche e gestionali, riguardanti l'intera area di distribuzione e tutte le diverse fasi di gestione. L'interpolazione e la rielaborazione di questi dati permette infatti di migliorare la comprensione delle formazioni forestali in esame, rendendo possibile interpretare le dinamiche e valutare il reale valore ecologico che caratterizza le foreste di *Ostrya Carpinifolia*. Aspetti questi, difficilmente affrontabili con i dati fino ad oggi disponibili in letteratura, ma che assumono un ruolo chiave nella realizzazione di modelli di previsione dinamici su base ecologica, sostanziali al fine della pianificazione forestale e paesaggistica. Gli studi effettuati e riportati in questa sede, mostrano come queste formazioni, comunemente etichettate come poco interessanti da un punto di vista ecologico, siano invece caratterizzate da una flora particolarmente ricca, un dinamismo molto vivace e da una forte resilienza. Pertanto, queste cenosi non devono essere interpretate come fasi transitorie o di recupero di cenosi più "mature", ma formazioni forestali semi-naturali stabili, molto ricche in termini di biodiversità ed oggi minacciate dal diffuso abbandono, esattamente come gli habitat di prateria secondaria.

Parole Chiave: *Ostrya carpinifolia*; Gestione forestale; Ceduo; Abbandono; Flora; Vegetazione; Suolo; Pedofauna; Paesaggio; Biodiversità.

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Introduction

Though from a global point of view the area covered by forest formations is in a strong decrease, at a European level the trend is the opposite (FAO 2018). The increase in forest area, however, is not always accompanied by an increase in terms of quality of the forest ecosystems (Kremer *et al*. 2016, FAO 2018). This phenomenon is marked in all the Mediterranean countries but particularly evident in Italy, where in the last 90 years the forest area has practically doubled (INFC, 2005). This forest expansion process, as well as having substantially started a landscape modification process, has not been homogeneous across the peninsula. In mountainous and hilly areas the advent of mechanization and the abandonment of inland areas have triplicated the extension of the forest area, while, in the same period, forest environments present in lowland areas have almost halved remaining very often completely isolated from each other (Gasparini & Tabacchi, 2011, Taffetani 2009). A dichotomy that has, as a single common point, over most of the concerned areas, the previous coppice management and the current widespread abandonment (Mariano, 2016). If under the point of view of the landscape this situation leads to a simplification of the typical environmental mosaic of the Italian territory, very few and heterogeneous data are available about the effects that isolation and abandonment have on the ecology and dynamisms of multi-century managed forests. A situation which is even more true for coppice forests, characterized by a management so intense and articulated that it has determined the shaping not only of the forest structure, but also of the flora and fauna and that characterizes more than 50% of the Italian forest area (Mariano 2015). This kind of management has been known since prehistory (Piussi & Alberti, 2015) and was systematically adopted in certain forest formations throughout the Mediterranean period, starting from the Etruscan-Roman period (Bernetti *et al*. 2012, Bernetti & La Marca, 2012). During the centuries the coppicing practice spread especially along the Apennine-Balkan sector, where also to date it remains widely diffused (Unraw *et al.* 2018). Examining the 401 articles published from 1975 to 2015 concerning the management and characteristics of the coppice formations (Schneberger & Dohrenbusch 2016) found during the initial bibliographic research, it was possible to realize how the literature does not examine the ecological dynamics related to the regular application of this form of government on the different forest areas involved. There are also no comparative studies that compare regularly managed coppice forests with the abandoned, converted or subjected to active conversion ones. Almost all the bibliographic sources focus on the effects of the active conversion of aged coppices or abandoned coppice. Furthermore, the evaluation of the different aspects taken into consideration is always carried out through indicators that find their point of reference in the virgin forests. Another important gap identified in the literature concerns the studied formations: the great part of the scientific production concerns the beech-forests, followed in terms of scientific production by oak-forests and sweet chestnut forests. Poplar and Black locust forests are the subjects of rather frequent publications that fall within the field of Short rotation Forestry, while riparian forest formations and Willow formations are the subject of dynamic and engineeristic studies. Instead, *Ostrya carpinifolia* forest formations remained virtually excluded from the scientific literature of the last 30 years. These latter formations were quite neglected even from the phytosociological and pedological point of view because they have always been framed as transitory or recovery phases of more "mature" and widespread coenoses, once again generally identified in Beech forests or Oak forests. The keystone species (sensu Zhau-hua *et a.l* 2001) of these forest formations is the European hop-hornbeam (*Ostrya carpinifolia* Scop.), a species with a rather limited chorological distribution. However, where it is present, this species tends to constitute forest formations whose traditional coppice management has characterized the landscape and medium-small economy for centuries. *Ostrya carpinifolia* forest formations qualify most of the Italian low mountainous and hilly areas while in the Balkan peninsula they cover more or less large areas, which interrupt the most extended beech-forests, creating ecological-structural discontinuities very interesting for biodiversity conservation and dishomogenization of the forest landscape. As already mentioned, to date there is little information available in the literature concerning *O. carpinifolia* and the forest formations that this species constitutes. However, all the available studies show high biodiversity and traditional coppice management, with characteristic rather short rotation periods (10 - 18 years). The general and prolonged lack of interest in the study of these formations should be read in light of the fact that these forests, not allowing the production of timber of high quality, were considered to be of little interest from a silvicultural and forest planning point of view until the second post-war period. Subsequently, the socio-economic changes that characterized the last eighty years, have led to research and enhance the direct and indirect ecosystem services in forest formations, which find their maximum expression in the most stable forest areas, commonly identified in the areas less subject to anthropogenic disturbance. Therefore, the virgin forests have been taken as a reference model for the assessment of the quality of forest ecosystem and the effects of the forest management practice. Strongly departing both structurally and ecologically from these,The Ostrya carpinifolia forest formations have once again aroused little interest, generally interpretated as transitional phases or recovery of formations considered more "mature". Although the *Ostrya carpinifolia* forests cover an area of over 852200 hectares (equal to 12.52% of the Italian forest area) in Italy (FRA 2015) and hundreds of thousands of hectares in the Balkan peninsula (Furkarek 1979, Puncer & Zupanic 1982, Vukelic 2012), these common assumptions have meant that these formations have never been reported to the European Commission. To date, none of the 14 categories and none of the 79 types of forest habitat described for the territory of the European Union actually includes these cenosis (Barbati *et al.* 2014). In the last decades, moreover, after centuries of uninterrupted management, most of these forests have been abandoned on the basis of the widespread vision, which however lacks direct scientific confirmation, of the abandonment of management as a guarantee of maintaining biodiversity and increasing the naturalness of forest cenosis. In the lowland areas, this situation has been made more problematic by the active reduction of surface and the parallel ecological isolation, due to the affirmation of intensive agriculture and the development of urban areas. In the light of what above briefly explained, the main objectives of the Ph.D research project were those of increasing the knowledge of these forest formations, highlight the dynamics and changes taking place during traditional management and following its abandonment, and analyze the effect of the ecological isolation in these forest formations. In order to achieve these goals, among the aspects proposed in literature, particularly interesting for the purposes have proved to be the study of the flora, the vegetation and the soil seed bank, through which it is possible to highlight the dynamic processes of the last decades, the actual status and the dynamic trend (Ubaldi 2003, Van Calster *et al.* 2008), the study of top-soil and Pedofauna, capable of indicating the current status of the analyzed coenoses (Parisi *et al.* 2005, Zanella *et al.* 2010), the analysis of the morphological characteristics of the Sub-soil, through which it is possible to bring out information about the status of the examined areas in recent centuries (Certini & Ugolini 2010). All off these aspects have been analyzed for all the sites studied following a standardized survey procedure designed *ad hoc* to minimize the discrepancies related to the survey activity in the different sites. This allows us not only to study in detail these aspects in each place, but also to carry out cross-analysis and comparisons among coenoses present in different places or at different dynamic moments. In order to provide a clear and complete picture of the work carried out, here below will be shown the published articles, submitted and drafted, the proceedings of the conferences, the unpublished results of the analyzes and the bibliographical reviews, carried out during the three years of doctorate. All these documents will be reorganized so as to constitute an organic piece of work, structured in five parts:

- Phylogenesis, taxonomy and morphology of *Ostrya carpinifolia*
- Distribution, Typification and management of the Ostrya carpinifolia forests
- Effects of traditional management, its modification and interruption
- Effects of ecological isolation
- Floristic studies

The first two parts summarize the information that emerged from the preliminary bibliographic studies and the unpublished data collected in order to update the data present in the bibliography. The next three parts, instead, show exclusively the results of the original research work that represent the true and innovative scientific contribution produced.

I

Phylogenesis, taxonomy and morphology of *Ostrya carpinifolia*

Men argue, nature acts
(Voltaire)

Elements of phylogenetics and taxonomy
(literature review– paper in project)

Ostrya carpinifolia Scop. belongs to the Betulaceae family (Stevens 2001; Bartolucci *et. al.* 2018), which, on the basis of paleobotanical, genetic and morphological evidence (Chen *et al* 1999), would appear to have originated about 70 million years ago during the Maastrichtian age (late Cretaceous) in the area corresponding to the present central China. To date, this taxonomical family is divided into two subfamilies (*Coryloideae* and *Betuloideae*) and six genera (*Corylus, Ostryopsis, Ostrya, Carpinus, Alnus, Betula*), which include about 150 species spread all over Europe, North Africa, America and Asia (Govaerts & Frodin 2008).

150 species spread in Europe, North Africa, America and Asia (Govaerts & Frodin 2008).

Of the 150 species present worldwide, only nine belong to the genus *Ostrya*:

- *Ostrya carpinifolia* Scop. (European hophornbeam) Italy, Balkans, Middle East, Turkey, Caucasus
    ↳ var. *corsica* Fliche - Corsica and Sardinia

- *Ostrya chisosensis* Correll (Big Bend hophornbeam) – Endemic of Texas

- *Ostrya japonica* Sarg. (Japanese hophornbeam) - Japan, Korea, northern China

- *Ostrya knowltonii* Coville (wolf hophornbeam) Utah, Arizona, New Mexico, Texas

- *Ostrya multinervis* Rehd. – Endemic of central China

- *Ostrya rehderiana* Chun (Zhejiang hophornbeam) Endemic of Zhejiang Province in China

- *Ostrya trichocarpa* D.Fang & Y.S.Wang – Endemic of Guangxi Province in China

- *Ostrya virginiana* (Mill.) K. Koch (Ironwood) - eastern Canada, eastern US, Mexico, Guatemala, El Salvador, Honduras

- *Ostrya yunnanensis* W.K.Hu (Yunnan hop-hornbeam) – Endemic of Yunnan Province in China

All of these species are characterized by rapid growth, high sprouts capacity and limited longevity. From the above-mentioned distributions we can see that, of these nine species, five are located in Asia (and of these, four are Chinese endemic), three are present on the American continent (of one endemic to Texas), while a single species is present in Europe. For this latter species, however, a variant has been described, present in Corsica and Sardinia. The presence of this geographic variant would seem to highlight a possible beginning of the speciation process, a symptom of an ongoing adaptation process (Gavnish 2010). This distribution suggested initially the bases of the currently most accepted hypothesis, according to which the genus Ostrya, originating in the central area of today's China about 50 million years ago (Larson-jhonson 2016), has subsequently spread to the Caucasus, to Libya and from the east to the west coast of the American continent, reaching Europe only after the last ice age (Willis 1996). This hypothesis, put forward in the past more or less directly by different authors (Hutchinson 1967, Takhtajen 1969, Harper1977, among others) is confirmed by the most recent studies carried out on genetic bases as well as morphological and paleobotanical ones (Manchester & Chenn1996, 1998, Gaston 2003, Manos *et al.* 2008, among others). From an evolutionary point of view, the genus *Ostrya*, contrary to what was initially hypothesized also by Scopoli who described it in 1772, must be considered relatively advanced according to its floral characteristics. Precisely the floral characters that, due to their simplicity, had led to classify the genus as not very evolved, until the phylogenetic revision implemented by Takhtajan (1959). The intuition of Takhtajan (1964, 1969) according to which the *Fagales* of Walters (1964), like other *amentiflores* would derive from the *Hamamelidales,* in which groups of plants already adapted to the anemophilous pollination already appeared, has in fact been confirmed by the most recent studies. As a matter of fact, although at the taxonomic level the order of *Hamamelidales* was not recognized as valid (APG 2003), these studies trace back the common origin of the *Fagales* to the oldest order of the *Saxifragales* (APG 2003, 2009, Larson-Jhonson 2016). As it has been demonstrated by a long series of systematic studies carried out on the various genres related to the order of *Fagales* (Tiffney 1986, Erksson & Bremer 1992, Dodd *et al* 1999, Vander 2001, Lewis 2001, Li *et al.*, 2004, Givnish 2010 , among others), the simplicity of its structures must in fact be considered as deriving from a previous structure in function of the anemophilia. The simplicity of the floral structure would therefore not be primary, but the result of subsequent reductive adaptation (Friedman & Barret 2008). These plants, already anemophilous, would have implemented a first adaptation to support entomophilous pollination and only afterwards they would have reorganized the flowers in catkins to achieve the dispersion of the pollen through the air, thus completing a real secondary adaptation. A further support to this thesis would come from the structuring of the fruits which, as initially pointed out by Endress (1977) and subsequently confirmed (Vander Wall 2001, Eriksson *et al.* 2000, among others), in the *Fagales* are characterized by a single, indehiscent seed and appear to be the consequence of evolutionary adaptation to anemophilia. The *Fagales amentiflore* have therefore developed catkin inflorescences and their gynoecium is composed of two or more carpels combined. According to various authors (Friis *et al.* 2011, Taylor *et al*. 2012), the ovary structure is important to the effects of the phylogeny of these plants, in fact an ovary made up of several combined carpels cannot be considered primitive, especially if it is accompanied by inflorescences at one with simple male flowers (without perianth). The catkins of the *Gymnospermae*, plants by definition older and less evolved, are in fact very different from those of a birch, a walnut or an oak. However, their apparent similarity induced the first botanists to hypothetically consider the *Angiospermae amentifloras* as primitives and the anemophilous pollination, common to both groups, had reinforced this erroneous hypothesis. In conclusion, if we accept the primitiveness of the *Magnoliaceae* (made clear when you assimilate their flower to a *strobilo*), it follows that the A*petale* (or *Monoclamideae,* according to De Candolle) including among other families also the *Betulaceae* and the *Fagaceae* (characterized by small unisexuate and simple flowers), must be considered already evolved because the simplicity of their flowers is not primitive but secondary (Friedman & Barret 2008). So also the genus *Ostrya,* included in the *Betulaceae* because of its flower characters, despite the fact that, according to several authors (Taylor *et al*. 2012, Larson-Jhonson 2016 among others) it dates back to about 50 million years ago (so several million years before *Castanea* , *Quercus* and *Corylus*), should be considered as advanced from an evolutionary point of view, since the simplicity of its structures must be considered derived from a previous structure according to the anemophilia.

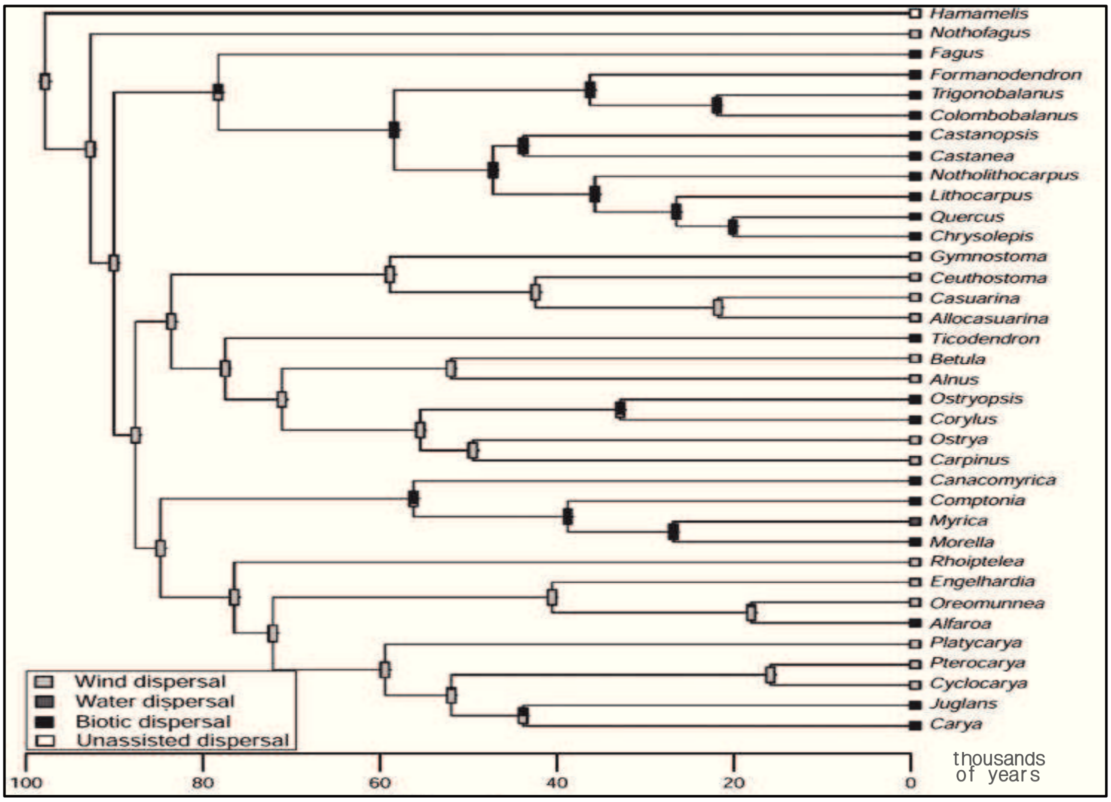


Fig. 1 - Dispersal mode ancestral state reconstructions produced using only extant taxa. (Larson-Jhonson 2016)

Morphology and anatomy

(based on unpublished observations of samples from Italy, Croatia, Istria and Montenegro)

It is a species mostly with tree habitus, generally from 12 to 15 metres high (rarely more than 20 metres) and has a globose-conical crown. The younger, silver-gray branches are covered with a thin layer of wax from which short conical hairs emerge. Within a couple of years the hair fades, until it almost disappears, and the bark turns reddish brown with many whitish horizontal lenticels. The trunk of the oldest trees (generally over 20 years) are characterized by the cracking of the bark, in which conspicuous gray longitudinal plaques become easy to detach The trunks in very old subjects can even measure 75cm in diameter at breast height. The light green, ovate-obtuse and hairless buds are placed alternately on the branches. The young leaves, when it is still enclosed in the bud, are finely pleated and covered with long silky hairs, more abundant on the lower page. After the leaves extension, these hairs remain present only along the ribs and on the petiole. At this stage of development and in the following ones, two types of hairs are clearly visible on the leaf: long and short pyice-like ones (the latter very similar to those present on young branches). Moreover, multi-cellular glandular hairs can be observed, especially along the ribs. A particular characteristic of the epidermis of the leaf is represented by the presence of waxes arranged in a thin layer which also covers the petiole. The stomata are numerous especially on the lower page, while not missing on the upper one. In addition, along the edge of the leaf lamina, at the apex of the teeth, elongated glandoliform structures are present. The leaves are shortly petiolate and at the end of development become of ovate-lanceolate shape, with doubly serrated margin and maximum width normally in the lower third. The leaves reach a width of 2-5 x 5-8 (10) and they can give the feeling of being more or less velvety at the touch. The leaves present 10-15 pairs of secondary ribs. Also the tertiary ribs are present, although not always easily visible. The male Inflorescences are organized in pendulous cylindrical catkins, characterized by a diameter of 0.5 - 0.8 cm and a length of 5-10 (15) cm. The stamens are brown and hairy, they are arranged within a concave heart-shaped scale. The female inflorescences are organized in strobiliform catkins placed at the end of the younger branches and they have dimensions of 3-5 cm. The female inflorescences are particularly dense with first erect bearing and then pendulous at maturity. The ovary is characteristically bicarpellar with 2 styles and appears protected by two hairy bracts. The antesis occurs between march and may in function of the climatic, physical and genetic characteristics. The infructescences consist of small clusters formed by a set of whitish (1.5-2 cm) vesiculous domes covered with hairs, resulting from the welding of the bracts placed to protect the ovary and enclosing each a smooth achene (nucula) of 4- 5 mm. The root system is quite expanded and sturdy. This often deepens up to the rock, where it tends to insert into the present cracks. The microscopic observation of different samples of roots has shown that the root system is abundantly provided with mycorrhiza. The presence of mycorrhizae has resulted to be greater as we move towards the most distal part of the root system. What observed appears to be in line with what can be deduced from the litterature (Del Favero *et al.* 1989, Amicucci 1999). *Ostrya carpinifolia* is characterized by a "definite" annual growth (like beech and oaks). In this type of growth the elongation axes of the main branches and the side shots with the relative leaves are already preformed and organized from year to year within the vegetative buds. When these structures open up, all the annual growth is completed in a short time (Grossoni *et al.* 2018). The defined growth involves an organization of the structure of the stem with wood rings of the "annular porosity" type with several wide lumen vessels gathered in the spring portion and a prevalence of wood fibers in the summer-autumn one (Nardi-Berti 2006). This structure is typical of trees that concentrate the crown development in spring, resulting in a very strong increase in the circulation of nutrient solutions and lymph in this season.

Synthetic descriptors:

Floral formula: P0 A6-14 (Male flowers)
P(3) G2 (Female flowers)

Biological Form: P scap (P caesp)

Corological type: S-Europ. – Pontic.

Indices of Ellemberg: 4 (Light); 8(Temperature); 4 (Continentality); 4 (Moisture)
X(Reaction); X (Nutrients); 0 (Salinity)

Maturity Index : 9

Phytosociological class of belonging: Querco – Fagetea

Accepted name: *Ostrya carpinifolia* Scop., 1772

Synonyms : *Carpinus ostrya* L., 1753; *Ostrya vulgaris* Willd., 1805; *Carpinus italica* Scop. ex Steud., 1840; *Ostrya italica* Spach, 1842; *Ostrya ladelchii* Sanguin., 1864; *Ostrya carpinifolia* var. *genuina* Fliche, 1888; *Ostrya italica* subsp. *carpinifolia* H.J.P.Winkl., 1904.

Fig. 2 - Morpholophobic details of *Ostrya carpinifolia* Scop.
A) tree structure; B) male catkins - immature phase; C&D) male catkins - mature phase; E) female catkins; F) young infructescence; G) mature infruttescence; H) achene; I) female flowers; L) stumps M) bark – young phase ; N) bark – old phase; O) bud; P&Q) leaves; R) seedling

Possible confusions: *Carpinus betulus* is the species morphologically more similar to *Ostrya carpinifolia*. Its geographic range partially overlaps with that of *Ostrya Carpinifolia*, but this species prefers more humid soils. *Carpinus betulus* is distinguished by being characterized by gray-cinerine bark lacking lenticels and plaques, with long longitudinal columnar ribs, decidedly ovate-elliptic leaves with lamina and more pronounced roughness, usually without tertiary ribs. The male and female catkins are shorter (<4 cm) than in *Ostrya Carpinifolia*. The fruits (nucule) are partially covered with a showy 3-lobed bract, of which the central one is longer and wider than the lateral ones. In the areas with more markedly mediterranean conditions it is instead possible to confuse *Ostrya Carpinifolia* with *Carpinus orientalis,* that prefers warmer and more dry environments. *Carpinus orientalis* is characterized by a shrub-like appearance, with gray-cinerine bark free of lenticels and plaques and slight ribs on the stem. Its leaves are characteristically more coriaceous and smaller in size than the leaves of *Ostrya carpinifolia*. The male catkins are always less than 3 cm in length and the female ones are characterized by flowers with toothed bracts with only one lobe. The fruits are completely covered with the same increased leafy bracts present in *Carpinus betulus*.

Elements on the suckers emission capacity
(integrated with unpublished data and measurements)

Due to its high sprouts capacity, *Ostrya carpinifolia* has always been considered one of the most suitable species for the coppice practice (Piussi & Alberti 2015). The species, in response to a strong stress (such as cutting), emits a very high number of caulinary suckers (over 60 [Mei 2015, Mei & Colpi - unpublished data]) coming from the proventitious buds (localized in the collar area) which remain vital even if buried. Instead, more limited is the production of adventitious buds, which however origin a number, albeit reduced (up to 15 [Mei & Colpi - unpublished data]), of "false suckers" at the edge of the cutting area, even if the cut is practiced over the soil level. The sprouts emission capacity in this species is maintained for a long time, even if after 35 to 40 years a gradually decrease of this capacity is observed. Lastly, contrary to what was asserted by Cappelli (1975) , the species does not seem able to emit radical suckers.

Growth dinamycs
(unpublished data and measurements – paper in draft)

Taking into consideration the development over time of the diameters at 130cm from the ground, it has been observed that the *Ostrya carpinifolia* suckers exhibit different diametric growth rates according to the different forest areas considered. Summarizing, the results that are emerging from the measurements made during this project and the comparison of these with those found in the literature, it is clear that in the formations of the mountain belt (*Ostrya carpinifolia* forest with beech participation for Del Favero [2010]), generally, *Ostrya carpinifolia* shows a rather accelerated diametric development, with a current increase of diameter already decreasing after 5 years from the cut. The average increase in these formations culminates at around 15 years, the age in which the suckers reach an average size ranging from 8 to 12 cm, generally 10% lower than those achieved by the beech. This difference, however, tends to increase reaching a 15% in the following 5 years. In the planitial and low hilly belt (Downy oak mixed forests for Del Favero [2010]), the growth appears much less rapid but more enduring. The average increase of *Ostrya carpinifolia* in these formations culminates at around 18 years, when the suckers reach an average size ranging from 7 to 10 cm. In these situations *Ostrya carpinifolia* usually shows 40% lower diameters compared to those of the downy oak itself, while it exceeds those of the manna ash of about 50%. The development of the diametrical growth in the pure *Ostrya carpinifolia* forest formations (high hill - low mountain belts) is very different. In fact, in this case there is a rather slow initial growth followed by a period of more rapid development that has its maximum between 15 and 20 years (coinciding with the age of culmination of the *current increase*). Then follows a new period of slow growth with an age of culmination of the *average increase* reached around 30 years. In populations over the age of 50, the high mortality intra and infra-stumps and the increasingly frequent phenomena of crashing and overturning cause a stop in the increase, when not even to phenomena of volume decrement at the stand level.The differences summarized with regard to the diametrical growth, which can be attibuited back to the different situations of fertility and interspecific competitive capacity, do not seem as clear when considering the development of height over time. In this case, regardless of the altitudinal plane, the *Ostrya carpinifolia* manifests different heights also differ greatly depending on the microstational conditions. If we also want to do for this parameters a generalization, we can assume that in the mountain plain, where it grows in association with the beech, *Ostrya carpinifolia* usually reach lower heights than those of the beech. This difference in height increases with the age of the population and the higher you get up in altitude. On the contrary, O*strya carpinifolia* usually in the low hilly and lowland belt does not differ in height from the downy oak, except when the latter species is clearly dominant. Also in this case, however, the hornbeam reaches almost never lower heights of 15% than those reached by the downy oak. Passing from individuals to populations it should be noted that the few alsometric tables valid for the *Ostrya carpinifolia* forest formations (all of which are not accompanied by the accessory values or even those of height development over time) indicate an age of culmination of the average increase in mass varying between 15 and 22 years, depending on the fertility. At these ages coincide respectively an average increases of 4 and 2 m3 / ha. The following is a summary of the results obtained from the processing of data collected on more than 170 stumps and 1400 suckers in seven different steps of the management rotation of an *Ostrya carpinifolia* coppice forest formation on the Umbria-Marche Apennines. The areas was selected i function of their similar to management, morphology , pedology, vegetation and exposure. The study is part of the Ph.D. project and is currently the subject of an article in draft. The preliminary results here reported was exhibited at the national congress of the Italian Society of Forestry and Forest Ecology (Mei 2015).

Introduction

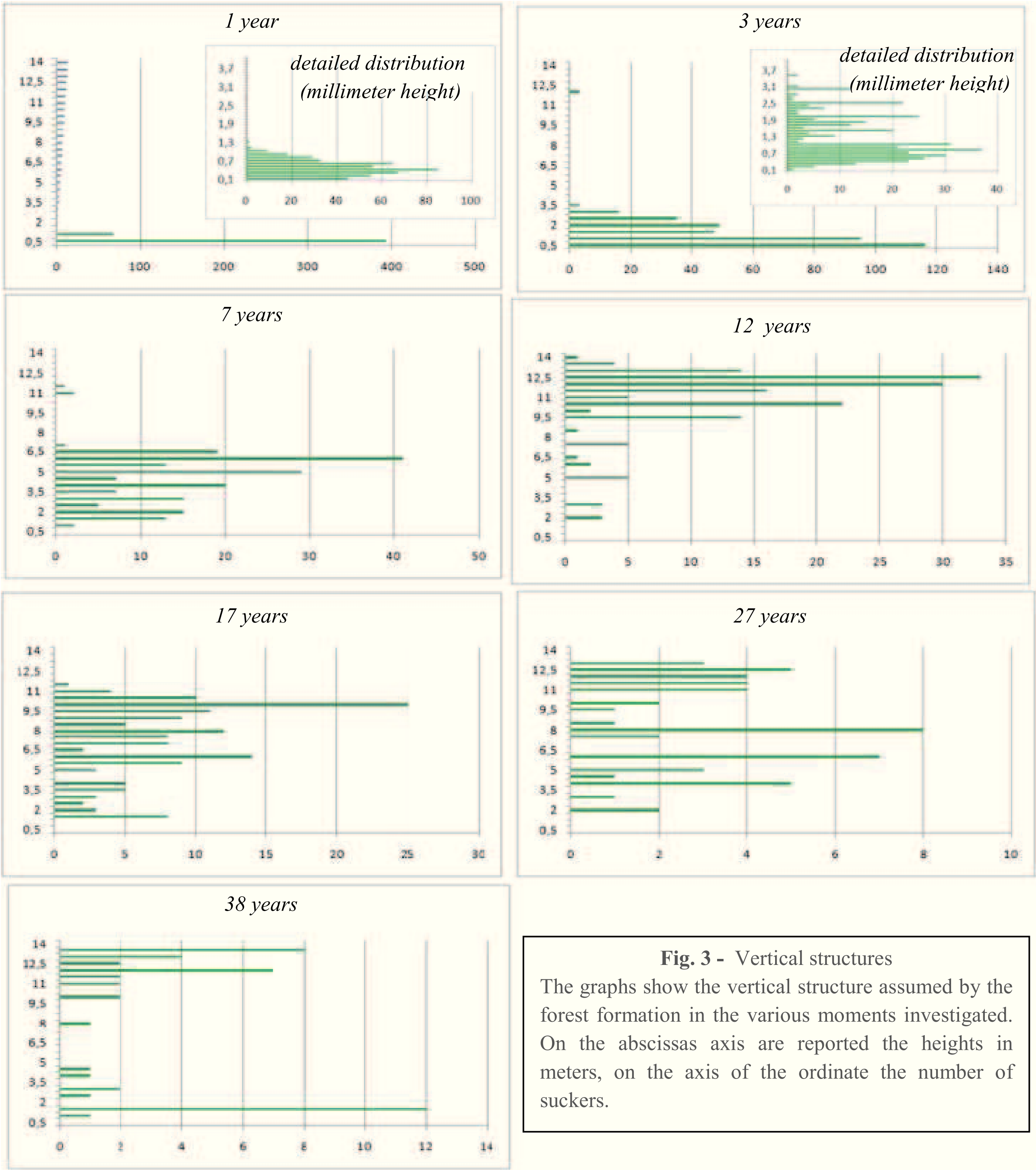
Given the scarcity of data and knowledge on the auxometry of the *Ostrya carpinifolia* forest formations and the total lack of dynamic studies, the aim of the study was to investigate the growth dynamics that occurring during the coppice rotation in a mesophyllic *Ostrya carpnifolia* stand managed for centuries as coppice with standards. This is in order to interpret the auxology and the structural modifications, even at the level of a single stump and draw useful information for a flexible and functional management. The data processing carried out until now allowed to reconstruct the evolution of the forest stand under many aspects, such as the trend of mortality and the changes in the vertical structure. The elaborations also show how advancing in the coppice rotation not only the numeric reduction of the suckers but also their change in the social position follow a trend that can also be interpreted mathematically. In fact, the belonging to the various social classes tends to change quite clearly, first within the stump of belonging and subsequently, when the hierarchies within the stump are fairly well defined, among the stumps.

Materials and methods

The *Ostrya carpinifolia* forest formation object of the study belonging in the phytosociological association *Scutellario columnae*-Ostryetum carpinifoliae. This is located on the North-Eastern side of the M. Nerone and it is uninterruptedly managed as coppice with standards for more than three centuries. The area falls entirely within temperate oceanic bioclimate, humid ombrotype, supratemperate thermotype (Pesaresi *et al.* 2014, 1016). Within the more than 80 hectares of *Ostrya carpinifolia* forest extension surveyed, were selected seven forest management units qualified by different age from the cut covering a period of over 38 years. in each of them a statistical sample was identified and therefore a plot area of 100 m2 was delimited. Within the pots all the suckers present each stump were measured. The height was measured for each sucker exceeding 2 cm with centimeter accuracy. The diameters were instead measured only on the suckers that reached 130 cm, with millimetric accuracy. the measurements concerned all the subjects, living and dead. Each suckers was then qualified by annotating its origin (gamic or agamic) and belonging to one or more of the six categories and eight attributes pre-established, concerning social status, vitality, physiology etc... (Mei 2014). Finally, was carried out a quali-quantification of the necromases.

Results

The punctual analysis of the data collected in the field and their graphic restitution allows us to appreciate the continuous variation of the development trends of vertical Structure (Fig. 3) and diametrical distribution (Fig. 4) during the whole time period investigated. Intuitible variations, but not appreciable, from the study of the only real hypsometric curves (Fig. 5). From the study of the physiognomic-structural characteristics (Fig.7), it emerged that the change is clearly perceptible and decipherable especially at the level of a single stump. In fact it was possible to develop a mathematical model capable of describing the changes with very high reliability ($0.703 \leq R2 \leq 0.981$). The analysis of the numerical variation living and dead stumps (Fig.8) within the time frame investigated shows that the competition is not limited to the selection of the suckers on the stump. it also causes the death of the dominated stumps, determining a turn-over with replacement of the dead stumps by seed plants present in the dominated plane at the time of cutting. The excessive lengthening of the rotation period ca be responsible for the degradation of the system, not only for the reduction of the sprouts capacity of the stumps but also by increasing the mortality of the stumps due to the increasing and prolonged competition. Also the risk of crashes, overturning and therefore the reduction of mechanical stability, considerably increases with the aging of the forest formation compared to a very little volume growth. furthermore, the rate of volume increase apparently in contrast with the information present in the literature (Ciancio *et al.* 2004), is explained by analyzing the evolution of the Basal Area breaking it down into its components (Fig. 9). This subdivision on a qualitative basis shows that the increase of the total basal area registered after the abandonment is due to a more than proportional increase of the deperient sukers which goes to add up to a less than proportional increase of the plants in excellent condition. The study of the Necromases (Fig.10) finally revealed how these, contrary to expectations, reach the qualitative and quantitative peak around the 7th year from the cut and not in the years subsequently the abandonment.


1 year

detailed distribution (millimeter height)

3 years

detailed distribution (millimeter height)

7 years

12 years

17 years

27 years

38 years

Fig. 3 - Vertical structures
The graphs show the vertical structure assumed by the forest formation in the various moments investigated. On the abscissas axis are reported the heights in meters, on the axis of the ordinate the number of suckers.

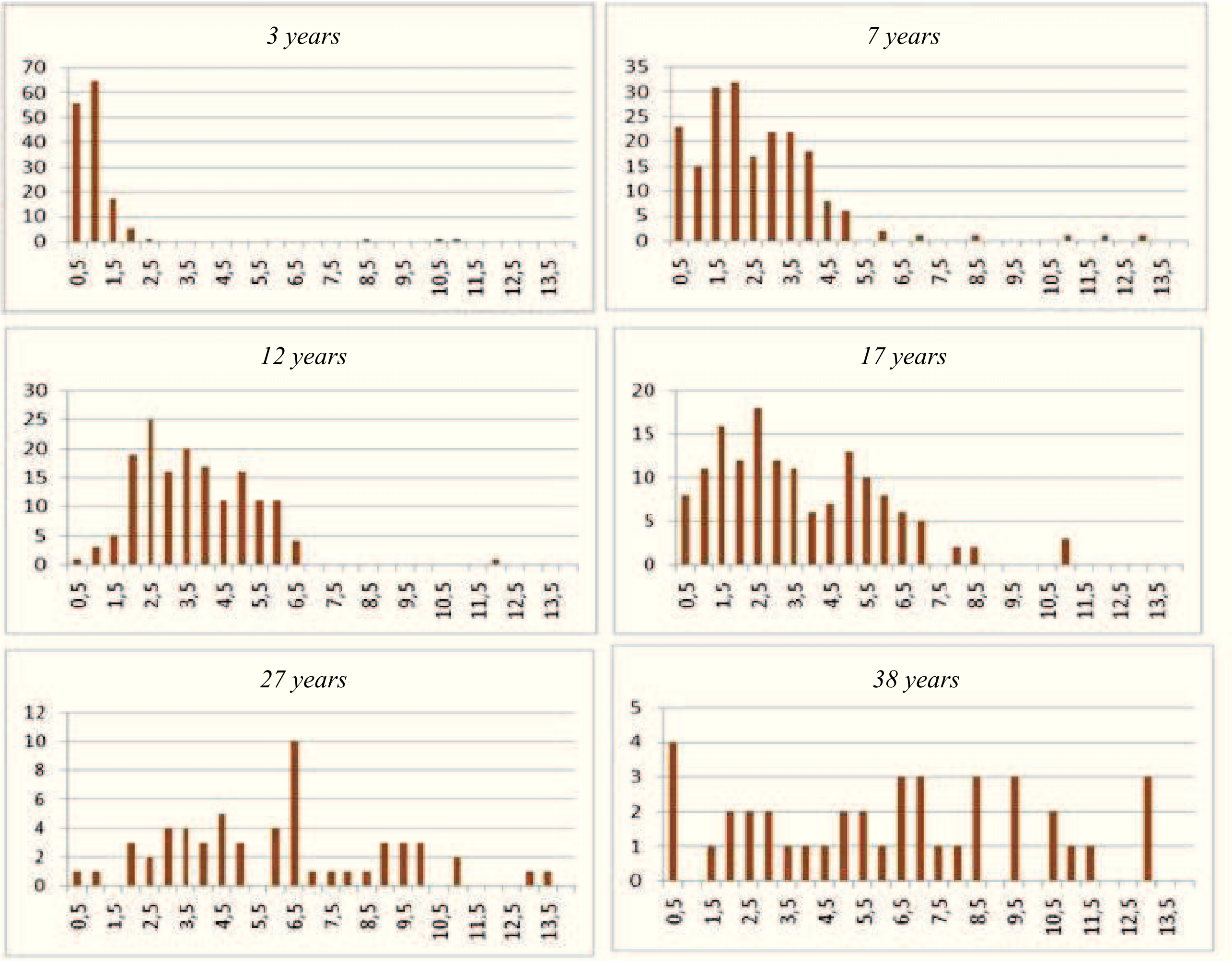


Fig. 4 - diametrical distributions

The graphs show the diametrical distribution assumed by the forest formation in the various moments investigated. On the abscissas axis are reported the number of suckers, on the ordinate axis are reported the diameters express in centimeters.

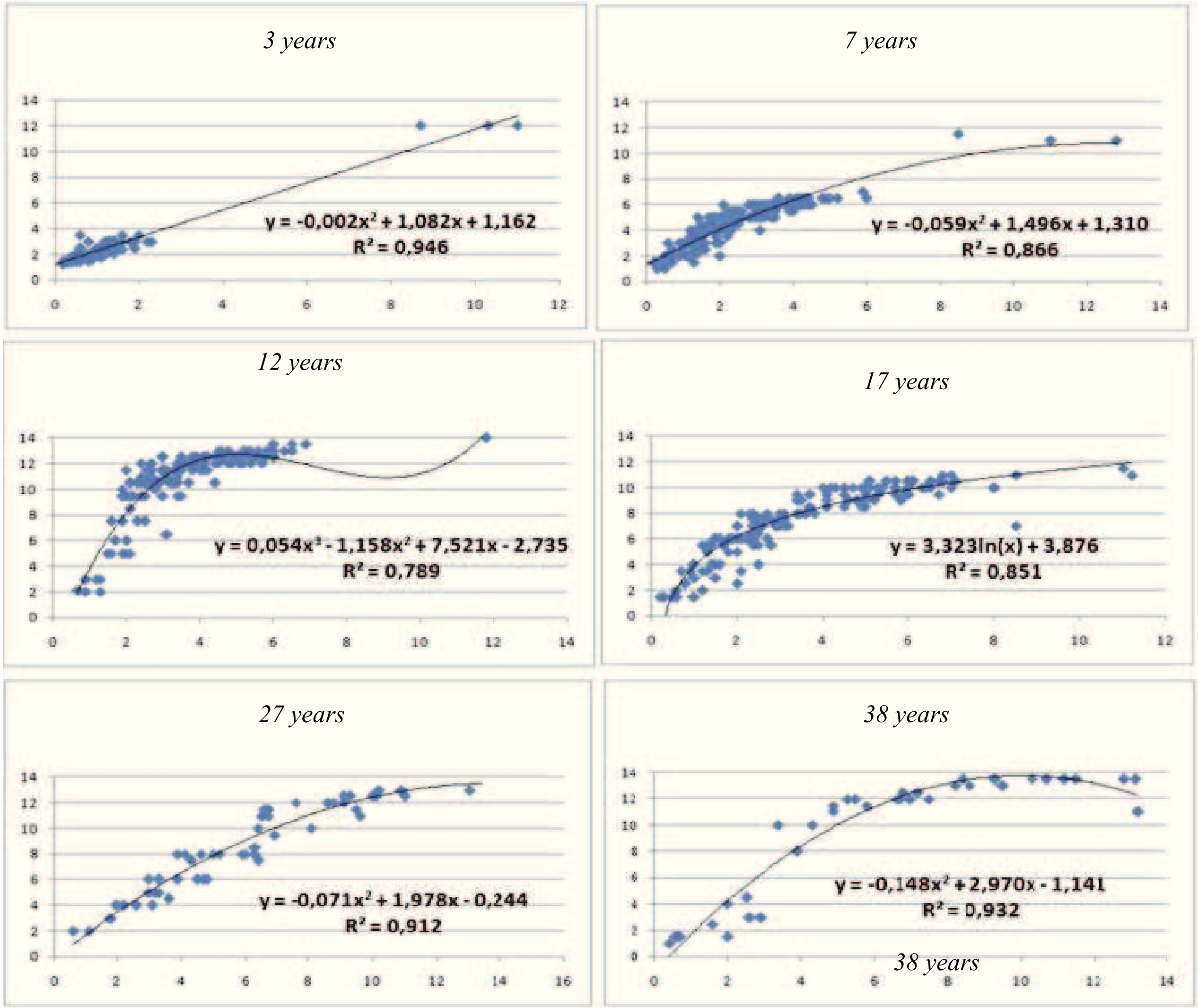


Fig. 5 - Real hypsometric curves

graphical representation of the correlation between the diameter at 130 cm and their height in the different moments studied. On the abscissas axis are reported the heights in meters, on the ordinate axis are reported the diameters express in centimeters.

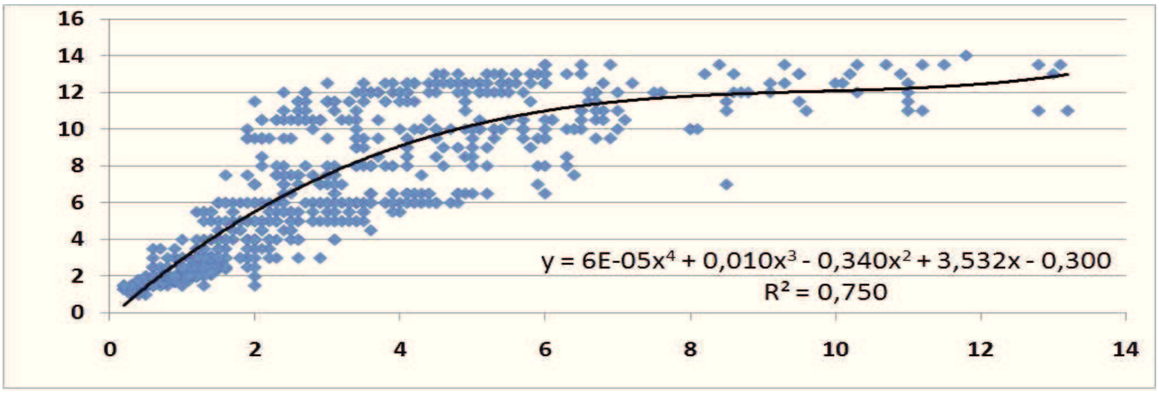


Fig. 6- Indicative hypsometric curves

graphical representation of the dynamic correlation between the diameter at 130 cm and their height, taking into account all the dynamic phases crossed by the examined population. On the axis of the abscissas are reported the heights in meters, on the axis of the ordinate the dimensions expressed in centimeters are reported.

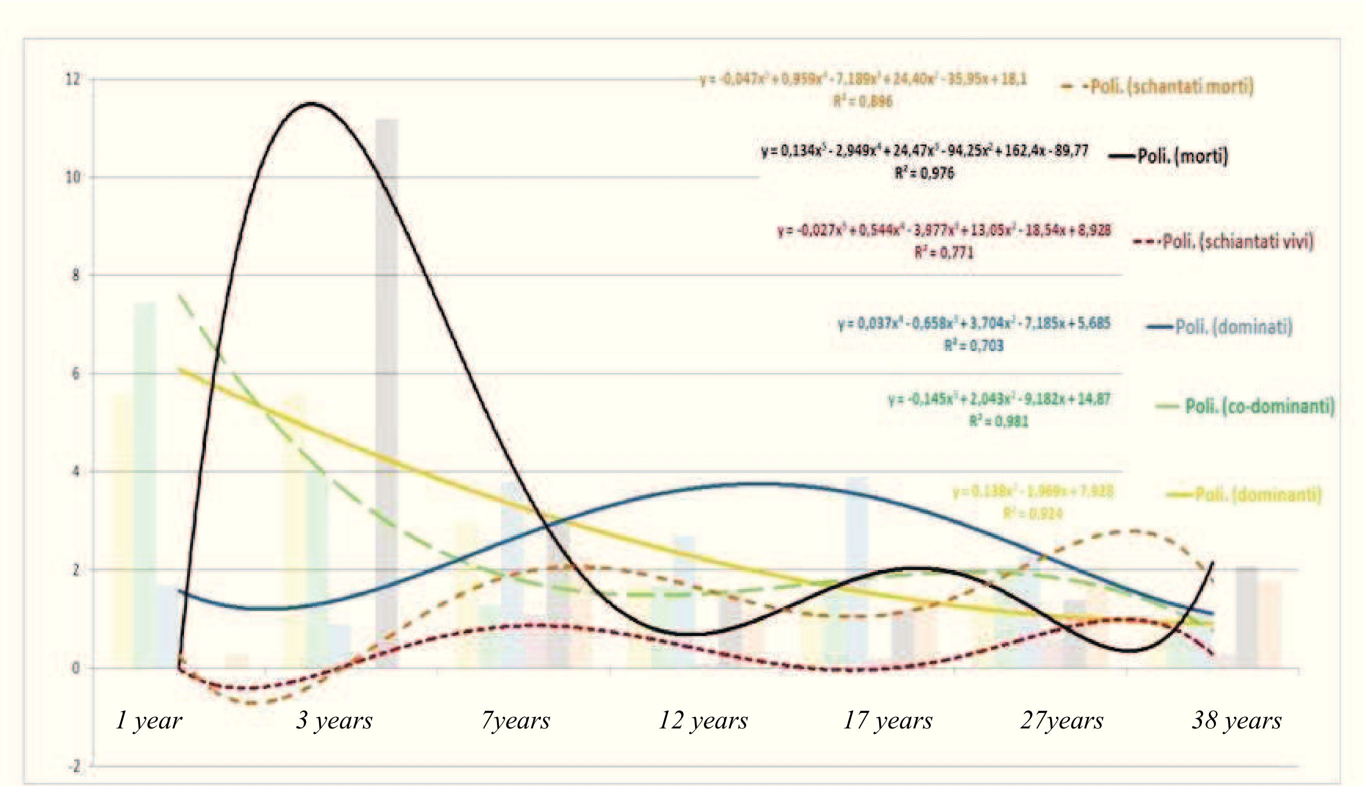


Fig. 7- modeling of the stump physiognomic-structural development

variation of the suckers belonging to the various categories on the stump within the time frame investigated and their mathematical interpretation. On the abscissas axis are reported the number of suckers, on the ordinate axis are reported the age of the stump.

Orange: crashed dead suckers ; Black: Dead suckers; Red: crashed live suckers; Blue: dominated suckers; Green: co-dominant suckers; Yellow: dominant suckers.

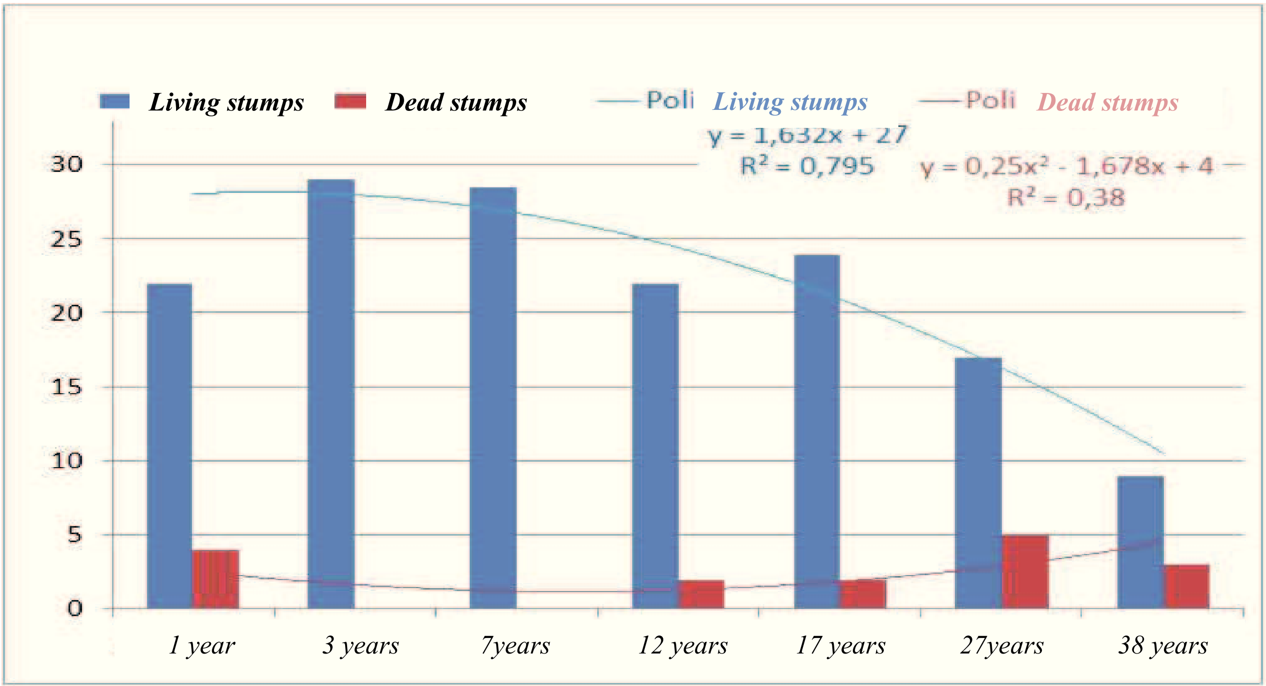


Fig. 8- modeling of the variation in the number of stumps and the mortality rate

On the abscissas axis are reported the number of stumps, on the ordinate axis are reported the years from the cut.

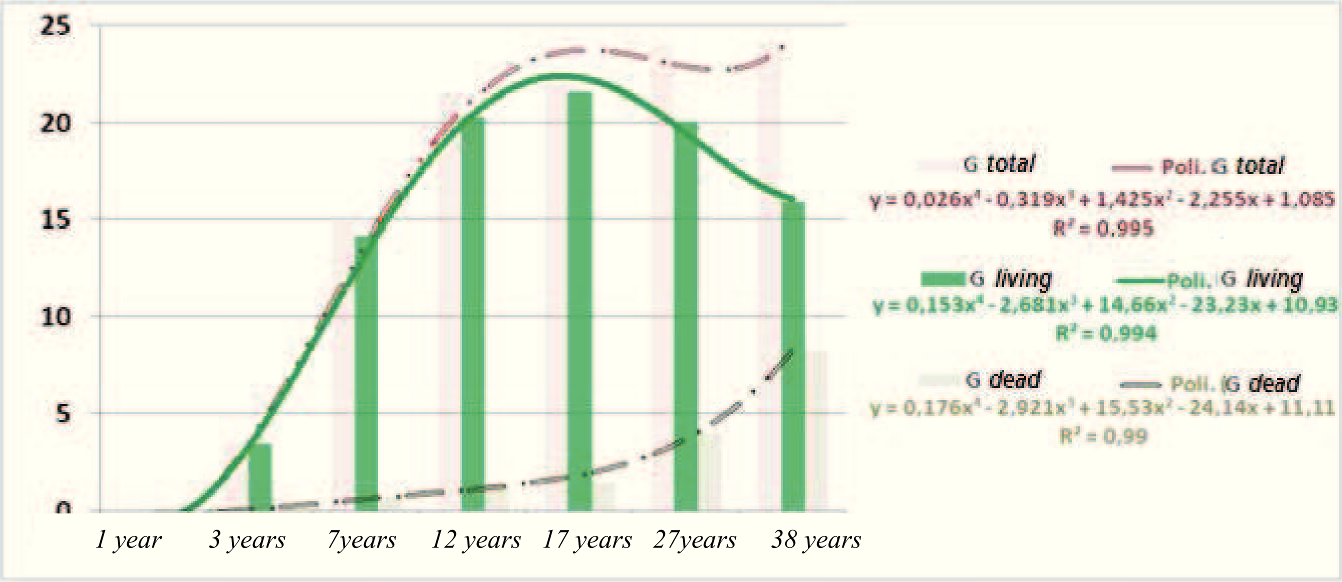


Fig. 9- Development of the Basal Area

dynamic trend of the basal area development referred to the living, dead and total component within the time period investigated.

On the abscissas axis are reported the value of the basal area (m2), on the ordinate axis are reported the years from the cut.

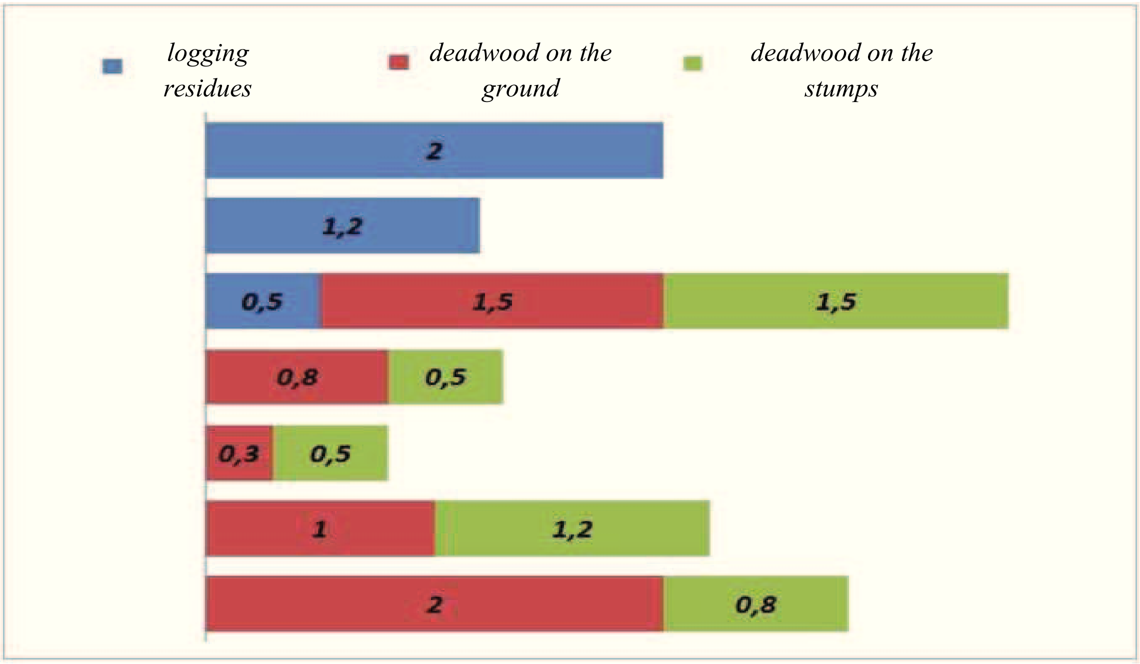


Fig. 10- Necromases volume and composition

the numbers inside the bars indicate the estimated volume in cubic meters

Conclusions

The study allowed us to reconstruct the dendro-auxometric and structural development of the forest formation analyzed, highlighting many interesting aspects. The development of vertical structure, diametrical distribution and the linked social dynamics highlight a sensitive and reactive system to microclimatic variations. The analysis of the suckers has allowed to highlight the dynamisms at stand scale but also at the stump scale: the belonging of the suckers to the various social classes tends to change in a rather evident and describable way also through mathematical models, first inside the stump of belonging and subsequently, when the hierarchies within the stump are fairly well defined, anong the stumps. Suckers and stumps show a growing mortality linked with the aging of the forest formation. Moreover with the aging of the forest also the risk of crashes and overturning increase triggering the decrease of the mechanical stability. The set of observed data suggest an optimal rotation period of about 17 years. This length of the rotation period result to be ten years shorter compared the rotation period currently widely adopted.

Characteristics of wood and its use

Ostrya carpinifolia wood is distinguishable by its reddish-brown color according to its macroscopic characteristics and by the scarce presence and visibility of the aggregate rays, which are instead clearly identifiable in the *Carpinus betulus* whose wood is gray-white in color. In both species, however, there is no differentiation between heartwood and sapwood. At the microscopic analysis the wood of *Ostrya carpinifolia* appears to consist of almost uniformly distributed vessels, isolated or in radial series of 3-5, with diameters progressively decreasing, sometimes also arranged in small groups in the area of early formation; he walls of the vases also show characteristic slight spiraling thickenings. The rays are very close together, one or two, which are high up to several tens of mostly procombent cells (Nardi Berti 2006). Percentage of the cell wall and percentage of porosity were calculated 56.87%, and 43.13%, respectively (Korkut & Guller 2008). As regards the physical and mechanical characteristics of the wood of *Ostrya carpinifolia*, it has a fine texture similar to that of beech and an irregular grain (Nardi Berti 2006) due to the frequent bad shape of the stems (usually suckers) which are often twisted and with non-circular cross section (Giordano 1971). The studies carried out by Nardi Berti (2006) and Korkut & Guller (2008) show that the wood of *Ostrya carpinifolia* is qualified by a density that varies from 1050 kg / m3 of fresh wood to 854 kg / m3 at normal humidity (22%). It is subject to strong shrinkage, but equally high is the degree of hardness, resistance to axial compression (from 320 to 640 kp / cm2 with an average value of 490 kp / cm2) and above all to bending (from 990 to 1620 kp / cm2 with an average value of 1360 kp / cm2). These characteristics would explain quite well the characteristics of difficult workability of this wood. In fact already Giordano (1976) underline how it lends little interests to sawing and reacts badly to drying, which to avoid splits and deformations must be carried out in a particularly slow way. To date peeling and shearing are not practiced and planning is quite difficult even if it can lead to excellent results. Bonding is normal and joining with nails or screws is good, but in this last case, the preliminary preparation of the groove is necessary. Satisfactory results are also obtained in the painting processes (Nardi berti 2006). It could instead be very interesting to use this wood in the composition of wood particle panels, but above all and as pellets and chips. To date, however, the timber of *Ostrya carpinifolia* remains almost unknown from the timber industry, as already observed by several authors (Giordano 1971, 1976, Del Favero *et al.*, 1989, Korkut & Guller 2008) not for technical problems, today easily of overcome, but rather for the reduced and inconsistent offer of this wood on the trade. Nowadays, the wood of *Ostrya carpinifolia* is almost exclusively used as firewood, a use for which it is however particularly sought after. In the past this wood was instead particularly wanted and used in function of hardness for different purposes such as furniture, axles, handles, levers, mallets, splitting wedges, canes, carpentry, wooden wares, novelties, fuel wood and charcoal (Alden 1995; Bozkurt & Erdin 1997, 1998, Bernetti 1995, among others).

Elements of Physiology

(literature review)

In the Mediterranean and sub-Mediterranean areas, the diffusion and dominance of each species are often linked to the complex relationships existing between the tree and the water. Frequent high temperatures, whether or not accompanied by scarce water availability in the soil, make up one of the main limiting factors in the vegetation in these environments. These species, which have some anatomical characteristics and particular physiological processes, are more resistant to these adverse situations, allowing them to overcome the moments of greatest difficulty without suffering irreversible damage. In trees, one of the most effective defense mechanisms against high temperatures is the possibility of variation in the transpiration process. This consists in the loss of water above all by the foliaceous apparatus and involves an absorption of thermal energy which results in a cooling of the surface of the leaves (Taiz & Zeiger 2012). It also increases the amount of water taken by the roots, thus increasing the speed of absorption of the mobile ions present in the circulating solution of the soil surrounding the root system. In general, those species with the highest transpiration values are more resistant to high temperatures when there is sufficient water availability in the soil. Contrariwise, when the amount of water available is very low, excessive transpiration leads to a negative water balance with possible damage (Hopkins & Huner 2007). Before this occurs, the most "efficient" plants reduce transpiration, closing the stomatal openings, in such a way as to cause the least effect on assimilation (Taiz & zeiger 2012). From which, it follows that plants more resistant to high temperatures should show high transpiration during periods of good water availability, while, in the opposite situation, reductions of this process would occur. Instead, plants that have more or less constant values of transpiration would not be very resistant. Through transpiration measures on trees of ash, oak and hornbeam in Croatia in two different formations belonging to the association of *Carpinetum orientalis*, Ilijanic & Topic (1982) have shown how the *Ostrya carpinifolia* showed the lowest transpiration values with minimal daily and seasonal variations. Again, Ilijanic & Topic (1982) show how in a formation belonging to the association of *Seslerio-Fagetum*, *Ostrya carpinifolia* and *Fagus sylvatica* show very similar values of transpiration. These observations confirm that the greater resistance of the downy oak, but above all of the ash manna to high temperatures, with more or less high water availability in the soil, are linked to the physiology of the species. Then *Ostrya carpinifolia* would show a behavior much closer to that of beech than to that of other more typically Mediterranean and sub-Mediterranean species to which it is generally associated and this would also explain the different growth patterns observed and reported above . Similar conclusions are also drawn from the studies on the osmotic potential of some plants, including *Ostrya carpinifolia*, carried out in Istria on formations belonging to *Fagetum croaticum seslerietosum* (Ilijanic & Topic 1972) and in Italy on formations belonging to *Quercetum pubescentis* of the Apennine and the coast area in the area of the Marche region (Pedrotti 1965). In fact, the results obtained in both studies show that O*strya carpinifolia* shows a behaviour typical of the stenohidric species, similar to that of beech, while the manna ash seems to be attributable to the category of Eurihidric. Therefore this makes it possible to explain why the sunniest and most windy slopes are often colonized only by the manna ash, which is the most resistant species to unfavorable conditions with regard to high temperatures. As a further confirmation, Kunz (1975) points out that *Ostrya carpinifolia*, the downy oak and the manna ash begin the process of closing the stomas more or less with the same water saturation deficit, much later than that of beech leaves. The complete closure of the stomata takes place for similar deficiencies in *Ostrya carpinifolia*, downy oak and beech (leaves exposed to the sun), while the leaves of the manna ash continue to transpire through the stomata even in the presence of higher deficits. In *Ostrya carpinifolia*, in the oak and beech (leaves of shade) the first symptoms of desiccation occur in the presence of a deficit of about 30%, while the manna ash bears values even slightly higher than 40%, so proving to be, among those examined, the most resistant species to drought (Kunz 1975, Larcher 1977). Considering the stenoidricity of *Ostrya carpinifolia* and its limited ability to withstand high temperatures, we can perhaps justify the increasingly infrequent cases of desiccation of the upper part of the hairs of some subjects during the summer months. A phenomenon already reported in the eighties by Cristofolini (1981) on reduced surfaces for populations "on superficial soils, in 25-35 year old suckers", today more and more frequent and on surfaces often extended during the summer months. At present, several forest technicians (personal communications) attribute this eventuality to the presumed limited longevity of *Ostrya carpinifolia* and the triggered decay of abandonment. However, in the light of what reported above and on the basis of the surveys made, this is to be considered unlikely since the drying process begins in subjects that, although of agamic origin, may still be considered relatively young. According to the research of Schwappach reported by Speranzini (1933) and based on observations and measurements, it can be seen that the *Ostrya carpinifolia* shows clear signs of aging decay in abandoned stumps or trees whose age is not less than 150 years. The desiccation of *Ostrya carpinifolia*, therefore attributable to a different cause, can be found especially in stations facing south, very steep and with very shallow soil (5-10 cm). In these areas, and especially along the prominent areas, where the water conditions are more unfavorable, many stumps of *Ostrya carpinifolia* have the largest suckers completely desiccated, while other suckers smaller and stunted appear still green. However, the phenomenon is present in the gorge areas too, even if much less evident. This symptom picture would therefore clearly indicate the diagnosis of "water stress" as the cause of this disease. Phenomena of diffuse death of *Ostrya carpinifolia* were also observed in diametrically opposite situations. In fact, in some formations attributable to the association of *Aceri-Fraxinetum* where the *Ostrya carpinifolia* is a minority compared to other deciduous trees (*Carpinus betulus, Fraxinus excelsior*, *Salix ssp*, etc.), placed along valleys affected by water stagnation, many subjects of *Ostrya carpinifolia* appear desiccated or in bad phytosanitary conditions. The presence in the undergrowth of an almost uniform carpet of *Allium ursinum* (L.) makes it possible to easily identify these "at risk" stations (personal observations). The visible symptoms of the pathological state, attributable precisely to excessive water stagnation, are the detachment of the bark in the basal part of the trunk and the desiccation of the distal branches. This is accompanied by a vast necrotic process involving the root system, clearly visible in the overturned stumps. If from the foregoing it is possible to deduce that *Ostrya carpinifolia* is a species enough sensitive to the soil water conditions, above all in the presence of high temperatures, we cannot say the same with regard to the vulnerability of the species at low temperatures. The research conducted by Larcher (1968-1977) and Larcher & Mair (1968) on the resistance at low temperatures of Mediterranean and sub-Mediterranean species, including *Ostrya carpinifolia, Quercus pubescens* and *Fraxinus ornus* highlights in fact a strong resistance of the species. In addition, the authors have shown how the mechanisms of resistance are independent of the subjects' provenance. In fact, the suckers taken in January at Riva del Garda (minimum temperatures around -7 °) and Innsbruck (minimum temperatures on -20 °) showed, at the same temperature, similar damage in all three species. The authors highlighted how the defense mechanisms towards low temperatures start already at the first appearance of values close to zero and are more precocious in the coldest locations independently of photoperiodism. The resistance to cold is gradually increasing as the temperature decreases and is generally the highest in January. During this period temperatures below -40 ° are required, so that more than 50% of the vascular cambium of the younger branches is damaged (Larcher 1977). In springtime the resistance to low temperatures decreases considerably, However, once again Larcher (1977) shows in his study how *Ostrya carpinifolia* seems to endure better the less favorable conditions and this especially in late winter (February), in late summer (August and September) and in early autumn (October and November). This leads us to consider that *Ostrya carpinifolia* is able to overcome unscathed, more than the other two species, both the late frosts and the early ones. Larcher & Mair (1968) have also pointed out that the resistance to cold of trees of *Ostrya carpinifolia* varies from individual to individual in relation mainly to the phenological phase. However, the authors point out that the most critical phase corresponds to the sprouts emission in which the first damages occur already with temperatures of -4 °C, above all in the vascular cambium, while total damage occurs only at temperatures of about -17 °C. It can therefore be concluded that *Ostrya carpinifolia* is a species resistant to the action of spring and autumn frosts, more than *Quercus pubescens*, *Fraxinus ornus* and perhaps even *Fagus sylvatica*. lastly, Gellini & Grossoni (1997) & Grossoni *et al*. (in press) highlight how *Ostrya carpinifolia* has a short period of dormancy and low chilling needs.

II

Distribution, typification and management of the *Ostrya carpinifolia* forests

Chorology

(literature review & unpublished data – study in progress)

Ostrya carpinifolia is an exclusive species of the countries that gravitate in the north-eastern area of the Mediterranean basin (Pasta *et al*., 2016). The upper limit of diffusion of the species can be fixed at the 47th parallel, while the lower limit follows about 35 ° parallel (Gellini & Grossini 1997). The species is absent in the countries south of the Mediterranean Sea (Tunisia, Morocco, Egypt, etc.) as well as in the western sector (Iberian peninsula), while in France it is marginally present (Tison & de Foucault 2014) on the limestone hills of the department of the Maritime Alps (Perrin 1963) where it mixes with the holm oak (*Quercus ilex*), downy oak (*Quercus pubescens*) and the Manna ash (*Fraxinus ornus*). In Corsica it is present sporadically along the east coast. A variant (Fliche 1888) was described here, characterized by fruiting catkins that are constantly longer than 30 mm. The species is also present, but with only very few sporadic specimens even in the extreme south of Switzerland (Schmid 1939, 1949, 1950, Guidi & Piussi 1993) and in Tyrol (Mayer 1977). On the contrary, *Ostrya carpinifolia* assumes considerable importance in the Central-Eastern Mediterranean countries, and in particular in Italy, Istria and Croatia. Here it is possible to identify its greatest expression, both in extension and in ecological diversity, especially in the area corresponding to the Umbria-Marche Apennines.

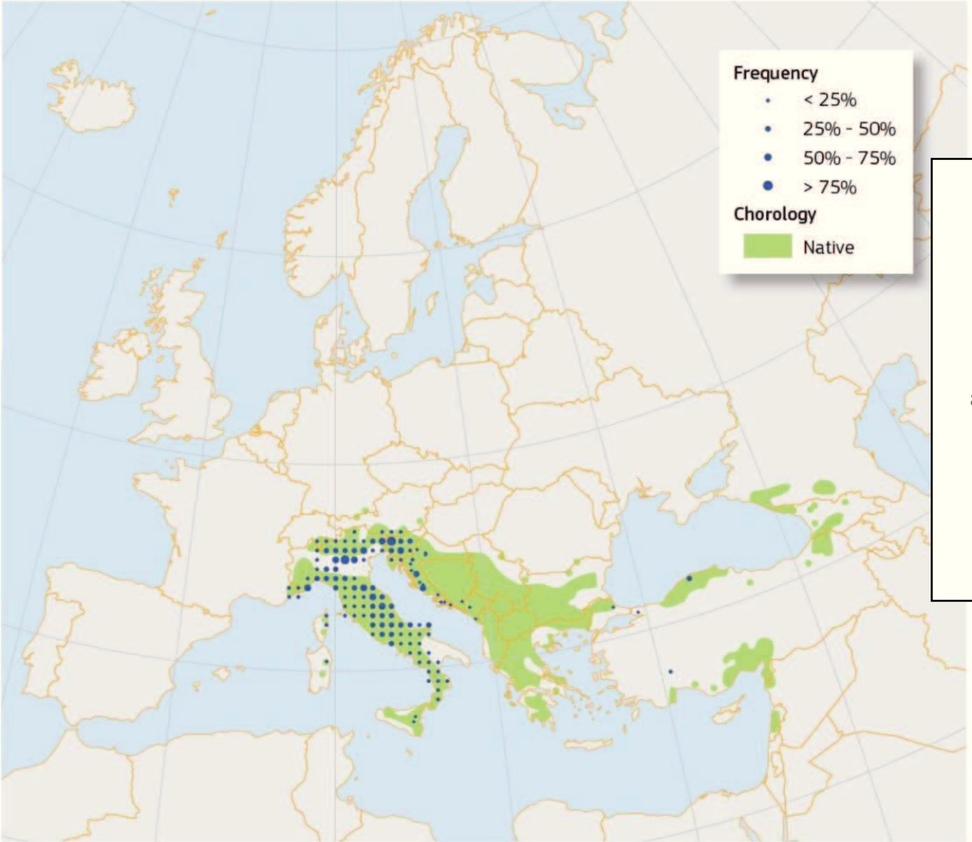


Fig. 11- Plot distribution and simplified chorology map for *Ostrya carpinifolia*.
Frequency of *Ostrya carpinifolia* occurrences within the field observations
as reported by the National Forest Inventories. The chorology of the native
spatial range for is derived after Meusel & Jäger 1989
(Pasta et al. 2016 – modified)

Distribution in Italy

The diffusion within the Italian territory of *Ostrya carpinifolia* was studied in detail only by Hofmann (1982), on whose research all subsequent studies are based (Bernetti 1998, INFC 2005, Del Favero 2008, 2010, 2013, among others). In his study Hofmann (1982) distinguishes in two geographic areas the *Ostrya carpinifolia* formations in the Italian territory: one in the Alps and the other along the Apennines. The disjunction of the two sub-areas was attributed by various authors (Hofmann 1982, Ubaldi 1990, Del Favero *et al.*, 2016, among others) to the continentalization of the climate in the Po Valley area and to the presence of acid soils on an unclear " crystalline plinth "(Hofmann 1982, Bernetti 1995) in the lower slopes of the Western Alps. Conditions that are not very favorable to the species and that would have stopped its progress. On the basis of the surveys and observations carried out in this project and the information deducible from other studies (Favaretto *et al.*, 1990, Tassinazzo & Fiorentin 2003, Di Giovinazzo & Andreis 2006, Poldini *et al.*, 2009 among others), this justification would seem to be valid only in part. More than the marked continentalization of the area, confirmed by a bioclimatic point of view also in Pesaresi *et al.* (2014, 2017), the almost lacking of Ostrya carpinifolia in the Po plain area would seem to be due in equal measure to the geo-pedological characteristics and to human activity. While on the one hand the plain area of the Po valley shows a clear geological (Tacchia 2004) and pedological differences (Costantini *et al.*, 2012) that clearly separate the pre-Alpine reliefs from the Apennine range, on the other hand various authors point out that the two mountain ranges are in geological (Tacchia 2004), Pedologica (Costantini *et al.*, 2012) and ecological (Pignatti 1982, 1998, Pignatti *et al* 2018) communications, settling in the area of the Maritime Alps. The total absence of *Ostrya carpinifolia* forest formations in this whole area would seem to be more easily attributable to management activity, which over the centuries has favoured other species, and therefore other forest formations. In fact, several historical sources show how in this area all the silvicultural activities were aimed at supplying the shipyards of the city of Genoa (Boscolo 1978, Airaldi 2007, Musmarra 2015 among others). Based on the estimates made, the Alpine host lands occupy an area of approximately 238,000 ha extending from the east bank of Lake Maggiore (therefore excluding the alpine area of Piedmont) up to the eastern national border with greater diffusion in Lombardy (provinces of Brescia and Bergamo for a total of 78,100 ha) and in the Veneto region (65,000 ha). *Ostrya carpinifolia* forests in the Alps go up the valleys, where the geo-pedological context allows it, until it disappears within the lower limit of the beech forest. The species usually grows on calcareous soils, but exceptionally it is possible to observe the formations (Valtellina, Bolzano, Merano, Bressanone) also on sub-acid soils on shales and in soils of flint origin (Personal observations). On the Appenines the *Ostrya carpinifolia* forests are instead extended to 614200 ha, starting from the Maritime Alps and descending along the entire Apennine chain down to Calabria. The greatest extension is in the area of the Umbria-Marche Apennines. Here these formations extend over a surface that can be estimated, analyzing the data present in different studies (IPLA 2001, INFC 2005, Umbria Region 2009) around 185.800 ha, equal to about 65% of the total forest area. With 120.800 ha (INFC 2005) Umbria in particular is the region most characterized nationally by these formations. In the Apennine area the *Ostrya carpinifolia* forests occupy mainly the hilly belt up to low mountain belt (where they give way to the beech formations), while the diffusion towards the lowland belt is limited by the presence of the agricultural crops. Frequent is also the replacement of the *Ostrya carpinifolia* forests with plantation of *Quercus cerris* and *Castanea sativa* in the high hilly and low mountain belt and with the agricultural crops in the low hilly and lowland belts. Brullo (1983) and Ubaldi (1990, 2008) also report the presence of *Ostrya carpinifolia* in Sicily, on the calcareous soils of the Madonie. Bacchetta *et al*. (2004) instead indicate the presence of the species in Sardinia, in a small strip under the summit of Gennargentu, in the upper Val Flumendosa, around 1500 m above sea level. Overall, by comparing the data available in the literature (Hofmann 1982, Bernetti 1995, Pignatti 1998, INFC 2005) the forests of *Ostrya carpinifolia* would therefore extend to 852200 ha (238,000 ha of the Alpine range, 614,200 ha of the Apennine one, of which 850 ha Sardinian disjunction). Moreover, of the overall 852200 hectares, about 170440 hectares would be characterized by cenosis in which *Ostrya carpinifolia* would participate in the dendrological composition in a percentage lower than or equal to 30%. In other 255660 hectares *Ostrya*

Fig. 12- Distribution of *Ostrya carpinifolia* in Italy
(Hofmann 1989 – modified)

carpinifolia would be present in a percentage between 20 and 50% while in the remaining 426100 hectares the species would exceed 50% of the dendrological component. *Ostrya carpinifolia* forests are therefore the fourth most widespread forest category in Italy (INFC 2005) but probably the most peculiar and characterizing landscape.

Distribution in the Balkans

The Balkans are certainly the second area most affected by the presence of *Ostrya carpinifolia* forests. From the investigations of Puncer & Zupancic (1982) only in Slovenia 150,000 ha of forest are strongly qualified by the presence of this species. From the investigations of Horvat (1950), Fukarek (1968, 1979) and Vukelic (2012) we can instead deduce that the black hornbeam is present a bit in all the Balkan regions. In this territory the O*strya carpinifolia* participates as a minority species in the constitution of mixed forests with prevalence of *Carpinus betulus* at lower altitudes. The species instead becomes dominant in areas characterized by rocky outcrops and shallow soils of the mountain belt. In particular in Croatia it is often found to be associated with oaks or beech on superficial calcareous soils (Vukelic 2012). In Serbia and up to the border with Bulgaria, in an area with a rather dry climate, it still mixes with the thermophilous oaks, among which mainly the Turkey oak and the downey oak.

Distribution in Greece

The area of diffusion of *Ostrya carpinifolia* in Greece can be inferred from the works of Mavrommatis (1980), Barbéro & Quezel (1976), Horvat *et al*. (1974), Schumacker (1942), Jalas & Souminen (1976), Debazac & Mavrommatis (1971). According to these authors, the species is present in Macedonia, in Thessaly, in the Peloponnese and in Epirus where it participates in the supramediterranean vegetation characterized by the constant presence of *Carpinus orientalis*. *Ostya carpinifolia* dominates instead in the upper altitudes mixing, as well as with *Carpinus orientalis*, with *Quercus frainetto* on siliceous soils and with *Quercus pubescen*s on calcareous soils. Relatively frequent, especially in the higher areas, is also the mixture with *Fagus sylvatica* and in some rare cases with the *Abies borisii-regis* (Mattf.). In the Peloponnese area on carbonatic substrates with very impoverished forest vegetation to *Ostrya carpinifolia* and *Quercus pubescens* is added *Pinus pallasiana* Lamb.

Distribution in Turkey

The vegetation of Turkey has been particularly studied, from the phytogeographic point of view, by Quezel & Pamuckuoglu (1973) Akman *et al*. (1979) and more recently by Ansin *et al*. (1998, 2001), Yaltirik & Efe (2000). From these studies it can be inferred that *Ostrya carpinifolia* is present in two different areas, qualifying however about 0.01% of total forest area in Turkey (Konukcu 1998). The first area is located in the north of Thrace, on the hills that border the shores of the Black Sea. here *Ostrya carpinifolia* prevails in the hilly belt, while the *Fagus orientalis* Lipsty dominates the mountain belt. The second area of presence is located in the Tauern. Here *Ostrya carpinifolia* constitutes mixed forest with *Carpinus orientalis* and *Quercus cerris* in the low mountain belt, instead in the high mountain belt it is mixed with *Pinus heldreichii*.

Typification of the different *Ostrya carpinifolia* forest vegetations

(literature review & unpublished data – study in progress)

From a taxonomic point of view, the studies on *Ostrya carpinifolia* forest coenoses have been very inhomogeneous both by method and by interpretation made. This has meant that to date in the literature these formations are described in over 70 associations referring to 11 alliances in turn attributable to five classes. A first analysis of the information found in the bibliography has immediately underlined that it is absolutely necessary a work of sintaxonomic revision able to clarify various aspects that are incomplete or highly doubtful. On one hand a large part of the synoptic tables describing the associations are very heterogeneous and could probably be merged into different associations or be further subdivided. Others, on the other hand, to a more careful analysis and in the light of modern analysis techniques and developments in interpretative skills, do not seem to differ sufficiently clearly both floristically and ecologically. Moreover, almost all of these were made following the initial method (Braun blanquet 1927, Tüxen, 1956, 1977, Pedrotti *et al.*1967, among others) carrying out surveys covering whole forest areas, including different micro-environmental situations that today would have been excluded from the context and described separately (Géhu *et al.* 1991; Theurillat 1992a, b, Biondi 1994, 2011, Biondi *et al.*, 2004, Rivas-Martínez 2005, among others). However, as already mentioned above, the reduced interest in these formations has meant that to date no syntaxonomic reviews have been made, nor updates or corrections to the associations described. Currently a work of syntaxonomic revision of the entire existing literature has been started by prof. Poldini of the University of Trieste, with whom there is a collaboration relationship in order to implement and support the revision work with new ad hoc surveys. However, this taxonomic revision is not the subject of this project, and although it is currently in progress, it has been decided not to discuss any longer these aspects in this work. Here below is instead reported and briefly discussed the subdivision of *Ostrya carpinifolia* forest formations carried out on ecological-physiological basis, based on the surveys made during the project and the information available in the literature.

Orno-Ostryetum : It is certainly the most widespread and representative category. About 2/3 of the *Ostrya carpinifolia* formations analyzed on the Italian and Balkan territory belong in this group. These formations grow on rather fertile, fresh but well drained calcareous soils of the hilly and low mountain belt. The exposure varies a lot according to the characteristics of the station but it tends to move from North to South-East as you go up in altitude. Despite the slopes, which can be very high (often over 60%), these formations are characterized by high vigor and heights that often exceed 15 metres in 30 years. Despite the high density, the stumps have a very high number of suckers that remain elevate even more than 20 years after the cut. These typically mesophilous formations are characterized by a rich floristic cortege (often over 60 species) qualified by numerous orchids and different species typical of open forests that tend to disappear in the aged and / or abandoned formations.

Ostrio-Quercetum : rather common formations of the deciduous oak woods belt. They are characterized by good values of density, diameter and height, probably not very high compared to the potential of the species, but certainly high if compared with other forest formations of the same vegetational belt. The underwood is characterized by a homogeneous and diffused shrubby layer. This is characterized by a high presence of *juniperus sp.* The presence of *Cotinus coggygria* characterizes the areas with warmer exposures and shallow soil. The coverage by the herbaceous layer is rather low even if the number of species is generally high.

Seslerio-Ostryetum: Very common formations in the Balkan area, characterized by small diameters and heights and rather reduced density. They are typically found on calcareous soils, rich in skeleton and generally shallow. The high brightness promotes the spread of a rich grassy layer characteristically represented by species belonging to the genus *Sesleria*. The species of *sesleria* differ according to the geographical area and the reference altitude (generally *S. varia* in the Apennines and *S. autumnalis* on the Balkans). These formations are also pushed to higher elevations where the edaphic characteristics are not suitable for the development of beech forests. At higher altitudes, or in more fertile conditions, these formations are enriched with species of the *Carpinion* alliance (*Asarum europaeum, Rosa arvensis*, etc ..) when it does not even appear an appreciable contingent belonging to the *Fegetalia* order (*Acer platanoides, Festuca heterophylla, Mercurialis perennis,* etc ..). On the contrary, at lower altitudes and in warmer exposures, these formations differ in the presence of elements related to the *Quercetalia pubescentis - petreae* order (*Sorbus* ssp., *Cornus* ssp., *Melittis melissophyllum*, *Tanacetum corymbosum*, etc ..). their massive presence indicates a link between the Seslerio-Ostryetum and the Ostrio-Quercetum.

Pioneer Ostrya forests: a very heterogeneous group that highlights adaptations to the climatic and / or edaphic xericity thanks to the frugality, rusticity that characterizes the species involved. They characterize very different situations, all of which are associated with the scarcity of soil. They generally colonize in high mountain scree, eroded soils of the hilly and mountainous belt, abandoned quarries, quarry dumps, more stable gullies, etc... These formations are characterized by reduced heights and diameters and low density. Sometimes they also assume a shrubby structure. They can generally be considered dynamic phases of the forest vegetation that, where the edaphic conditions allow it, evolve very slowly in another *Ostrya carpinifolia* forest type.

Thermophilic Ostryetum: typical of supramediterranean environments characterized by very low summer rainfall where it colonizes the areas exposed to the north. They are generally formations of good fertility and rather dense. The underwood is characterized by the presence of *Smilax aspera* and often dominated by a continuous carpet of *Hedera helix*. After abandonment, these formations are characterized by the vegetative explosion of *Ruscus aculeatus* which tends to cover completely the underwood triggering a strong regression of all the other species present. This phenomenon is pretty common and diffused throughout the Italian low hilly belt.

Xerophyllic Ostryetum: hilly hostures, of north exposure, similar to the previous ones but with a structure that recalls the Mediterranean scrub. The mixture with the *Quercus ilex* becomes frequent in Mediterranean environments where the *Ostrya carpinifolia* is concentrated at the bottom of the valleys, while upwards it fades up to be present only with a few individuals interposed to the evergreen sclerophyllous forest.

Wall gorge Ostyetum : they are observable in correspondence of rocky slopes of gorge, on rocky slopes exposed to the North in the planar belt and in the South in the high mountain, they are pioneering forest formations with edaphic determinism with very little evolutionary possibilities. They all have in common the ability of characterizing cool areas even in summer, in shady places and very rich in moisture. They generally qualify steep slopes, often rocky walls. This type, one of the few which were difficult to be used even in the past, is generally characterized by a high floristic richness with the presence of numerous endemic and relictual species.

Aceri-frassinetum with Ostrya: formations observed near the impluvium areas, where there is accumulation of soil and organic matter, but always in the context of a rocky landscape with steep slopes. In these formations *Ostrya carpinifolia* is associated with species related to the Tilio-

Acerion alliance (Fraxinus excelsior, Tilia cordata, cardamine Pentaphyllos, Phyllitis scolopendrium, Actea spicata, etc.). The plants of *Ostrya carpinifolia* tend to localize on the best drained bumps and in all the more dry positions, while those present in slightly drained or more humid sites show symptoms of premature aging and tend to die in few years.

Traditional management techniques, modern trends and current status

On the basis of the bibliography available (Bernetti 1998, Piussi & Albeti 2015, Vukelic 2012, among others), the historical forest management plans consulted regarding various provinces of the Italian and Croatian territory and the surveys carried out during the three years of the project, it is possible to assert that in all the distribution area, the *Ostrya carpinifolia* forest formations were traditionally managed as coppice. The study carried out also showed how this management practice was characterized even from the beginning of the last century by rotation periods, which could vary according to the conditions of the forests, from 12 to 20 years. At the end of this period the entire forest area was coppiced, with the exception of a number of standards ranging between 10 and 80 per hectare. Intermediate forestry practices were not foreseen and the area coppiced, generally all privately owned, had an average surface of less than 2 ha. To very few forest formations (all identified on the Balkan territory) was applied the disetaneous coppicing, which consisted in the cutting of only part of the suckers on the stump and that allowed to shorten the period between the cuts, produce poles of different sizes and maintain a constant soil coverage. These forest formations, unlike many other forest formations objects of the same form of management, were not subject to grazing. The coppicing was implemented by the cutting of the suckers at ground level. This was done in order to increase the stability of the stump by the emission of roots by the suckers and avoid raising the stumps from the ground level over the years. The dying stumps were often subjected to the practice of "*tramarratura*", that is to the artificial breaking of the stump in order to stimulate the activation of dormant buds and triggering the emission of new suckers. More rare was the practice of burying the stump in order to get the suckers to take root. The substitution of the dead stumps was generally carried out by replacing it with one of the seedling present, however in case of seedlings absence, a fairly widespread practice was the "*propagginatura*". This practice consisted in bending a young sucker and blocking it on the ground by means of stakes or rocks and burying it to stimulate the roots emission. After the roots emission by the suckers, the connection with the old stump was severed thus obtaining a new stump in the course of a rotation period. Since the 1960s, the diffusion of fossil fuels, the collapse of the price of fire wood and the spread of chainsaws and tractors for logging, has led to the abandonment of areas that are more difficult to reach and to a general lengthening of the rotation period in Italy and to an occasional, not planned use of these formations in the 'Balkan area. In the last thirty years there was a general abandonment of these forest formations. In fact, as highlighted by Gasparini & Tabacchi (2011) and Mariano (2015) today in Italy over 70% of these formations are aged or abandoned.

III

Effects of traditional management, its modification and interruption

“ it’s humbling to think that all animals,
including human beings,
are parasites of the plant world. But it is reality.”
(Isaac Asimov)

introduction

The study of the effects of the modification and the abandonment of management on the various components of the forest ecosystem were the main part of the doctoral project. Since there are no studies of this type for coppice formations in the literature, the realization of this part of the project required the identification of the most suitable components of the ecosystem to be assumed as an indicator, the conception of a methodology of data collection, and a long and multi-year monitoring and data collection campaign in order to base the analysis on a statistically solid amount of data. The results obtained over the three years of Ph.D. were summarized in the following paragraphs. These have been structured by reporting or reorganizing studies and analyzes currently published and in preparation, enriched by the addition of unpublished data inserted in the text or reported in the attached databases reported in digital format.

Effects on vegetation, topsoil and seed bank. (paper in publishing)

For the detailed treatment of these aspects,is reported below part of the research article entitled: "Vegetation, topsoil and seed-bank modification during coppice rotation and after ten years of abandonment in a *Ostrya carpinifolia* forest in central Italy" currently in pubblication phase on Plant biosystems journal and fully reported in the attachments. The aim of the study infact, was exactly to investigate the long-term effects on forest vegetation, seed-bank, and soil properties of the traditional coppice management, the rotation lengthening, and the coppice practice abandonment in a specific European hophornbeam stand extending for 85 ha that was uninterruptedly management as coppice since the Middle Ages. In particular, we tested the hypotheses that i) forest vegetation, seed-bank, and soil properties mutate in different moments of the traditional coppice rotation, but they alter with lengthening and abandonment of the coppice rotation, and ii) these alterations involve biodiversity, coenoses stability, and ecological maturity of the forest.

Materials and methods

Study site

For the Italian peninsula, the main distribution area of *Ostrya carpinifolia* forests is in the northern-central Apennines (Tabacchi and Gasparini 2012). Based on geological, ecological, management and property data provided by the technical offices of Regions, Provinces, Municipalities, and

National Forest Service, the area of Mt. Nerone massif (43 ° 33 'N, 12 ° 30' E) was selected as it ensured an uninterrupted coppice management longer than 350 years (Fig. 13). Here, in an area of 85 ha, the uninterrupted management as coppice with standards was documented in the historical booklet of the common property since 1656.

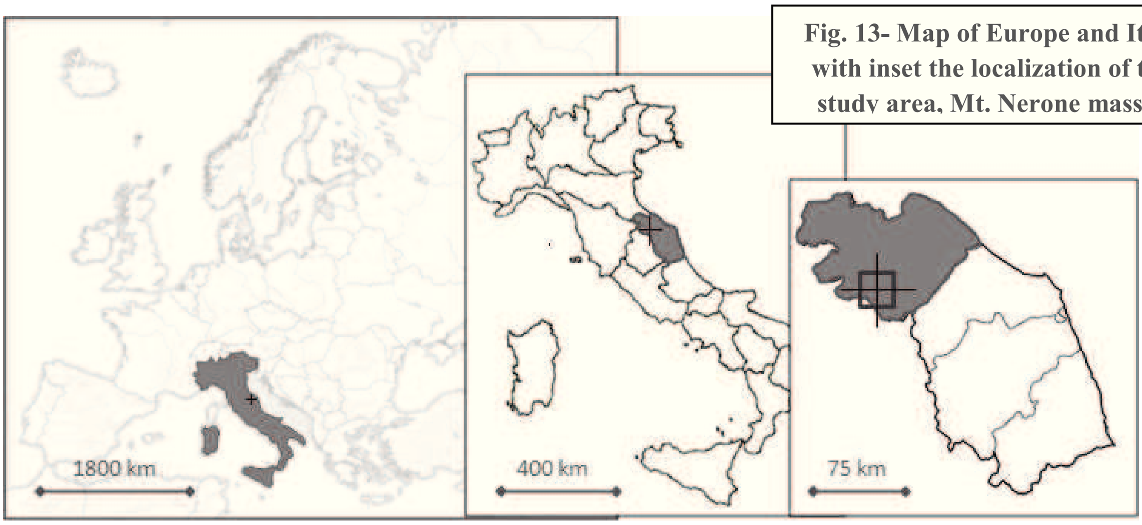
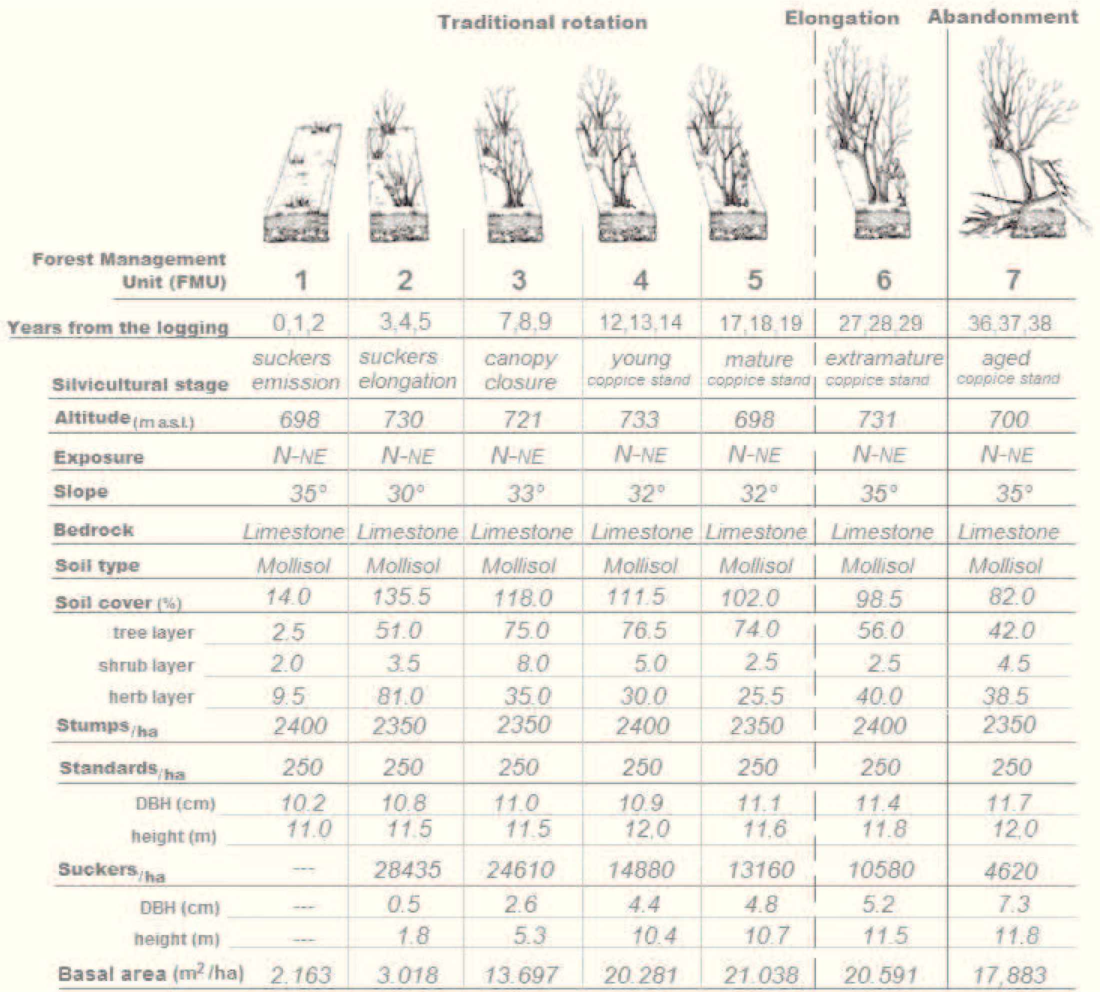


Fig. 13- Map of Europe and Italy with inset the localization of the study area, Mt. Nerone massif.

The Mt. Nerone massif covers an area over 60 km^2, reaches the height of 1525 m above sea level, and is considered as the limit between the northern and central Apennines. The study area is located on the north-eastern slope of the massif, at an altitude between 600 and 1000 m. The mean annual air temperature is about 12°C, with a mean annual precipitation of about 1700 mm. The bioclimatic definition of the area derived from the bioclimatic map of Italy (Pesaresi *et al.* 2014, 2017) is as a temperate oceanic bioclimate, humid ombrotype, supratemperate thermotype (Rivas-Martinez *et al.* 2011). The geology of the area is dominated by calcareous marl, and the soils are mostly represented by Mollisols. Syntaxonomically, the vegetation of the area was attribuited to the association *Scutellario columnae - Ostryetum carpinifoliae* (Ballelli *et al.* 1982), as indicated in maps of the vegetation (Biondi *et al.* 1989). It should however be underlined how the table describing this association, as usual in the past, is very heterogeneous and a syntaxonomic revision in the light of modern vegetation survey and analysis techniques seems to be necessary. However this aspect was not an objective of this study, therefore no syntaxonomical analysis and revision were performed. On the bases of the historical booklet of the common property, the traditional 12 year coppice rotation was extended to 18-year coppice rotation around the 18th century, and to 28-year rotation in the 1980s.

Forest management units and plot selection

Using QGIS_2.8 Wien (QGIS development Team 2015), we merged the information obtained from the Military Geographic Institute, the Land Registry offices, and other historic and collective property records. In this way we constructed a detailed map of the forest management units (FMUs) area that included geo-morphological and historic management information. Then, standardized forms (Bianchi *et al.* 2006) for the description of the environmental, management, and infrastructural aspects were obtained during the inspections of the FMUs on this mountainside, from the bottom of the valley to the summit meadows. The map was then completed with the insertion of this collected information. Based on this map, seven management units with similar extension (about 2 ha), morpho-physiographic characteristics, and silvicoltural conditions (Fig. 14) were selected in function of the different times from cutting. These units were object of surveys for three years. Five of these units defined different stages of the traditional management, one represented the elongation of the coppice rotation, and one exemplified the post-abandonment condition (Fig. 14).



	Traditional rotation					Elongation	Abandonment
Forest Management Unit (FMU)	1	2	3	4	5	6	7
Years from the logging	0,1,2	3,4,5	7,8,9	12,13,14	17,18,19	27,28,29	36,37,38
Silvicultural stage	suckers emission	suckers elongation	canopy closure	young coppice stand	mature coppice stand	extramature coppice stand	aged coppice stand
Altitude (m a.s.l.)	698	730	721	733	698	731	700
Exposure	N-NE	N-NE	N-NE	N-NE	N-NE	N-NE	N-NE
Slope	35°	30°	33°	32°	32°	35°	35°
Bedrock	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone
Soil type	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol
Soil cover (%)	14.0	135.5	118.0	111.5	102.0	98.5	82.0
tree layer	2.5	51.0	75.0	76.5	74.0	56.0	42.0
shrub layer	2.0	3.5	8.0	5.0	2.5	2.5	4.5
herb layer	9.5	81.0	35.0	30.0	25.5	40.0	38.5
Stumps/ha	2400	2350	2350	2400	2350	2400	2350
Standards/ha	250	250	250	250	250	250	250
DBH (cm)	10.2	10.8	11.0	10.9	11.1	11.4	11.7
height (m)	11.0	11.5	11.5	12.0	11.6	11.8	12.0
Suckers/ha	---	28435	24610	14880	13160	10580	4620
DBH (cm)	---	0.5	2.6	4.4	4.8	5.2	7.3
height (m)	---	1.8	5.3	10.4	10.7	11.5	11.8
Basal area (m^2/ha)	2.163	3.018	13.697	20.281	21.038	20.591	17,883

Fig. 14- Scheme of the seven studied forest management units according to the years from the coppice cutting. Mt. Nerone massif, Italy. (DBH: diameter at breast height;)

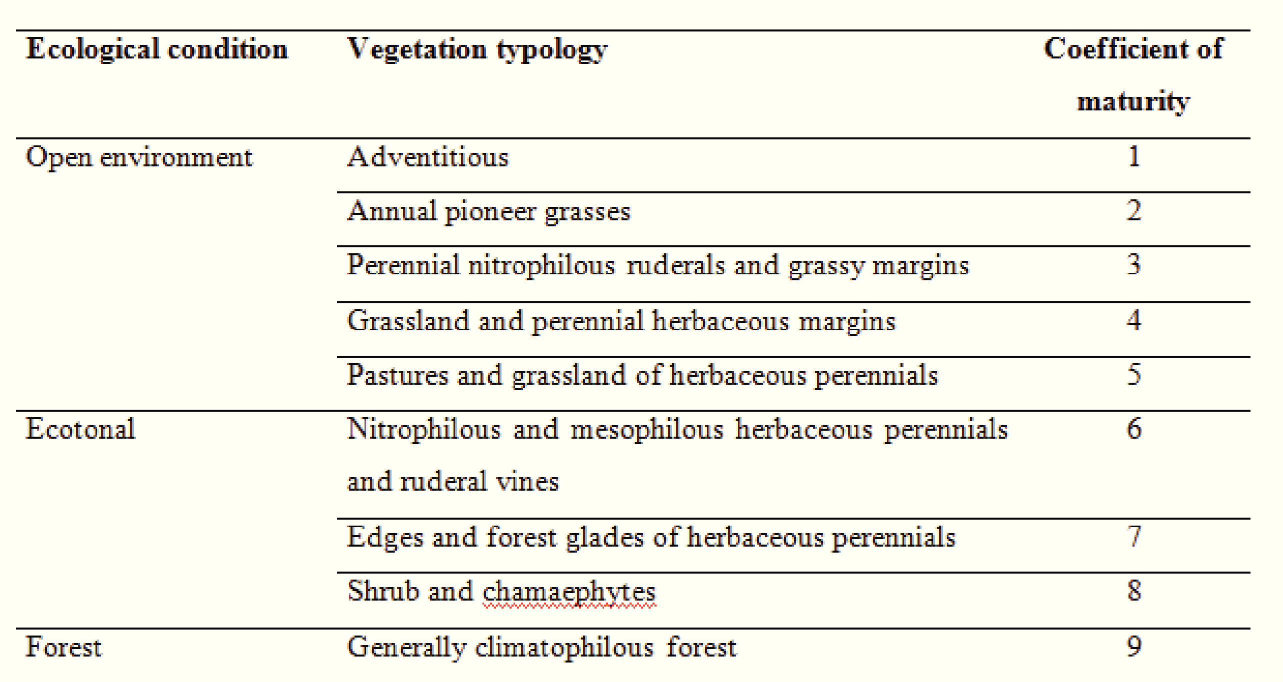
Data collection

During the first year of the study, within each of the seven units, two permanent plots of 200 m^2 each were randomly defined for the monitoring of the forest coenoses development. A soil survey was conducted inside these seven FMUs, with the opening of auger holes and mini-pits to assess soil average conditions inside these permanent plots. Then, a soil profile was dug in each plot, down to the parent rock. The soils were morphologically described according to Schoeneberger *et al.* (2012), but for the organic horizons we followed Baize and Girard (2008). The morphological observations of the soil profiles are reported in Supplemental Materials Appendix A. In each plot, soil cover was evaluated separately for tree, shrub and herb layers by estimation of the proportion of the sky obscured by vegetation when viewed from a single point (Jennings *et al.* 1999). From 2015 to 2017, inside each plot the topsoil was opened and described. The topsoil description was repeated in Spring and Autumn, to follow the seasonal changes in thickness and structure. A quantification of the soil seed-bank was carried out through seed counting, identification, and evaluation of seed viability, for the seeds recovered from a soil volume of about 3.375 cm^3 collected using a 15 ×15 cm frame hammered into the soil to a depth of 15 cm starting from the OLf horizon. The viability evaluation was carried out using the cutting test, with confirmation of viability using Lugol solution (Bacchetta *et al.* 2006). During the late springs 2015, 2016 and 2017, the species composition and abundance was recorded in each plot according to the Braun-Blanquet scale. Plant species nomenclature followed Conti *et al.* (2005). Furthermore, for the vascular plant species we selected the following plant functional traits: the Ellenberg indicator values (Pignatti *et al.* 2006), and the Maturity Coefficients (Taffetani and Rismondo 2009). The Ellenberg indicator values express both climatic (L, light; T, temperature; C, continentality) and micro-edaphic (U, soil moisture; R, soil reaction; N, availability of soil nutrients) conditions of the species. The Maturity Coefficients express the dynamic and evolutionary grade of the vegetation in terms of the vegetation series and the ecological environment (open-environment, ecotone, forest) (Lancioni and Taffetani 2011)..

Data analysis

Species and functional composition

To analyze the silvicultural system management effects on species and functional composition, an analysis of the floristic composition and an indirect gradient analysis were performed. The Braun-Blanquet values of the 21 paired vegetation relevè were converted to the Van der Maarel scale (Westoff and Maarel 1978), and mean species composition was calculated for each FMU. The matrix "FMU x mean abundance species" was obtained. This matrix was taken through the correspondence analysis (CA) sorting technique. Thus, the matrix of mean traits values of the FMUs “FMU x mean traits values” was obtained by multiplying the binary (presence-absence) matrix ‘‘FMU x species” with the matrix “species x functional traits values” (Ellenberg and ecological Maturity)”, and dividing by the specie number of FMU. To interpret (indirectly) the vegetation composition variation in functional terms, the correlation between the main vegetation composition gradients extracted from the CA (CA axis), and the mean traits values of the FMUs were calculated, tested by the modified permutation test of Zeleny and Schaffers (2012), and fitted into the CA space. Similarly, to interpret the relation between vegetation composition and dendrometric-silvicultural aspects, the correlation among number of stumps, diameter at breast height (DBH), basal area (G) (Fig. 14) and the CA axis were calculated and tested by permutation test. We also performed indicator species analyses (ISA) to identify the species significantly associated (*phi* coefficient > 0.4, p<0.05) with a particular FMU or FMUs combinations (De Càceres and Legendre 2009).



Ecological condition	Vegetation typology	Coefficient of maturity
Open environment	Adventitious	1
	Annual pioneer grasses	2
	Perennial nitrophilous ruderals and grassy margins	3
	Grassland and perennial herbaceous margins	4
	Pastures and grassland of herbaceous perennials	5
Ecotonal	Nitrophilous and mesophilous herbaceous perennials and ruderal vines	6
	Edges and forest glades of herbaceous perennials	7
	Shrub and chamaephytes	8
Forest	Generally climatophilous forest	9

Tab. 1- Details of the vegetation evolution stages and ecological conditions, with the corresponding coefficients of maturity (modified from Taffetani and Rismondo 2009).

Soil seed-bank

To estimate the variation and mortality of the seed-bank for each sample in relation to the temporal distance from the cutting, the seed density (viable seeds m^{-2} soil surface) and seed viability (viable seeds as a proportion of the total number of seeds) were calculated. To obtain the means for each FMU, the variations were evaluated by frequency and quantity analysis on the means of two samples taken for each FMU.

Soil morphological characterization

To determine the management effect on the soil, the topsoil was considered as the ensemble of the O and A horizons (De Feudis *et al.* 2017), being the topsoil the soil portion most sensitive to human disturbance and climate change (Baize and Girard 2008). For each FMU, the mean topsoil thickness of the Spring samples was compared to that of the Autumn samples. As there were no significance variations in the structures of the topsoils, the thickness of the Spring and Autumn samplings were combined together so as to have solid annual replicates. The main variations in the topsoil for the different plots were then analyzed for the thickness of the topsoil running a principal component analysis (PCA).

Soil - vegetation relationships

To interpret the soil-vegetation relationships, correlations between the main vegetation composition gradients extracted from CA (CA axis) and the mean thicknesses of the O and A horizons described for the FMUs were calculated, tested by permutation test and fitted into the CA space. Thus, the non-randomness ('significant') co-variation between the main composition gradient of the vegetation (CA1, CA2) and the main topsoil gradients (PC1, PC2) was tested by Procrustes analysis (Peres-Neto and Jackson 2001). The Procrustes analysis rotated the PC1 and PC2 soil configuration to maximum similarity with the CA1 and CA2 vegetation configuration, and tested the significance by permutation test. The measure of fit provided (m^2) is the square root of (1 – SS), where SS is the sum of squared differences between vegetation configuration (CA1 and CA2 scores) and the soil rotated configuration (PCA1 and PCA2 scores).

Statistical analyses

All the statistical analyses were performed using the R software (R Core Team 2014). The 'vegan' (Oksanen *et al.* 2015) package for PCA, CA, Procrustes analysis, and permutation tests for the indirect gradient analysis was used.

Results

Species and functional composition

Overall, 203 species were collected and defined (see Supplemental Materials Appendix B). FMUs 1, 2, and 7 showed the highest species richness (88, 158, and 115 species, respectively), with the lowest for FMUs 5 and 6 (67 and 66 species, respectively). At an examination of all the flora, the open-environment species were the most numerous (82), followed by the forest (76) and ecotonal (42) species (Supplemental Materials Appendix B). However, 48.8 % of the open-environment species and 31.0% of the ecotonal species were exclusive to FMUs 1 and 2, and although the forest species were stable and complete in all the FMUs, they showed greater completeness in FMUs 2, 3, 4, and 5 (Supplemental Materials Appendix B). The only alien species identified was *Setaria italica* (L.) P. Beauv., which was the exclusive of FMU 7. The CA analysis ordered the FMUs in terms of the main vegetation composition gradients (variation represented by CA1 and CA2: 55% and 22%, respectively; Fig. 15). In terms of functional traits values, the indirect gradient analysis showed that CA1 is positively correlated with forest species environment and Maturity coefficients, and inversely correlated with the Ellenberg light (L) index and the open species environment. In terms of dendrometric-silvicultural aspects, instead, CA1 is positively correlated with G and C. The CA1 axis is also related to the thickness of the mollic A soil horizon (Fig. 15). In terms of topsoil thickness, the indirect gradient analysis revealed a significant relationship between the CA1 axis and the mollic A soil horizon only. All results of the indirect gradient analysis are reported in the Supplemental Materials Appendix C. The procrustean analysis (see paragraph Soil and vegetation relationships) showed significant correlation among CA1 and PC2 (determined by OH and mollic A horizons), while CA2 is inversely correlated with PC1 (determined by OFr, OLn, and OLv horizons). The first vegetation gradient (CA1) separated FMUs 1 and 2 from all the others. The 1 and 2 stages immediately followed the cutting and were largely characterized by low M, G, and C values, species typical of open environments (e.g., *Bromus erectus*, *Campanula rapunculus*, *Cerinthe minor* subsp. *auriculata*, *Brachypodium ruperstre*, *Fragaria vesca*), and a thin mollic A horizon. The FMUs 3, 4, 5, and 6 were mainly characterized by forest species (e.g., *Hepatica nobilis*, *Melittis melissophyllum*, *Euphorbia amygdaloides* subsp *amygdaloides*, *Arum maculatum*), high values of M, G, C, and a relatively thick mollic A horizon. The FMU 7, representing the post-abandonment stage, occupied an intermediate position in the CA1 gradient. Although forest species were abundant in FMU 7, this stage was characterized by a high presence of open-environment species, intermediate M, G, and C values, and therefore showed some affinities with FMUs 1 and 2.

The second vegetation gradient (CA2) separated the FMUs 2, 3, 4 and 5 from the other three. The group of FMUs 2, 3, 4, and 5 corresponded to the central and final stages of the traditional coppice rotation, and were characterized by high C values, a high number of sciaphilous forest species (e.g., *Mercurialis perennis*, *Cephalantera longifolia, Lathyrus venetus*) and higher thickness of OLn, OLv, and OFr horizons. The other group of FMUs was represented by those related to the initial stage of the traditional rotation (FMU 1), the lengthened rotation (FMU 6), and the post-abandonment stage (FMU 7), all qualified by the lowest C values.

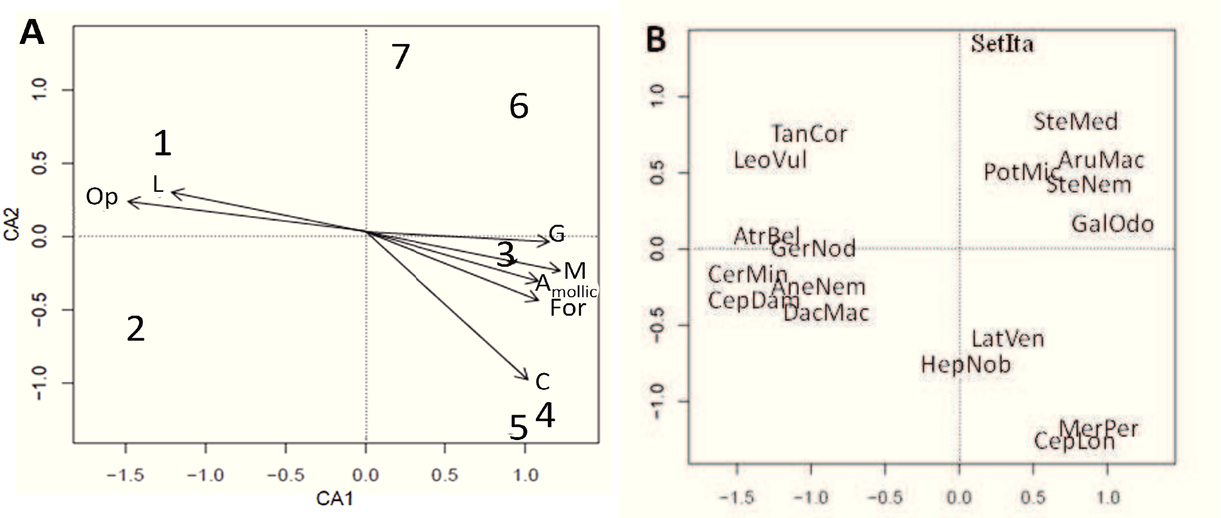
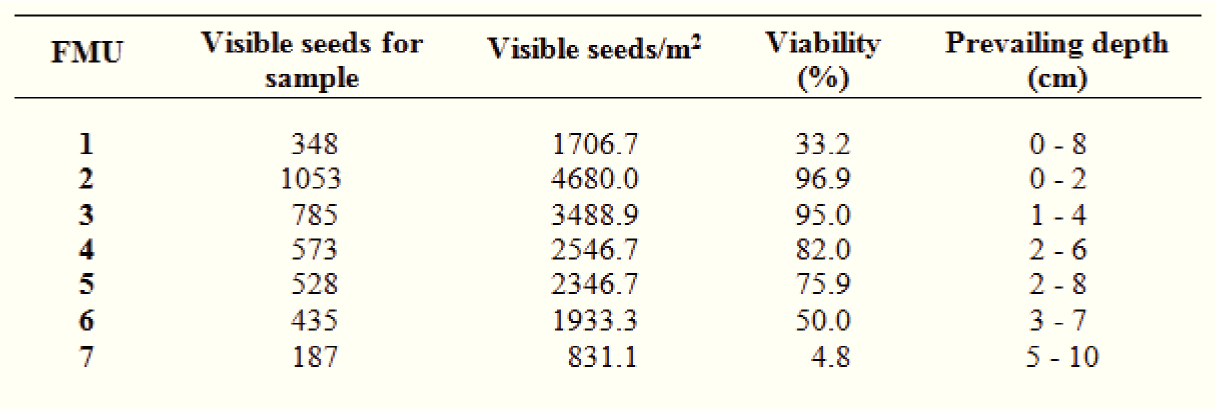


Fig 15- Correspondence analysis ordination plots of the mean vegetation abundance data for the seven studied forest management units. Mt. Nerone, Italy.
(A) The seven forest management units according to the identification numbers given in Figure 1. Arrows represent the correlation of the significant ($p < 0.05$) ecological parameters (L, Ellenberg Light index; M, Maturity index; Op, open-environment species; For, forest species; Amollic, thickness of the mollic A soil horizon; C, tree layer cover (%); G, Basal Area. (B) Species ordination plot that shows the main indicator species of the forest management units. SetIta, Setaria italica; TanCor, Tanacetum corymbosum; LeuVul, Leucanthemum vulgare; AtrBel, Atropa bella-donna; GerNod, Geranium nodosum; CerMin, Cerinthe minor subsp. auriculata; AneNem, Anemone nemorosa; CepDam, Cephalanthera damasonium; DacMac, Dactylorhiza maculata subsp. maculata; HepNob, Hepatica nobilis; LatVen, Lathyrus venetus; CepLon, Cephalanthera longifolia; MerPer, Mercurialis perennis; GalOdo, Galium odoratum; SteMed, Stellaria media subsp. Media; PotMic, Potentilla micrantha; AruMac, Arum maculatum; SteNem, Stellaria nemorum subsp. montana;

Among the species collected, the indicator species analysis identified 66 species associated with a particular FMU or FMUs combination (see Supplemental Materials Appendix D). Of these species, 20 open-environments species, 5 forest species, and 3 ecotonal species were characteristic of the first years after the cut (FMU 1 and 2), 9 forest species and 2 ecotonal species appeared to be related to the central and final stages of the coppice rotation (FMUs 3, 4, 5, and 6), and only *Setaria italica* was found as characteristic of the post-abandonment stage (FMU 7).

Soil seed-bank

The soil seed-bank of FMU 1 highlighted lower density and higher viability with respect to the FMU 7 (Table 2). FMUs 2 and 3 had seed-banks characterized by very high viability (96% ±1%) that tended to decrease with increasing time at a rate of about 2% per year until FMU 5. A marked decreasing trend in viability occurred in FMUs 6 and 7 (Fig. 16). Indeed, for the post-abandonment stage (FMU 7), the seed-bank was characterized by the lowest viability (≈5%), with seeds located at a greater depth than in the other FMUs. Furthermore, unlike all the other FMUs, FMU 7 did not include any viable seeds of *Cerinthe minor* subsp *auriculata* or *Atropa bella-donna*, which are ecotonal species that can grow and develop only in forest areas with reduced coverage and that were found in vegetative phase only in the FMUs 1 and 2.



FMU	Visible seeds for sample	Visible seeds/m^2	Viability (%)	Prevailing depth (cm)
1	348	1706.7	33.2	0 - 8
2	1053	4680.0	96.9	0 - 2
3	785	3488.9	95.0	1 - 4
4	573	2546.7	82.0	2 - 6
5	528	2346.7	75.9	2 - 8
6	435	1933.3	50.0	3 - 7
7	187	831.1	4.8	5 - 10

Tab. 2- Main data characterizing the seed-bank according to years from cutting. Mt. Nerone, Italy

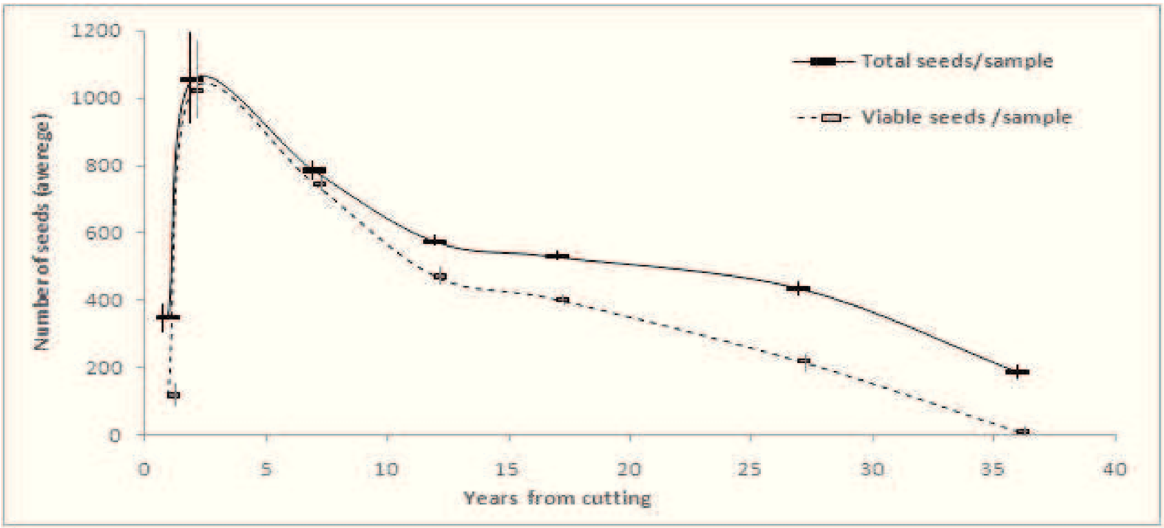


Fig. 16- Total and viable seed numbers for the soil seed-bank according to years from cutting.

Soil morphological characterization

In all the FMUs the soil was a Rendzic Leptic Phaeozem (skeletic) according to the IUSS (2015), or a Mollisol according to the SSS (2014) (see Supplemental Materials Appendix A). Even though in the various FMUs the topsoils showed different morpho-structural characteristics, they all belonged to the Hamphimus class (Baize and Girard 2008). The PCA ordered the FMUs according to the thicknesses of the horizons forming the topsoil (Fig. 17). PC1 and PC2 represented 57% and 29%, respectively, of the total variation. PC1 was mostly determined by the covariation of the OLn, OLv, and OFr horizons, which contrasted the central stages of the traditional coppice rotation (FMUs 3 and 4) and the first stage immediately following cutting and those subsequent at traditional coppice rotation (FMUs 1, 6, and 7). PC2 was determined by the covariation of the OH and mollic A horizons, which contrasted the most recent stages after the cutting (FMUs 1 and 2) and the other FMUs (Fig. 17).

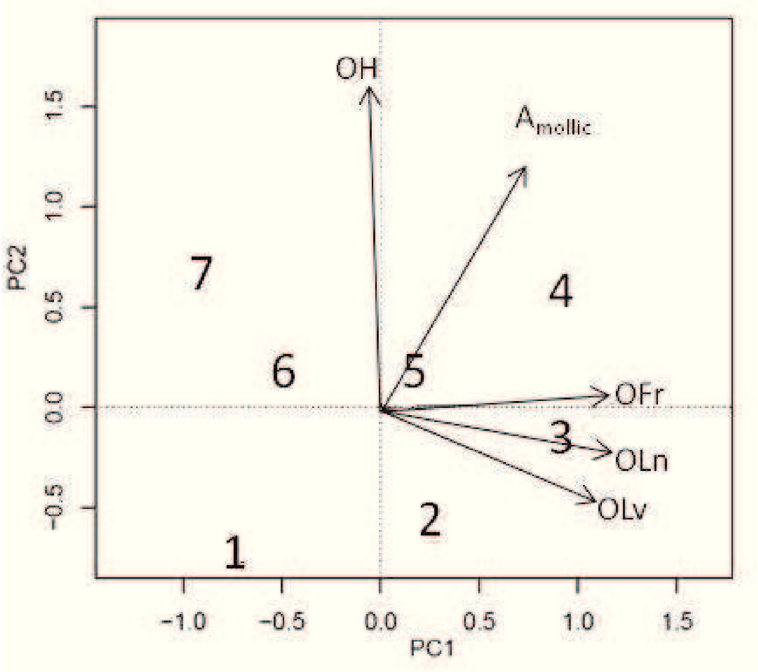


Fig. 17- Principal component analysis biplot for the topsoil horizon thickness data.
PC1 and PC2 represent 57% and 29%, respectively, of the total variation. The numbers indicate the seven forest management units defined in Figure 1. OLn, OLv, OFr, and OH horizons referred to Baize and Girard (2008), Amollic represented the mollic A horizon as for Shoeneberger et al. (2012).

Soil and vegetation relationships

The correlation between soil horizons thickness data of the topsoil and the main variation gradients of the vegetation (CA1, CA2) was significant only for the mollic A horizon. In particular, the mollic A horizon was mainly related to CA1 (Fig. 15). The Procrustes analysis, instead, showed a global significant relation ($m^2 = 0.40$, $P = 0.0323$) among the main gradients of the soil (PC1 and PC2 rotated) and the main gradients derived from the analysis of the vegetation composition, and especially between CA1 and PCA2 (Fig. 18).

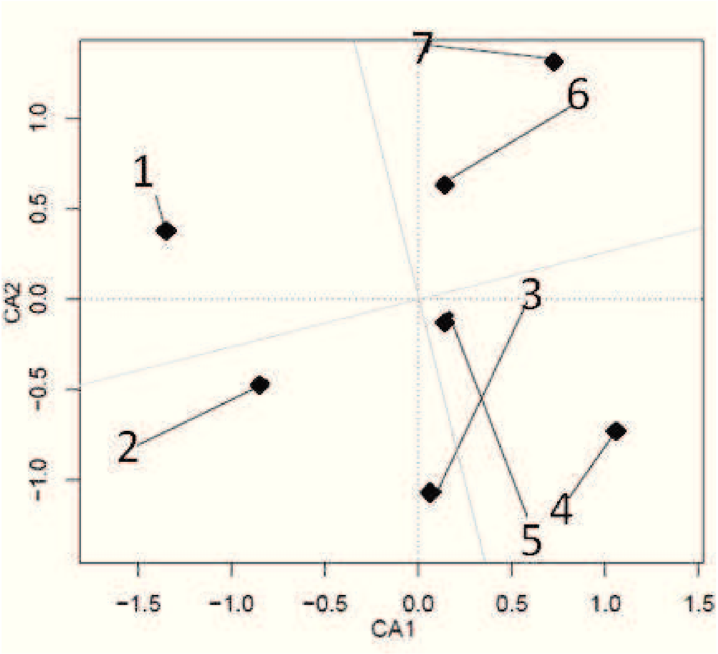


Fig. 18 - Procrustean superimposition plot of the forest management units based on two different configurations obtained from the two first axes of the principal component analysis of the topsoil horizons thickness data (diamonds) and the two first axis of the correspondence analysis of the vegetation abundance data (bold numbers). Black solid lines are the Procrustes residuals from the two different configurations. Grey dotted lines are the CA axes (CA1, CA2) and the grey solid lines the rotated PCA axes (PC1, PC2).

Discussion

Species and functional composition

The synchronous study of this coenose during its management and post-abandonment stages has revealed that the length of the coppice rotation have effects in terms of vegetational composition, seed bank vitality and topsoil structure. Indeed, in this case the vegetation shows a peak in terms of species numbers in the first years after cutting, which was then reduced approaching the maximum canopy closure. Subsequently, we observed a gradual re-increase in the number of species. This increase culminated in the post-abandonment stage, which was characterized by a diffuse decrease in tree layer cover. At this stage, the number of species assumed the level of the first years after coppicing. The analysis of the various FMUs, however, demonstrated that the increase in the number of species in the post-abandonment stage does not correspond to an increase in qualitative terms. The elimination of the tree layer due to the coppicing provides sudden removal of soil coverage, with modification of microclimatic conditions. This makes it possible to achieve optimum germination conditions for the soil seed-bank, whose species create an almost complete herbaceous coverage over the first two years from cutting. As observed in other studies (Mason and Macdonald 2002; Broome *et al*. 2011), in the first five years after cutting, the growth and seeding of these species is continuous and abundant. This allows rapid reconstitution of a seed-bank characterized by a well-defined species pull, which reaches its highest values in terms of number and viability by the third year after cutting. The immediate regrowth of suckers greatly amplifies ecotonal environments and create, in correspondence of the stumps, refuge habitats suitable for the maintenance of the forest species. Although our areas were pedologically homologous, the topsoil in the early stages of coppicing is marked by simplification of the topsoil horizons and reduced variability in terms of its relative thickness (Annexes A and E). The central and final stages of the traditional coppice rotation are here characterized by reduction of ecotonal and loss of open-environment species. The vegetation composition is characterized by shade-adapted forest species, which highlight a strong stability in terms of composition. The number and the viability of the seeds in the seed-bank showed a small decrease that then remains stable for over a decade. The topsoil is characterized by the presence of all types of organic horizons, which creates a high number of ecological niches that are suitable to host a complex soil fauna (Hättenschwiler and Gasser 2005), with an increase in the relative thicknesses of the more superficial horizons. The lengthening of the coppice rotation did not produce large changes in the vegetation composition, but highlighted a simplification of the topsoil morphology. This was accompanied by relatively stable numbers of seeds in the seed-bank compared to the stages of the traditional coppice rotation, although these showed significantly lower proportions of viable seeds. Subsequently, the abandonment shows in this case a reduction of the ecological maturity of the coenoses. Here, the number of suckers collapsed due to the increasing competition and the physiological characteristics of the species. This caused a soil cover reduction and allowed the formation of areas where the conditions become suitable for the development of ecotonal and open-environment species, which are responsible for the increase in the number of species. However, the viability of the seeds in the seed-bank after abandonment was practically null (Annex E). This involved the loss of about 50% of the open-environment species and 31% of the ecotonal species that can grow and seed only in the years immediately after coppicing, which are therefore present in the seed-bank only. On the other hand, this extends the ground uncover period, and aggravates soil loss, which can allow entry of species from neighboring environments. This implies a reduced and less varied floristic contingent at the slope level, which is particularly serious as most of the post-abandonment area are surrounded by strongly anthropized or degraded environments. The dynamics that in this case characterized lengthening of coppice rotation, and especially the post-abandonment stage, contrasted partly to what has been reported in other studies for other forest formations (Kopecky *et al.* 2013; Müllerová *et al.* 2015). This can be attributed to the dynamic and physiological characteristics of *O. carpinifolia*, which assumes a structural, functional and dynamic importance in this coenoses and must be considered as the key species (Zhao Hua *et al.* 2001). Nevertheless, in line with the same studies, it is highlighted that the species that here suffer the most significant losses are those typical of open woodlands, which abound in the years immediately following the cutting, and the seeds for which are present only in the seed-bank. In line with several studies (e.g., Molder *et al.* 2014; Kopecky *et al.* 2013), we argue that the prolonged period of canopy closure is the most probable cause of decline and represents a threats for biodiversity.

Global effects at the slope scale

Coppice management is traditionally characterized by reduced forest management units sizes, which constitute an environmental mosaic at the slope level that includes the simultaneous presence of all the different stages of coppice rotation in a relatively small area, as in this case. This peculiarity provides a large number of refuge habitats that are constantly present, from both the faunistic (e.g.. Spitzer *et al.* 2008; Maccol *et al.* 2014; Kosulic *et al.* 2016) and floristic (e.g., Cervellini *et al.* 2017; Decocq *et al.* 2005; Hédl *et al.* 2017) points of view. As many other studies have emphasized for other forest formations, also in this case the maintenance of traditional forestry management is the basis for the structural complexity and stability of the system (e.g., Baeten *et al.* 2009; Campetella *et al.* 2016; Cervellini *et al.* 2017). Indeed, contextualization of the FMUs in this study at the slope level shows how biological and micro-environmental aspects that characterize the different stages of coppice rotation provide a unique and complex ecological system where the dynamic balance is strictly related to the fullness of all these stages. Given the high number of interactions and feedback effects, the separate analysis of one or more of these stages in coppice management does not provide a real evaluation of their ecological and biological value, their degree of resilience and resistance, and the level of naturalness provided by the whole system. The presence of all coppice stages can maintain an ecological system characterized by stability in terms of species composition and environmental characteristics over large surfaces, albeit marked by microevolution over limited areas, with variability of even conspicuous aspects. This stability seems to be supported by the seed-bank and by the soils type present in the whole study area. In fact, all soils belonged to the Mollisol order, the formation and conservation of which are mainly related to the process of melanization. This requires constant water and soil thermal regimes, and favors accumulation, incorporation and protection of organic matter into the soil, for which only a few decades are necessary for complete mineralization (SSS 2014).

Implications for coppice management

Based on the data here presented, it is possible to argue that in this case, from an ecological point of view, lengthening of rotation does not involve any real increase in naturalness, and could have negative effects on the viability of the seed-bank. Alterations to all the aspects investigated are observable within the first decade from abandonment. In a few decades, this results in structural and ecological simplification at the slope level, with consequent reduction in biodiversity.

Conclusions

In this study several components of the forest ecosystem were analyzed through an interdisciplinary approach, to follow the dynamism that characterize an *Ostria carpinifolia* wood in central Italy during traditional coppice rotation period, its lengthening and following management abandonment. The results here obtained have shown that traditional coppice management is key to maintain of a high level of biodiversity and ecological maturity. This seems to be due to the frequent soil uncover at local level and to the coexistence of different refuge habitats al the slope level. With the lengthening of the coppice rotation period and moreover after the abandonment, a simplification of the topsoil morphology and vegetation composition was observed. Although the study was conducted in a restricted territory qualified by conditions of singular management constancy, we analyzed one of the most widespread Italian and Balkan forest type. We underline the need for further studies on this forest formation in order to extend the results obtained to other areas. However, on the basis of the results obtained, we suggest to considering carefully the consequences that could derive from management decisions that today seems to be increasingly oriented towards a lengthening of the rotation period up to conversion for abandonment, with the aim of protecting biodiversity.

Humus forms as dynamic indicator of the environmental status of coppice forests *(conference proceedings - published)*

The possibility of using forest humus as indicators of the ecological status of forest coenosis has been repeatedly proposed and applied by several authors (Galvan *et al.* 2005, Baize & Girard 2008, Zanella *et al.* 2010, Fox *et al.* 2010, among others) for the comparison of different environments (Mayer 2008, Sitzia *et al*. 2005, Cherish *et al* 2006, among others) or of different management modalities (Albeho & Graca 1996, Purahong *et al*. 2014, Schilling *et al*. 2016 amond others). However, in the literature there are no case studies that apply this analysis to the evaluation of coppice forest regularly managed in different steps of the rotation period. The possibility to use forest humus as an indicator of the ecological status of a forest regularly coppiced and the evaluation of the sensitivity of this index, has therefore been the object of a study whose results were presented at 41 ° National Congress of the Italian Society of Soil Science, held in Ancona from 5 to 7 December 2016 and at the National Symposium: "Management of coppices over turn: technical and scientific advances and operational applications" held in Genoa on 15 December 2016. In the following paragraphs is reported a summary of the conferences proceedings published.

Introduction

Particularly significant for the purposes of understanding the system results the interpolation of the data related to the vegetational studies with those of the soil. Pedological researches developed in recent years are proving that soil is a highly effective indicator for the interpretation and evaluation of the dynamic trends of ecosystems (Zanella *et al.* 2010, De Feudis *et al*. 2016). For this purpose, some of the chemical, physical and biological characteristics of the different pedological horizons and, in particular, for this space-time scale, of the topsoil are useful (Galvan 2005). For this purpose this part of the research project work has taken into consideration the study of the forms of forest humus (Baize & Girard 2008) as an indicator of environmental dynamism. The structuring of topsoil is in fact the result of a myriad of spatio-temporal interactions between micro- and macro-climate, geochemical condition, vegetation, animals (macro- meso- and microfauna), bacteria, fungi, etc. (Zanella *et al*. 2001, 2008). The humus forms are therefore a factor of synthesis between short and long-term forest evolution, capable of providing information on the forest system that is complementary to those inferred from the vegetational study.

Materials and methods

Within permanent plot areas referring to different moments of the traditional ro,tation period, its modification and its abandonment homogeneous under vegetational, bioclimatic and management points of view (Mei *et al.*, In press), we opened two micropits for the soil description. Within the micropits, detailed morphological observations, measurements and description of the organic horizons according to Baize & Girard (2008) and of the organo-mineral horizons were performed (Shoeneberger *et al.*, 2012) for two consecutive years on a seasonal basis. Based on the presence or absence of the various types of horizon and their arrangement, the different humus forms have been labelled following Zanella *et al.* (2011). For each horizon, what-quantifications of the excrement of the pedofauna were also carried out(Galvan *et al.* 2005). Finally, by combining structural and biological complexity, a value of ecological complexity was attributed to each profile (Zanella *et al.* 2011, 2014). The data thus obtained were statistically treated by means of linear regressions and principal component analysis (PCA) in order to highlight the variations found due to the seasonality or to the different development of forest formation. One-way ANOVA and the Tukey test (data were appropriately transformed by log or sqare root if necessary) were used to test the differences in the thickness of the different horizons between the different moments analyzed. All the analyses were performed using R software (R Core Team, 2014) in particular the ‘vegan’ package.

Results and discussions

The study found that all the topsoils analyzed in the areas, representing different steps of the coppice rotation belong to the Hamphymull humus typee (Zanella *et al.* 2011), even if they result characterized by very different morphological and structural characteristics. All the analyzed topsoils present in fact an Amollic horizon (SSS 2014), clearly lumpy, characterized by the presence of humic-clay complexes, which can be labelled as "Biomacrostructured" according to Zanella *et al.* (2010) and a succession of horizons OLn, OLv, OFr and OH characteristic and exclusive of this form (Baize & Girard 2008, Zanella *et al.* 2011). However, the study revealed the need to distinguish this form in at least two "subforms", the difference of which is clearly differentiated by the PCA (Fig. 19). In fact, it clearly differentiates the humus forms found in the plot concerning the first years after the cut and subsequently the abandonment from those present in the plots concerning the time laps within the traditional rotation period (PC1, 59% of total variation). Contrary to what was hypothesized, the differences among the areas related to the first years after the cut, from those following the closure of the crowns are much less significant (PC2, 27% of the total variation).

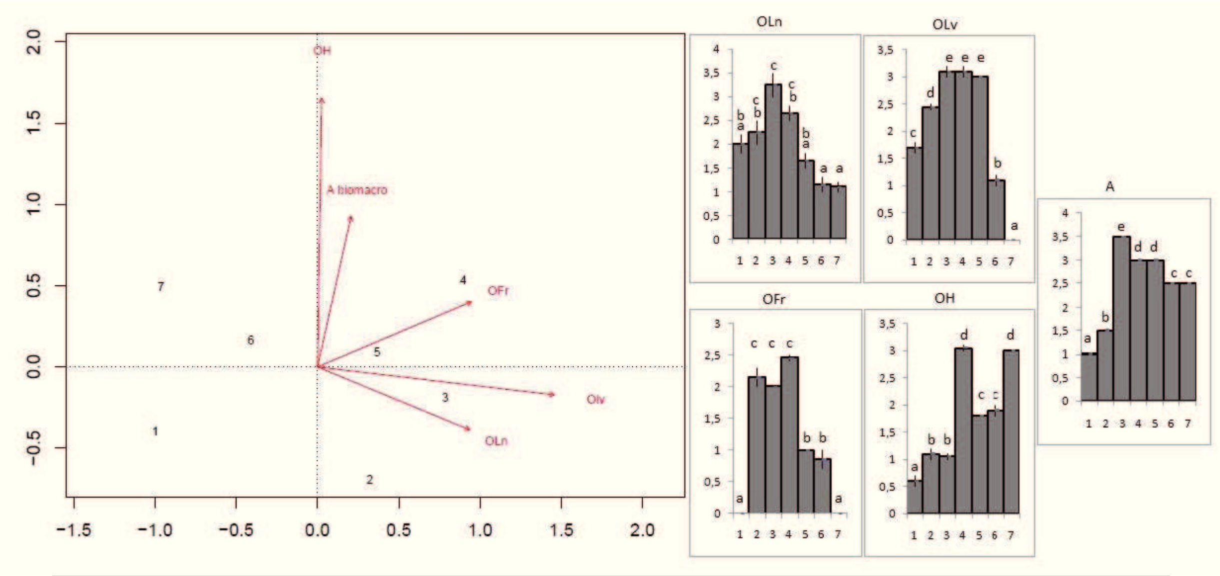


Fig. 19 - Nonmetrics multidimensional scaling of temporal change in species composition.
Left: Results of DCA analysis on the moments studied, sorted by humus structure. Right: results of Tuckey test on humus horizon thickness

The first Subform characterizes the cenosis from two to twenty-eight years after the cut (traditional rotation). This shows the classical sequence of horizons OLn, OLv, OFr (this last one discontinuous until the third year after cutting), OH and a typical A Biomacrostructured organo-mineral horizon, whose mixing is clearly linked to the digestive activity of earthworms, as evidenced by the abundant presence of coprolites attributable to this macro-group. The second "subform" characterizes the plots relating to the years immediately following the cut and those corresponding to the overrun. This "subform" is characterized by the absence of the OLv and OFr horizons and by a Macrostructured horizon.in which the remixing and the presence of the clay-clay complexes is however due in large part to abiotic processes. This structural simplification, the cause and at the same time a consequence of the loss of pedofauna biodiversity appears to be worrying in the aging phases of cenosis. The widespread presence of mosses observed in the plot related to this moment indicates prolonged periods of uncovered soil. The development of humus forms during the rotation period, partially in line with the vegetational and ecological data available in the bibliography, has highlighted an extremely complex and dynamic system, highlighting the importance that this type of management assumes in the maintenance of this component of the coenosis.

Conclusions

In the light of what emerged from the study it is therefore possible to affirm that the analysis of the humus forms appears appropriate as an indicator of the ecological status of these kinds of formations. Although the current identification keys were not appropriate for the accurate description of the forms found in these environments, not allowing the distinction of clearly different forms and indicating dissimilar ecological conditions, it was nevertheless an excellent indicator of environmental quality and ecological dynamics. The importance of active management was then confirmed both by the trend assumed by the assessment of the ecological complexity of the various forms and by the analysis of the plot relative to the period after the shift, in which contrary to what could be assumed, the organic horizons are discontinuous.

Effects on mesofauna composition

(Paper in draft)

Soil represents one of the most important reservoirs of biodiversity (ESDAC 2015). It reflects ecosystem metabolism since all the bio-geo-chemical processes of the different ecosystem components are combined within it (Bünemann *et al*. 2018). Therefore, soil quality fluctuations are considered to be a suitable criterion for evaluating the long-term sustainability of ecosystems (Knoepp *et al*. 2000, Parisi *et al*. 2004, Yan *et al*. 2012, among others). Within the complex structure of soil, biotic and abiotic components interact closely in controlling the organic degradation of matter and the nutrient recycling processes (Bünemann *et al*. 2018). Soil fauna plays an essential role in various aspects of the soil ecosystem (ESDAC 2015, Gardi *et al*.2009). In recent years an increasing number of studies have therefore considered this component in order to obtain indications on the soil quality (Eijsackers 1982, Santorufo *et al*. 2012, Menta *et al*. 2016, among others) , management effects (Moore *et al*. 2002, Malmstrom, *et al*. 2009, Bachi *et al*. 2012, among others) and ecosystems integrity (Knoepp *et al*. 2000, Wagg *et al*. 2010, Blasi *et al*. 2013, among others). The ecosystem services provided by soil fauna are one of the most powerful arguments for the conservation of edaphic biodiversity. Decomposition of organic matter by soil organisms is crucial for the functioning of an ecosystem because of its substantial role in providing ecosystem services for plant growth and primary productivity (Maharning & Miller 2008). Analyzing this component of the "soil-system" many studies (Tabaglio *et al*. 2009, Giordano 2011, Mocali 2012, among others) demonstrate that moisture content and pH of the soil have probably the greatest influence on the distribution of the hemi- and euedaphon fauna. Other authors (Galvan *et al*. 2005, Menta 2011; Madej *et al*. 2011, among others) highlight how the characteristics of the litter, the porosity of the soil and numerous other structural and morphological factors are also fundamental in determining the vertical distributions of edaphons. In recent years, several studies have also focused on highlighting how precise correlations exist between vegetation and pedofauna (Korboulewsky *et al*., 2016, Coyle, *et al*., 2017, Sauvadet, *et al*., 2017), and between management types and pedofauna (Siira *et al*., 2009, Neto *et al*., 2012, Blasi *et al*., 2013, among others). To date, however, there are few studies that analyze the dynamism of this component in relation to the different stages of development of forest formations, managed or not. If then we take into consideration the forest formations managed in coppice, these appear almost unknown from this point of view. Cognitive gap also highlighted during the international congress held in Antwerp in 2016 and in the one held in Limonges in 2017, on coppices in Europe (Unrau *et al* 2018). Moreover, the few studies present in the literature take once more into account only beech and oak forests. At the moment there is no bibliographic data of any kind relating to the *Ostrya carpinifolia* formations. In the light of what briefly exposed above, the study of this component of the forest ecosystem appeared of great interest in order to increase the knowledge and the understanding of the *Ostrya carpinifolia* forests. During the first year of the PhD program, on the basis of the various methods proposed in the literature, a survey protocol was devised and an optimal sampling method in function of the objectives of the study was set up. In the following two years we proceeded to the sampling, extraction and determination of the mesofauna, that is the component of the pedofauna of dimensions including between 2 and 0.2 mm. Indeed, this component has been identified on the basis of available literature as the most suitable to be used as an environmental indicator due to its sensitivity. Since the counting and correction phase of the counts carried out on the extracted mesofauna has just been completed, in the following part are described the survey methods, the extraction methods, the counting and a summary of the results obtained from the preliminary statistical processing of the data. These aspects will be the subject of a series of research articles, the first of which is currently being drafted. Given the amount of data produced by this part of the project, it was also not possible to insert them into the paragraph. These can however be viewed as digitized and organized into three datasets reported in the informatic attachments.

Materials and methods

In order to analyze the effects of traditional management and its interruption on the biological component of the pedosphere, extensive bibliographic research was carried out aimed at identifying among the components of the pedophile the one capable of providing the most fruitful and comparable results with the data present in bibliography. This component has been identified in the mesofauna of the soil. The mesofauna is that part of the pedofauna composed of arthropods ranging in size from 0.2 mm to 2 mm (Wallwork 1976, Mint 2011). This range includes many species of arthropods that can be traced back to 30 taxonomic macrogrypes and to which Parisi *et al.* (2004) attribute a different value of ecological specialization on the basis of morphological characteristics (EMI) (Parisi *et al.* 2004, Menta *et al.*2011). The analysis of the macro-groups constituting the mesofauna of a given site therefore allows to evaluate the degree of adaptation and specialization of this component, which will be higher in healthy soil with an elevated level of ecological complexity (Maharning & Miller 2008, Mint 2011). Various methodologies for the sampling and the analysis of mesofauna have been proposed in the literature (Knoepp *et al* 2000, Parisi *et al* 2004, Yan *et al* 2012, among others). Starting from the method proposed by Parisi *et al*. (2004), on the basis of various tests carried out in the field during the preliminary phase of the work, an Ad Hoc survey and analysis modality were designed, that allow us to obtain qualitative-quantitative information of the mesofauna composition characterizing the O horizons and the horizons A constituting the top-soils characteristic of the different moments analyzed. Within a slope of more than 85 hectares managed by a coppice for over 300 years and qualified by the same pedological, vegetation and cultural characteristics (Mei *et al*. – in press), four forest units of different ages were identified, related to different steps of the traditional rotation period (2 and 10 and 20 years) and to its abandonment (39 years). Within these, the horizons A and O have been described and sampled in double, within a frame of 9 dm2 (30cm x 30cm). These were stored separately in special plastic bags that allow transpiration but prevent the movement of the mesofauna present. The bags were then placed in thermal containers in order not to expose the samples to strong temperature variations during the transport phases. The sampled material was arranged on extractors of the Berlese-Tullgren type (Fig. 20) in the shortest possible time (and in any case never more than 24 hours from the sampling). These extractors, made ad hoc during the initial phases of the project, are located in a special laboratory, in which during the extraction phases no external light was maintained, no air currents and constant temperatures were maintained. Each extractor is made up of a plastic cylinder with a diameter of 35cm, within which a tempered steel filter with meshes of 3 mm diameter is placed at a depth of 15 cm. Below the filter the cylinder shrinks until it enters directly into a 50 ml falcon containing 30 ml of 70% ethyl alcohol. Each sampled horizon was placed in a different extractor and covered with a metal fly screen with 0.5mm meshes. The extractors are inserted, at the shrinkage point, into a wooden base which has the task of keeping the extractors in a vertical position and repairing the lower part of the extractors and the falcon from the light. At a height of 70 cm above the extractors are placed 400-watt halogen lamps, arranged so as to illuminate the extractors perpendicularly and eliminate any shadow zone. In addition to lighting, these lamps allow the slow

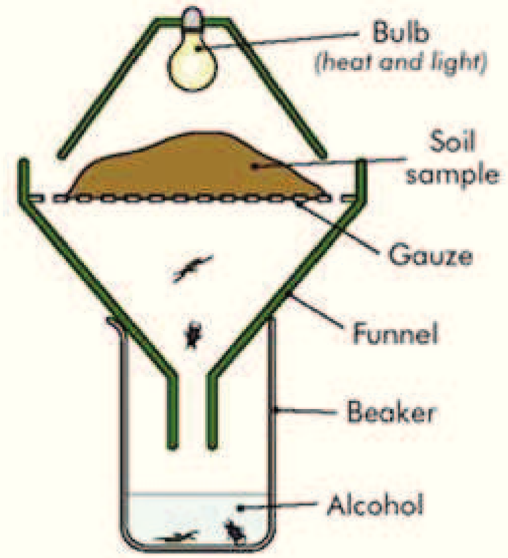


Fig. 20 - Berlese Tullgren extractor

and gradual drying of the profile, developing a constant temperature of 35°C. This optimizes the transmigration of the pedofauna, characteristically lucifugus and hydrophilic, towards the lower parts of the extractor and from there, by gravity, inside the falcon. The soil samples were kept in the extraction room with the lamps lit continuously for 20 days. At the end of this period we proceeded to perform screening, crushing and chemical analysis of the samples of the A and O horizons. Indeed, for all the samples C, N and pH (in water) have been determined (Colombo & Miano 2015). For the O horizons were carried out also the analysis and detailed quantification of the composition: on the basis of the fragments present, the plant species were identified and their percentage contribution in volume and according to the different levels of degradation were estimated. The content of each falcon, after being manually cleaned by coarse sediments and impurities, was placed in a 5cm diameter Petri dish divided into 24 sectors and examined at the stereoscope at a magnification of 35x. The taxonomic determination of all the arthropods present was limited to the identification of the taxa up to the level of order. Each order was included into a different functional macro-group to which was attribuited the EMI value proposed by Parisi *et al.* (2004). On the basis of these values the QBSar value was calculated for each sample (Parisi *et al.*, 2004). All the individuals present in each sample were photographed, counted, sampled manually and subdivided according to their macrogroup in 1.5ml Eppendorf tubes with a sealed seal and filled with 75 ° ethyl alcohol, in order to keep them for future studies. Each Eppendorf was labelled with a unique reference code to which information concerning the sampling period, plot of provenience, Horizon, chemical-physical data of the soil sample of origin and number of individuals was added. The Eppendorf were then stored separately for each reference season, divided into sample and horizon of origin. The data on the composition of the mesofauna thus obtained were statistically treated by principal component analysis (PCA). The PCA was used to identify the main variation gradients in the mesofauna composition. The count data was first log and Hellinger transformed. For the interpretation of gradients, the stational, seasonal and pedological factors were superimposed to the PCA bi-plot as a spider plot. All the analyses were performed using R software (R Core Team, 2014) in particular the 'vegan' package.

Preliminary results

The chemical analyzes have not highlighted particular differences between the different samples in relation to the season or to the different management moments. The values of pH, C and N have in fact remained almost unchanged both as the seasons vary and during the different moments of the rotation period and overrun. The plant composition and the level of degradation of the horizons O has instead made it possible in the first analysis to highlight a differentiation between the horizons detected in the phase of post abandonment and the others. A differentiation definitively more distinct than the one linked to the seasonal trend. As regards the mesofauna, in the 48 samples examined, 13005 arthropods were identified, photographed, measured and stored, subdivided into 26 reference macro-groups. Although very marked differences were recorded, on average each sample contained 270.94 arthropods belonging to 20 different macro-groups. The O horizons were found to be the richest in terms of biodiversity and of numerousness. In fact in these were found 8939 arthropods belonging to 26 different macrogroups. In the A horizons were found 4066 arthropods belonging to 24 macrogroups. From a qualitative point of view, the QBS counts show that during the rotation period the highest values are reached in the horizons O (average value 245.3 ± 8.3) although these never diverge by more than 18% from those reached by the Horizons A (value average 211.67 ± 15.34). With the management abandonment, the situation is reversed, highlighting a drastic reduction in the QBS value of the horizons O (average value 174 ± 5.5) and a clear increase in horizons A (average value 226 ± 9.25). Rather small are instead the differences related to the seasonal trend. Only the samples relating to the autumn period in fact show values appreciably higher than all the others. However, the increase appears uniform, not changing the relationship between the values relative to the horizons A and those relative to the horizons O. The PCA identified the main variation gradients of the mesofauna composition. In particular, the first gradients, axes PC1, PC2, PC3, represent respectively 30%, 14% and 9% of the total compositional variation. Plots ordered according to these gradients are shown in figure 20. The PC1 axis opposes the A-horizon plots characterized by Symphyla, Protura and Diplura, compared to the O-horizon plots, which are characterized by Isopoda, Aranae, Opilionidae and larvae of holometalular insects. The PC2 axis is opposed to the surveys of the land related to overrun, characterized by a high presence of the macro-groups of Acari, Collembola, Diplopodae and Himenoptera, to the samples of all the other plots, related to areas managed mostly characterized by ants and pauropoda. Seasonality does not have a clear effect on PC1 and PC2 axes while it seems to be responsible for the PC3 axis (not shown in the figure). The PC3 axis opposes the surveys carried out during the summer, with an increase of Diplooda groups, larvae of insects holometabolous and Tisanoptera to those instead carried out in the spring and autumn periods. Summarizing , the indirect gradient analysis shows that the stratification of horizons is the main factor responsible for the variation of composition and abundance of mesofauna. Within the horizons the composition is determined by the management and abandonment and finally by the seasonal variation. Given the initial phase of the analysis of these data any other conclusion would be forced at the moment. In order to make the work of identification, digitization and data collection appreciable, the database containing the datasets relating to thickness variations, chemical analyzes, qualitative-quantitative composition of the horizons and and qualitative-quantitative data of the analyzed mesofauna, has been attached in digital. In addition, the photographic database containing the photographs of the arthropods belonging to the different macro-groups divided by season, horizon and sample is also attached in digital format.

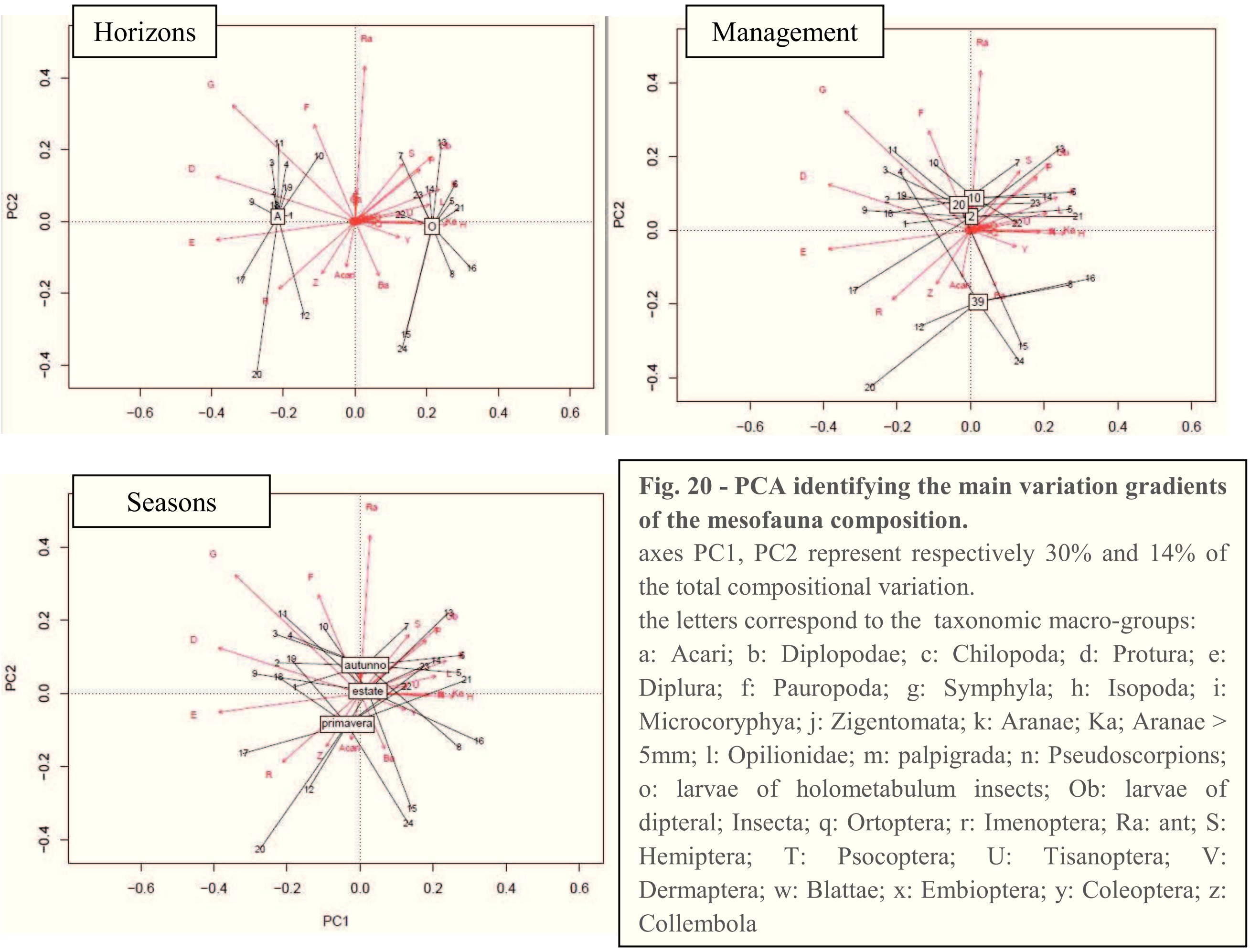


Fig. 20 - PCA identifying the main variation gradients of the mesofauna composition.
axes PC1, PC2 represent respectively 30% and 14% of the total compositional variation.
the letters correspond to the taxonomic macro-groups:
a: Acari; b: Diplopodae; c: Chilopoda; d: Protura; e: Diplura; f: Pauropoda; g: Symphyla; h: Isopoda; i: Microcoryphya; j: Zigentomata; k: Aranae; Ka; Aranae > 5mm; l: Opilionidae; m: palpigrada; n: Pseudoscorpions; o: larvae of holometabulum insects; Ob: larvae of dipteral; Insecta; q: Ortoptera; r: Imenoptera; Ra: ant; S: Hemiptera; T: Psocoptera; U: Tisanoptera; V: Dermaptera; w: Blattae; x: Embioptera; y: Coleoptera; z: Collembola

Conclusions and discussions

InIn the light of the data emerging from the current study and from the preliminary elaborations it is possible to state that even if it is generally accepted that the removal of trees by clear-cutting, or other methods, has a significant effect on the invertebrate fauna of the forest floor (Heliovaara &Vaisanen 1984, Hoekstra *et al*. 1995) the effects on arthropod communities are complex and difficult to analyze since various taxonomic groups are affected and they react to impacts differently (Bird *et al*. 2000, Hill *et al*. 1975). From our data the abundance, diversity and composition of species of the soil mesofauna seem to be closely linked to traditional management. The maintenance of the composition of the mesofauna seems to be influenced by the management maintenance to a greater extent than that linked to the seasonal trend. The constancy of the chemical characteristics of the samples examined also suggests that this change is probably due to more physical-structural factors characterizing the horizons A and O and the microclimatic characteristics that are established at ground level during the different moments analyzed. This situation is perfectly in line with what was already claimed by several authors (Bird *et al* 2000, Theenhaus & Schaefer 1995). On the contrary, the data are strongly contrary to what was claimed by Blasi *et al*. (2013) who assert that in central Italy silvicultural practices or their interruption and the composition of deciduous forests do not seem to have any important effect on the structure of microarthropod communities. Instead, these are in total accordance with what has been suggested by Moore *et al*. (2002) that underline how several studies about the effects of silvicultural practices on soil fauna found important impacts on soil forest fertility/productivity and in the terrestrial food chain. The lack of differentiation of samples relating to the forest management units cut less than 2 years before those of the following phases of the rotation, would seem to indicate a rapid recovery of the mesofauna. This aspects is for Bird *et al*. (2000) a clear index of a good level of the ecosystem integrity (community resilience).

General overview:
(conference proceedings - published)

in addition to the aspects discussed above, other parallel studies concerning phenological trends, floristic value, forest planning and evaluation of the degree of vegetation evolution have been carried out over the three years and are currently the subject of data collection for future publications. An overall picture based on the preliminary results of all the studies carried out was presented at the Coppice forest in Europe international congress: ecosystem services, protection and nature conservation, held from 15 to 17 June 2016 in Antwerp (Belgium). In order to propose a more complete overview, the extended form of the short communication published in the congress documents is reported below

Introduction

Although coppicing is an ancient practice that over the centuries has shaped and characterized, and still characterizes, much of the Italian landscape of low mountains and hills, the coppice forestry has always been considered simple and inexpensive, arousing little interest from the scientific point of view. Over the years, however, the way of considering "the forest" has undergone profound changes, especially related to changes in socio-economic and cultural rather than the deepening of knowledge of the biological and physiological system. Coppicing was so criticized for its modest contribution to the landscape, the impoverishment of the soil and a substantial loss of biodiversity.

The common aim of the studies here reported was therefore to investigate the effects of the recurrence of this kind of management on the recovery process of the "forest system" in a mesophilic European Hophornbeam stand, analyzing the evolution of its various parameters during the rotation period. In order to assess the degree of naturalness characterizing these formations and to provide new knowledge on the dynamics established in the "forest mosaic", that include all the forest management units, we are studying the formation of this flora, verifying the origin of herbaceous species and considering the impact that this type of management has on the soil genesis and conservation. As said above, about these aspects only little information is available in the literature, despite the European Hop Hornbeam forest representing the fourth most widespread type of forest throughout the Italian territory.

Materials and methods

The choice of the study site, based on research and cartographic information provided by organizations or municipalities in the preliminary phase of the work, has fallen on a forest stand in the Umbria-Marche Apennines, identified thanks to the involvement of stakeholders, on the North-East side of Mt. Nerone, in the municipality of Piobbico (Marche region - province of Pesaro e Urbino), 85 hectares of mesophilic European Hophornbeam managed continuously for almost three centuries as a coppice with standards. Here we selected forest compartments of different ages inside the management rotation that cover a time period of 40 years. The choice was therefore to interpret the stand dynamics through a synchronic approach. Within each forest compartments selected we have identified 3 areas in an elevated position with respect to the main routes of skidding (or at least 600m away from these), distant less than 50m from a charcoal pit and not less than 50 m from non-forested areas, slope as similar as possible, difference of exposures less than 30 ° and altitudinal difference less than 100m.

Thus, sample plots of 100m2 were plotted, in which we proceeded to the collection of several data:

- average and real slope, coordinates of the midpoint, predominant exposure;
- millimetric measure of diameters of all the subject ad DBH
- centimetric measure of height of all the subject (even less than 130cm)
- characterization of the subjects on the basis of origin, physiological and structural characteristics,
- number of the stumps (living and dead),
- quali-quantification of necromasses;
- determination of the floristic entities and their quantification (phytosociologic value);
- indication of the growth stages for each individual of each species;
- description of geomorphological features, opening and description of soil profiles.

Results

The elaborations of dendrometrics data and the phytosociological study showed the analogy of analyzed forest stands to those stands surveyed at regional level by IPLA (2001) for the Regional inventory. The analysis of floristic data highlighted a number of species and floristic density in line with that indicated in the literature (Pignatti, 1998 - Ubaldi, 2012) for this type of stand, significantly higher than the values recorded for other forest formations. Particularly interesting are the data emerging from the interpretation of the biological spectrum. This analysis revealed a large percentage of geophytes (16%), that spread a bit in all climates, but in high percentages they become an excellent indicator of not too disturbed forest ecosystems.. Regarding therophytes, a biological form that indicates anthropized and / or disturbed environments, there was a marked difference between the percentages observed within the plots (7.5%) and those concerning the entire forest management units surface (15%): this difference is attributable to the presence within the management unit or to confinement of it with clearings, rocky outcrops and areas recently affected by the cut, where annual plants result the predominant component. The interpretation of this situation has clarified the main origin of the species in this biological form, which is most likely due to the germination of seeds in the soil seed bank following the favourable conditions that are realized with periodic soil uncovering, characterizing this form of management, and not as a result of the contribution due to human activities. This situation was confirmed and sustained by the analysis of the chorological spectrum, which shows a fairly high percentage of endemic species (5%), constant throughout the period under investigation, and constantly higher than the percentage of the cosmopolitan species (3%). Also interesting is the analysis of proportion between the number of families, genera and species (taxonomic spectrum) used to provide paleobotanical indications, which allows to estimate the origin of the examined flora in the subatlantico period (Iron Age), in line with the age of formation of a large part of Italian forest floras (Piussi, 1994). However this flora highlights subsequent specializations and adaptations due largely, but not exclusively, to the practice of coppicing and to the conditions of periodic disturbance related to it. This aspect is confirmed in the modest homotonia evidenced to "inverted J" trend found in the ecological spectrum and confirmed by the values of similarity index (Jaccard index): a typical trend that Ubaldi (2012) attributes to fairly well setting cenosis in whose ecological selection either a competition or a very important environmental factor intervenes (Ubaldi 2012). The analysis of the phenological trends showed, after an initial phenological phase, shifts linked to the sudden elimination of the tree layer, a strict synchronization of the phenological phases among the species. Phenological synchronization that remained constant in all the investigated stages, with the exception of the post-abandonment one. At this stage, constant phase shifts of the phenology phases were highlighted. The seed bank analysis showed a peak of number of seeds and seeds viability around the third year after coppicing. Subsequently, both the number and the viability of the seeds tend to decrease following constant trend up to the last years of the traditional rotation, while the specific composition remains substantially unchanged. With the lengthening of the rotation, the viable seeds decrease following an accentuated trend and triggering slight changes to the specific composition. Instead, the seed bank of the post-abandonment stage shows strong differences in all aspects, both qualitative and compositional. The latency period, corresponding to 18 to 20 years of the traditional rotation, determine the loss of the seed bank if excessively protracted or if it remained associated exclusively to phenomena of the snagging and tipping, which does not allow the realization of such conditions on surfaces of extensions adapted to the emergence of a population large enough to its maintenance over time. Also interesting are the results of the application of the method developed by Taffetani and Rismondo (2009), which allows to measure the impact of management activities and to observe the changes that follow, highlighting the ecological structure through the division into classes of vegetation. The application of this method highlighted that the more sizeable floristic quota results to be attributed to the phytosociological class of *Querco-Fagetea*, remain still well nourished quotas of species of forest edges (class of *Rhamno-Prunetea*) and elements of many other classes of herbaceous prairie vegetation. Among these, the most interesting group results to be that of the class *Epilobietea angustifolii*, representing the elements of the vegetation of the forest clearings, accompanied by some species of phytosociological class *Galio-Urticetea*, including the species of nitrophilous forest edges. The analysis also allows to highlight how many closely forest entities that seem to disappear in the years immediately after cutting, in reality find refuge in the areas of contact with the stumps in which are to be realized appropriate microstational situations. In addition, the process has helped to highlight how the "stable" prairies placed in the immediate vicinity of forest areas represent the main source of species that colonize the areas uncovered by cutting, immediately after opening; role played in disturbed or strongly humanized environments by species of the *Stellarietea mediae* class, or even by invasive alien species, which are absent or very little represented in this case. The absence of these classes is indicative of a flora characterizing a system in perfect dynamic balance with the activities in progress. Full confirmation is found in the phytosociological studies carried out, that although they relate to forestry compartments of different ages inside the rotation, characterized by chronological and structural differences, attest membership of all areas examined not only at the same phytosociologic association (*Scutellario columnae-Ostryetum carpinifoliae*) but also to the same sub-association (*Violetosum reichembachianae*). This datum once again puts into evidence how coppicing does not drastically alter the balance and the dynamics of the vegetation observed, but rather allows the maintenance of cenosis and a high degree of biodiversity. The pedological study showed the presence in all areas of soil to label as Rendzic Leptic Phaeozem (Skeletic) (IUSS, 2006), belonging to the class of Phaeozems for WRB and attributable to the class of

Mollisols for ST. Soils in this class are among the most fertile in the world (Certini and Ugolini, 2010) and are characterized by base saturation greater than 50%, very dark colour and structure strongly developed with lumps of different sizes (Chaney and Swift, 1984). For their formation and conservation, mainly related to the process of melanization, these soils need a humid continental climate characterized by water and thermal regimes of the soils that favor the accumulation and protection of organic matter incorporated into the soil (SSS, 2003 - 2010). Finally, the dendronomic analysis allowed to reconstruct the dendro-auxometric evolution and structural population highlighting several interesting aspects. The evolution of the vertical structure and diametric distribution as well as the social dynamics which accompany them show a system sensitive and responsive to changes in microclimatic addition to the pressure from the wildlife. The analysis of coppice shoots allowed to detect the dynamics at the level of single stump: the membership of the coppice shoots to various social classes tends to change in a rather obvious and describable through mathematical models, first within the stump of belonging and later, when the hierarchies within the stump are fairly well defined, between stump and stump. Even for these last, as you progress through the rotation, there has been increasing mortality to which is added the risk of snags and tipping. The set of observed data, and among these especially the trend over time of basal area, distinct in its living component and dead component, both appreciated in view of the destination of the wood (timber for fire and coal), suggest a rotation of the optimal duration of about 17 years. On the basis of data obtained from this study and summarized above, it is therefore possible to argue that the coenosis analyzed not only are not depressed or damaged in any way by the normal management practices, but on the contrary are shaped and selected by these. Moreover, the forest mosaic that the set of these areas constitutes, creates a high number of refuge habitats, able to accommodate a flora whose number of valuable species is high when compared with the average given in the literature (Del Favero *et al*, 1999 & 2000 - IPLA, 2001) for other forest categories, leading to a re-evaluation of the importance of this forest type. In addition, this management allows the increase of the areas with ecological conditions analogous to those of the forest edges, essential for the maintenance of species floristically interesting, the presence of which is strictly linked to the perpetuation of coppicing, as well as for storage of high levels of biodiversity (Peterken and Francis, 1999; Del Favero, 2001; Riondato *et al*., 2005), as confirmed by the analysis of vegetation.

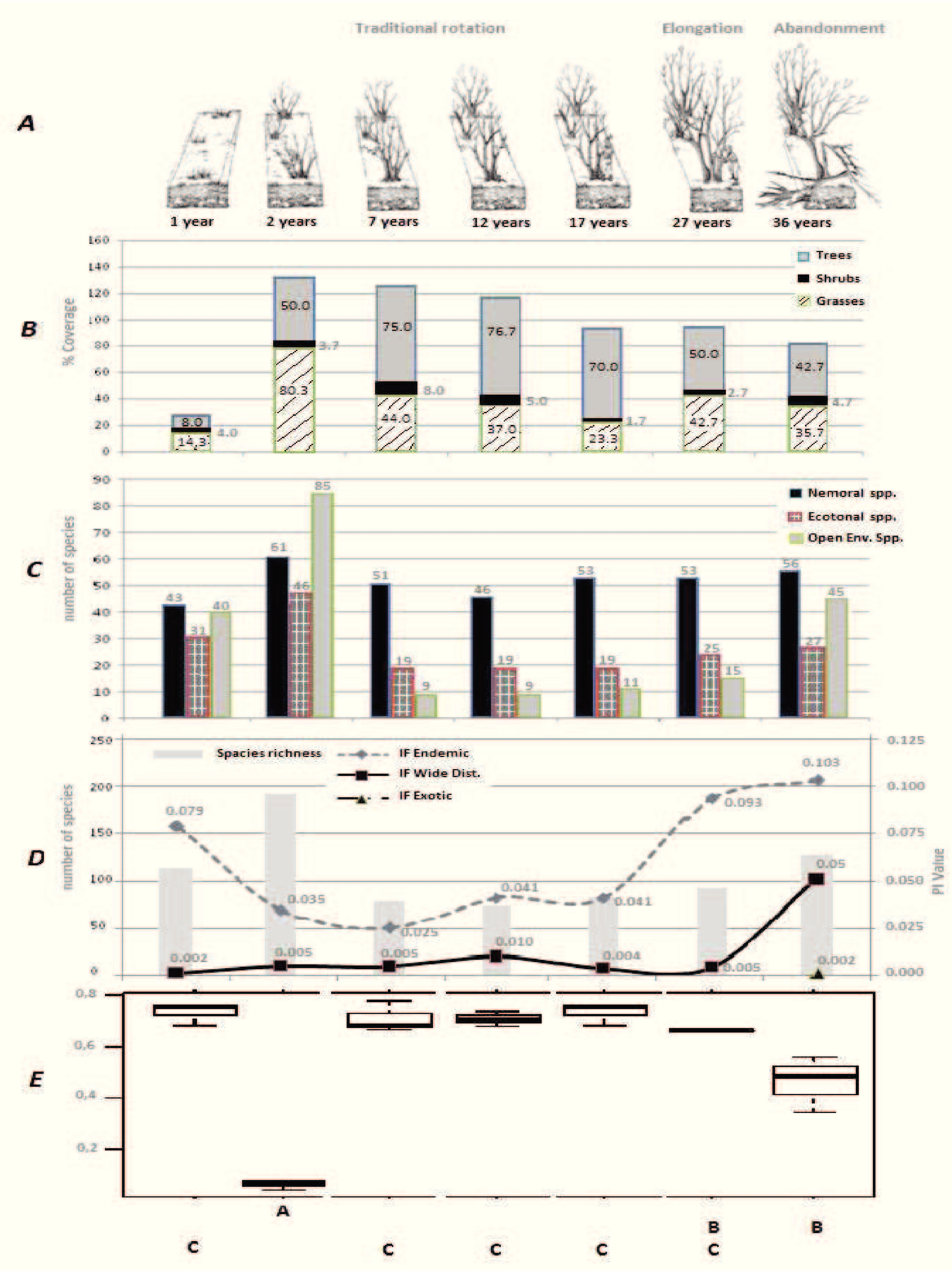


Fig. 21 - **(A)** Transect of coenosis (Scutellario columnae-Ostyetum carpinifolia) development during the rotation and after its abandonment; **(B)** Histogram of ground cover; **(C)**Histogram of flora composition in terms of ecological groups; **(D)** Graphs of IL, ID, IE indices correlated with species richness; **(E)** Results of tukey analysis relative at the maturity index

Ostrya carpinifolia forests in the Balkans: actual knowledge, structural, silvicoltural and ecological features. (Project in progress)

Introduction

In order to extend the study of these formations to their entire geographical distribution area, in March 2018 a cooperation relationship was established with the Department of Forestry and Forest Ecology of the Faculty of Forestry of the University of Zagreb (Hr). This study is currently in its full development phase. Here below a summary of the activities carried out is given, together with the methodologies adopted and a quick explanation of the organization and potential of the Balcans Ostrya Forests (BOF) database. This database is the main result of the established scientific collaboration. Also in this case, due to the amount of data collected it is impossible to insert the BOF directly into the text. However, in order to allow consultation, the preliminary version of the database has been reported in the annexes.

Materials and methods

On the basis of the information available in the literature and from the various forest offices from April to July 2018 numerous inspections were carried out in order to identify the areas qualified by the real presence of the different *Ostrya carpinifolia* forest types on the whole Croatian national territory. On the basis of this preliminary study, the most representative formations from a point of view of extension and / or ecological characteristics were identified. In each of these, preliminary floristic-vegetational surveys were carried out in order to verify the real belonging of the analyzed formation to the *Ostrya carpinifolia* forests group and to be able to estimate the representativeness of each type detected. Subsequently, in the most representative areas of each site identified were carried out surveys aimed at deepening the knowledge on the current ecological status of the different *Ostrya carpinifolia* forest formations present on the Balkan territory and acquire new floristic-vegetation, pedological, structural and management data about these. In each area, in fact, a variable number of plots representing the entire surface area in question have been identified. In these plots, vegetational surveys were carried out following the method proposed by Brau blanquette (1927) and subsequent modifications (Géhu *et al*., 1991; Theurillat 1992a, b, Biondi 1994, 2011, Biondi *et al*., 2004, Rivas-Martínez 2005 , among others). Moreover, morphological descriptions of the topsoils according to Baize and Girard (2008) for the O horizons and Schoeneberger *et al*. (2012) for the A horizons were made. Lastly, data regarding structure, past , present and future management plans were collected.

Standardized survey form

In order to speed up the survey activities and standardize the descriptive parameters of reference for the descriptions, various standardized survey methods present in the literature (Biachi *et al*. 2006, Zanella *et al*. 2010, IPLA 2001, among others) were tested during the three years of the PhD program. These, however, taken individually did not allow us to cover the entire spectrum of the aspects to be examined. In collaboration with the section of Botany and Applied Ecology of the Department of Agricultural, Food and Environmental Sciences, of the University of Ancona, Professor Colpi of the Department of TESAF of Padua and the Department of Forestry and Forest ecology of the Faculty of Forestry of University of Zagreb, a standard survey form and an informatics format for the computerization and statistical treatment of the data regarding forest structure, management, vegetation, phytosanitary status and pedological aspects were developed. In the light of the results obtained from the use of this format for surveying in the field, at the moment this tool is being tested on other forest types in order to verify and evaluate its use in other research areas, in order to propose it through an article currently being drafted, as a shared survey method for multidisciplinary studies on forest systems. The survey forms (shown in the annexes) are structured as to take into consideration 1) geomorphological and environmental information, 2) physiological and phytosanitary aspects, 3) silvicultural aspects, 4) structural aspects, 5) topsoil characterization. In order to minimize the time necessary for the survey procedures and reduce the variation in the descriptors adopted as much as possible, all the reference descriptors are already provided for each aspect taken into consideration. During the phases of survey in the field it is therefore necessary only to identify and check the descriptor corresponding to the situation in question. On the survey form each descriptor shown is also equipped with a numerical code. This code corresponds to a specific area of the informatic format for the computerization of the data. This reduces errors in the transcription phase and speeds up the computerization process.

Preliminary results

The main result of the forest formation analysis campaign of the *Ostrya carpinifolia* forest formations on Croatian territory is the creation of a database containing a considerable amount of unpublished floristic-vegetational, structural, management and pedological data. This has been renamed BOF (Balcans Ostrya Forests database). The BOF database is organized into three datasets containing: ecological, structural and management data the first one; pedological data the second one; floristic-vegetation data the third one. Due to the size of the database it was not possible to insert it directly into the text. This database has been listed among the computer attachments in order to allow its consultation. If we want to summarize very briefly what emerged from the preliminary analyzes and the observations made in the field and on the basis of the literature, it is possible to assert that the importance of the *Ostrya carpinifolia* Forests on the Balkans does not lie so much in their extension but in their capability to enrich the Croatian forest heritage. In fact, these formations realize cameos of very high-biodiversity and ecological valence that interrupt the extension of much larger forest formations, mainly represented by beech and oak woods. These formations, because of their structure and dynamic characteristics, constitute a large number of refuge habitats for different plant and animal species that find their optimum in open woods and transitional environments. The general conservation status of these coenoses generally appears to be fairly good. The number of plant species present in the different formations surveyed ranges from 26 to 72, with a modal value of 48 species. From the phytosociological point of view the major floristic component belongs to the Querco - Fagetea class. The presence of this floristic composition is a point in common with the *Ostrya carpinifolia* forest formations present on the Italian territory and underline a strong link between them. Another point common to all the surveyed formations appears to be the structuring of the topsoil. In fact, all the analyzed cenosis resulted to be characterized by the presence of Hamphymull. The presence of this type of forest humus highlights an optimal environment for the development of all the components of the pedofauna and therefore a high biodiversity even at soil level (Baize & Girard 2008). A reduction of species, which can reach 32% compared to homologous but regularly managed formations, or subject to repeated disturbances of various kinds (falling rocks, snowfall, etc.) is instead recorded in the areas that have not been managed for a long time. This situation, fully in line with what has been shown for the corresponding coenosis present on the Italian territory, seems to highlight how the formations under examination take advantage of a regime of repetitive disturbances that makes them much more competitive than other formations.

Conclusion

The forests of *Ostrya carpinifolia* present on the Balkan territory appear to be very important elements for the maintenance of Balkan forest biodiversity. In fact, even if these are not particularly important in terms of surface area, they take on enormous value in terms of biodiversity and the maintenance of refuge habitats. These forest formations show significant points in common with the formations present on the Italian peninsula, especially with those present in the Central Apennines area. This aspect remarks the close bio-geographical link that binds the Apennine chain and the

Balkan area. The study also revealed that this type of forest does not find its greatest expression in the Balkan peninsula but in the Italian one, where it is possible to identify as a point of greatest expression the area of the Umbrian-Marche Apennine. This particular geographic area that, together with the central part of the Velebit chain, is also strongly characterized by the presence of these formations, can be considered the heart of the Balkan Appennino biogeography region. These unpublished data thus underline the close ecological correlation within the Apennine-Balkan region and seem to identify in the *Ostrya carpinifolia* forest formations one of the major common points.

IV

Effects of ecological isolation

The real problem of humanity is the following:
we have paleolithic emotions;,
medieval institutions
and god-like technology.
(E.O. Wilson)

Residual forests in the Marche region: distribution and main characteristics

Introduction *(Project in progress)*

The "residual woods" are a specific reality that characterizes the hilly and lowland belt between the Apennine ridges and the Adriatic coast (Taffetani, Giannangeli *et al.*2009). These patches of forest vegetation are defined as residual because they represent the result of the long process that has led the forest areas, once very extensive, to be significantly reduced under agricultural and urban planning pressure. They have a double value: a documentary value, as they allow us to interpret the vegetational potential of an extensive area now almost completely transformed by agricultural activities and the biodiversity conservation value, constituting real reservoirs and shelters of plants and animals that have become rare in the rest of the territory (Biondi e Morbidoni 2010). Their existence and their degree of conservation is however closely connected to human activity. In fact, the presence of these small forest groups within the agricultural landscape and their management and conservation that shaped them during century depends on those activities (Taffetani 2009). The size and position of the area are two factors of considerable importance for the conservation of these areas: the pressure that agricultural, economic and social activities exert on natural environments must be considered the main cause of the alteration of ecosystems. The transformations therefore occur more quickly and drastically in relation to the reduction of surface of these forest areas. One of the main problems arising from this close relationship between human activities and natural areas, however, is the intensive exploitation of cultivated agricultural land that characterized the last century. For example, sowing is carried out up to the edge of the forest, with the consequent disappearance of mantle and edge formations. Moreover, the carrying out of some cultivation operations, first of all the chemical weeding, takes place without respecting a minimum protection belt. The conservation of the forest and its naturalness are also hindered by the presence of reforestation. Often species unrelated to the potential vegetation of these areas (generally conifers) were in fact used due to the ease of engraftment and growth that ensured their success. The analysis of historical data concerning the size of the properties and the land use (*Cabrei* of the XVII century and Gregorian land register of XIX century) allowed us to reconstruct some of the most important environmental modifications, such as the reduction of forest surfaces and the disappearance of habitats of prairie at the edge or in the immediate vicinity of wooded areas. These types of habitats remained well preserved until the 1950s. Subsequently, the progressive industrialization and mechanization of agricultural practices led to a rapid loss of interest in these areas and their consequential drastic superficial reduction.

The census of the residual forests
(Monograph in press)

During the last 10 years the research team led by prof. Taffetani has carried out a capillary census of the residual forest formations extended to the whole Marche region. For the purposes of the census, only small forest areas, more or less well preserved and isolated from other residual formations and continuous and extensive forest areas were taken into consideration. Up to now, 59 forests have been studied in the flat and low-hill area of the Region. Of each forest subjected to the census during the last 10 years flora and vegetation were studied and analyzed by phytosociological survey. These survey concerned not only the narrow forest area, but also the marginal environments (such as mantles and edges), the surrounding fields and ruderal environments, in order to identify all the stages of the dynamism of vegetation. The study provided important elements for the assessment of the conservation status of the different forest communities and for the identification of the appropriate management forms. Precisely in this field of research belongs the part of the doctoral project that led to the study of hyper-detail of the residual *Ostrya carpinifolia* forest formations. If in recent years numerous studies analyzed the floristic and vegetational components of the different coenoses (Taffetani *et al.*, 2016), none of these focused on the analysis of the micro-dynamics of the cenosis openly in order to highlight the effect of traditional management, abandonment and ecological isolation. As a part of the PhD program, a survey campaign focused on the investigation of these dynamic aspects was carried out for over two years in *Ostrya carpinifolia* residual forests. The survey process recently concluded is currently in the cartographic restitution phase. The survey methodology and cartographic restitution procedure adopted are summarized below. The preliminary results obtained from the analysis of the surveys of the various forests surveyed will be reported by organizing them in summary descriptions of the residual forests analyzed. As for the analysis of micro dynamics, this is still under construction, and even in this case, given the amount of data collected, it was not possible to include them directly in the text. These were then organized into a dataset and reported in the attachments.

Materials and methods

In order to identify the micro dynamics triggered by management abandonment and ecological isolation, after an initial survey aimed at verifying and updating the floristic-vegetational data available for the studied formations, we proceeded to the cartographic restitution in the GIS platform of the six woods object of study. The maps obtained from cartographic geo-referencing in

GIS were loaded onto a portable GPS device in order to be sure to cover the entire area of all the six forest analysed. The surveys were aimed at highlighting the micro environments present in these forests. For each area, detailed surveys were carried out on the environments within a range of 25 meters from the edge of the forest, over the entire perimeter of the forest and over the entire forest area. Within each area where structural (reduction of the coverage of the foliage, areas of tipping of the stumps, areas of crash, etc ..) or compositional (nuclei characterized by different floristic composition, presence of exotic species, etc ..) differences were found, the species composition and abundance were recorded according to the Braun-Blanquet scale. Once determined the doubtful species and ordered the reliefs in phytosociological tables, each species was traced back to a phytosociological class of belonging to which was attributed the corresponding Maturity value (Taffetani & Rismondo 2009). All the surveys were georeferred and at the moment the updating phase of the maps in GIS is underway. In these maps, all the surveyed areas within the forest areas will be reported and will be accompanied by floristic list, maturity value and index values of Ellemberg.

Results

On the basis of the data present in the bibliography and from those that emerged from the survey, it was possible to characterize the six woods under study from a physiognomic and vegetational point of view. These results will be part of a monograph on the residual forests of the Marche Region (Taffetani *et al* - in press). Here the results of these physiognomic and vegetational characterizations are presented showing part of the sheets included in the monograph, regarding the formations under examination.

SELVA SEVERINI

Fig. 22 - Cartographic delimitation of the Selva Severini

Municipality of belonging:
Fano (PU)
Coordinates:
N 43.835804 E 12.964713
Geographic location:
hilly sub-coastal sector
Geology: sandstone with clayey interlayings
Altitude: 95 – 105m a.s.l.
Area: 6,02 ha

Fisionomy and Vegetation

A forest of private property that extends on the north-west side of a hill half a kilometer from the village of Fenile, on the right side of the Arzilla stream. We have documented information of this forest since 1873, as it has been used as a hunting reserve by the State Forestry Corps. From a structural point of view it can be divided into two parts: one with dominance *Quercus pubescens* together with *Quercus ilex, Fraxinus ornus, Sorbus domestica* and *Acer campestre* accompanied in the shrubby layer by thermophilous species such as *Rubia peregrina, Smilax aspera, Emerus major* subsp. *emeroides* and *Lonicera etrusca*. In the other sector, where the most abundant species is *Ostrya carpinifolia*, mesophilous species such as *Corylus avellana, Euonymus europaeus, Ligustrum vulgare, Cornus sanguinea* and *Lonicera xylosteum* are more represented. The low-shrub layer of the underbrush is dominated by *Ruscus aculeatus* and *Asparagus acutifolius*. In the herbaceous layer are present strictly forest species such as *Melittis melissophyllum, Daphne laureola, Anemone trifolia*, *Lilium bulbiferum* L. subsp. *croceum*. The forest has not been managed for years, and in the most open areas is present a good amount of *Rubus ulmifolius*. A comparison between the study carried out here and those of 1973 shows how the loss of biodiversity has not been achieved over the years, having substantially retained the number of species surveyed. However, by carrying out an investigation into the individual species, we observe the disappearance of as many as 18 species typical of forest habitats and 8 of forest mantle.

Environmental unit of sandstones

Edafoxerofilous series

- *Roso sempervirentis-Quercetum virgilianae*

Climacic series

- *Asparago acutifolii-Ostryetum carpinifoliae*
- *Lonicero etruscae-Cornetum sanguineae*

SELVA VALLE DEI PELATI

Fig. 23- Cartographic delimitation of the Selva Valle dei Pelati.

Municipality of belonging:
Pesaro (PU)
Coordinates:
N 43.930377 E 12.856229
Geographic location:
sub-hill hilly sector
Geology:
arenaceous-pelitic
Altitude: 85 – 125m a.s.l.
Area: 3,10 ha

Fisionomy and Vegetation

In this area there are different types of vegetation, depending on the presence of different environments. Herbaceous vegetation, mainly nitrophilous, is found in the area around the farm house, an adjoining wood with typically forest vegetation and a hygrophilous vegetationnear the ditch. The O*strya carpinifolia* forest is enriched by the diffused presence of *Quercus pubescens* and the sporadic presence of *Laurus nobilis*. In the shrub and herbaceous layer are found in abundance *Asparagus acutifolius*, *Rubia peregrin*a, *Emerus major* subsp. *emeroides, Buglossoides purpureocaerulea*) and very abundant *Hedera helix*. In the well-structured forest mantle are present *Spartium Junceum*, *Ligustrum vulgare*, *Cornus sanguinea*, *Emerus major* subsp. *emeroides* e *Rubus ulmifolius*). In the edge *Genista tinctoria*, *Scabiosa columbaria, Centaurea nigrescens* and *Prunella vulgaris*. The hygrophilous herbaceous vegetation present near the ditch is characterized by *Sambucus ebulus* e *Urtica dioica*, in the most distal areas, approaching the banks, *Aegopodium podagra ria*, *Glyceria plicata, Ranunculus repens* and, in contact with water *Agrostis stolonifera*, *Paspalum paspaloides*, *Apium nodiflorum*. On the surface of the ditch where the water is stagnant *Lemna minor* is present.

Environmental unit of the arenaceous-pelitic substrates

Climacic series

- *Asparago acutifolii-Ostryetum carpinifoliae*
- *Rubo ulmifolii-Ligustretum vulgaris*
- Aggruppamento a *Spartium junceum*
- Aggruppamento a *Genista tinctoria*

Hygrophilous azonal veetation

- *Helosciadetum nodiflori* Br.-Bl. 1952
- *Glycerietum plicatae* Kulcz. 1928 em. Oberdorfer 1954
- *Paspalo-Agrostidetum* Br.-Bl. 1936
- *Festuco fenas-Caricetum hirtae* Bolòs 1962
- *Urtico dioicae-Aegopodietum podagrariae* R. Tx. ex Görs 1968
- *Urtico dioicae-Sambucetum ebuli* (Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936) Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

SELVA S. NICOLA

Fig. 24 - Cartographic delimitation of the Selva di San Nicola

Municipality of belonging:
Pesaro (PU)
Coordinates:
N 43.881349 E 12.928011
Geographic location:
sub-hill / costal sector
Geology: sandstone
Altitude: 25 – 100m a.s.l.
Area: 6,20ha

Fisionomy and Vegetation

Under the name of Selve di S. Nicola there are two small wooded nucleus located in two adjacent valleys, included in the Rio delle Geniche basin. A century ago these two areas were united, today they are separated by a strip of uncultivated land. The smaller area is part of the park of a private villa. The areas are located on the slopes of the valley heads, with considerable acclivity and they insist on the Pliocene Inferiore formations, mainly sandy-molassic facies. They are characterized by forest formations to *Ostrya carpinifolia* and Quercus pubescens, whose specific composition and structure vary locally according to previous forestry activities. There are obvious areas not affected recently by silvicultural activities. In these areas the appearance is that of an aged coppice with standards. In other areas the conversion to high forest has started, while in other areas the development of the hunting activity has conditioned the management choices. Much of the surface is characterized by an oak forest, in which in addition to *Quercus pubescens*, there are present *Quercus petraeae, Quercus robur and Quercus virgiliana.* Interesting is the presence *Laurus nobilis* exclusively in the shrub state, probably favoured by the silvicultural activities for conversion into high forest. The shrubs, mainly *Ruscus aculeatus, Asparagus acutifolius, Rubus ulmifolius* e *Clematis vitalba,* are widespread, but have a low coverage, as they are affected by undergrowth cleaning operations. Among the herbaceous species are present *Arum italicum, Brachypodium rupestre, Buglossoides purpurocaerulea, Viola alba subsp. dehnardtii, Viola reichenbachiana.*

A flat nucleus of anthropic origin is present on fresh and deep dominant soil . It is characterized by the presence of *Carpinus betulus* and *Castanea sativa*, with *Acer campestre, Acer obtusatum, Quercus cerris, Prunus spinosa, Corylus avellana, Sorbus torminalis, Sorbus domestica, Tilia platyphyllos*. The shrub layer of the undergrowth, despite the cuts suffered to facilitate the collection of chestnuts, is very rich in species. The part of the forest not recently affected by silvicultural operations, presents the typical structure of coppice woods, with dominant *Ostrya carpinifolia* and the presence of Quercus pubescens that characterizes most of the standards. The top part of the area is characterized by the presence of permanent structures for hunting. The forest is sparse and essentially consists of *Robinia pseudoacacia, Fraxinus ornus, Quercus pubescens* e *Cupressus sempervirens*. The most widespread shrubs in the forest are *Emerus major* subsp. *emeroides*, *Cornusmas, Cornus sanguinea*, *Prunus spinosa*, *Ligustrum vulgare* e da *Crataegus monogyna*. The nemoral flora is composed of *Digitalis micrantha*, *Potentilla micrantha*, *Carex grioletii*, *Carex olbiensis*, *Carex sylvatica* and by many species of geophytes among which *Asplenium onopteris*, *Iris fetidissima*, *Lilium bulbiferum* subsp. *croceum*, *Hepatica nobilis*, *Lathyrus venetus*, *Ruscus hypoglossum*, *Ruscus aculeatus, Platanthera bifolia*.

Environmental unit of sandstones

Climacic series

- Gruping at *Quercus petraeae*
- *Asparago acutifolii-Ostryetum carpinifoliae*
- *Buglossoido purpurocaeruleae-Stachyetum officinalis*

SELVA MONTEGALLO

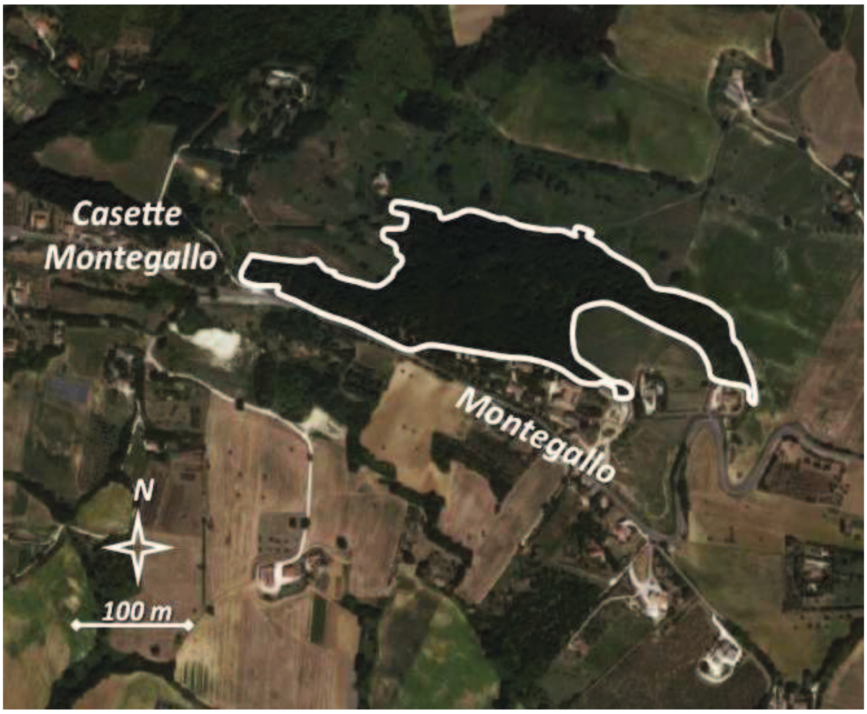


Fig. 25 - Cartographic delimitation of the Montegallo forest

Municipality of belonging: Offagna (AN)

Coordinates: N 43.526908 E 13.477179

Geographic location: hilly sector

Geology: sandstone

Altitude: 170 – 240m a.s.l.

Area: 9,90 ha

Fisionomy and Vegetation

It is a typical, well structured coppice forest. The tree layer is clearly dominated by *Ostrya carpinifolia* to which are associated *Fraxinus ornus*, *Quercus pubescens* and sporadically *Quercus ilex, Carpinus orientalis e Carpinus betulus*. There is also *Laurus nobilis* with young specimens, in the shrub layer togheter with *Ligustrum vulgare*, *Euonymus europaeus*, *Crataegus monogyna*, *Viburnum tinus*, *Cornus sangunea*, *Emerus major* subsp. *emeroides* and *Rhamnus alaternus*. In the low shrub layer there is a noticeable presence of *Ruscus aculeatus*. Very rich is the group of lianose species, of which the most abundant are *Smilax aspera Hedera helix*, wrapped in festoons on the trunk of the oaks. There is also *Rubia peregrina* subsp. *longifolia*, *Clematis vitalba* and *Rosa sempervirens*. In some stations located on the edge and inside the forest there are some Castanea sativa nucleus of anthropic origin, now abandoned and very often heavily damaged. These nucleuses are being renamed with the appearance of several shrub species, but they are also undergoing invasion by Robinia pseudoacacia. The well-represented grassy layer is characterized by the presence of *Lilium bulbiferum* subsp. *croceum*, *Sanicula europaea*, *Euphorbia amygdaloides*, *Mycelis muralis*, *Petasites fragrans* and *Cyclamen repandum*.

Environmental unit of sandstones

Climacic series

- *Asparago acutifolii-Ostryetum carpinifoliae*
- *Buglossoido purpureocaeruleae-Glechometum hirsutae*
-

SELVA MONTE DELL’ACQUA

Fig. 26 - Cartographic delimitation of the Selva di Monte dell'Acqua

Municipality of belonging:
Offagna (AN)

Coordinates:
N 43.512956 E 13.449681

Geographic location:
sub-hill sector

Geology:
sandstone and conglomerates

Altitude: 120 – 150m a.s.l.

Area: 1,91ha

Fisionomy and Vegetation

It is a mixed forest with dominant *Ostrya carpinifolia*, which is enriched, above all in the lower part of the forest, by *Quercus pubescens*, *Quercus virgiliana*, *Fraxinus ornus, Acer campestre, Laurus nobilis* and occasionally *Quercus ilex*. Among the most represented shrubs, there is *Rubus ulmifolius*, *Ligustrum vulgare*, *Viburnum tinus*). The undergrowth is enriched by mesophilous species like *Iris fetidissima*, *Arum italicum* and *Orobanche hederae*.

Environmental unit of sandstones

Climacic series

- *Asparago acutifolii-Ostryetum carpinifoliae*

Edafo-xerophilous series

- Gruping at *Quercus pubescens* e *Laurus nobilis*
- Gruping at rovo *Rubus ulmifolius*

SELVA DI FOSSO FONTANACCIA

Fig. 26 - Cartographic delimitation of the Selva di Fosso Fontanaccia

Municipality of belonging:
Ancona (AN)
Coordinates:
N 43.562084 E 13.563234
Geographic location:
Sub hill / costal sector
Geology:
marl and limestone
Altitude: 120 – 150m a.s.l..
Area: 5,00 ha

Fisionomy and Vegetation

This jungle develops on the top of a hill, north of M. Conero, above the Fontanaccia ditch. The main tree species characterizing the tree layer in this residual forest are *Ostrya carpinifolia, Quercus pubescens, Quercus virgiliana* and *Fraxinus ornus*. There is also *Prunus avium e Laurus nobilis*, whose presence is sporadic and limited to the freshest sectors. In the undergrowth a luxuriant shrub and herbaceous layer develops, with a good component of lianose species. Among the most represented species, we can mention *Cornus sanguinea*, *Lonicera etrusca*, *Clematisvitalba*, *Hedera helix*, *Rubus ulmifolius*, *Smilax aspera*, *Tamus communis*, *Euonymus europaeus*, *Melissa romana*, *Brachypodium rupestre e Stachys sylvatica*. In the basal part towards the ditch the herbaceous vegetation is enriched by hygrophilous and nitrophilous megaforbies as *Petasites hybridus*.

Marly-limestone environmental unit

Climacic series

- *Asparago acutifolii-Ostryetum carpinifoliae*

Conclusions

Even from the preliminary results it is clear how these formations, which host over 70% of the biodiversity of the Italian hilly and plains environments (Taffetani 2009) show more or less advanced symptoms of deterioration, mainly due to widespread management abandonment. The situation appears also to be exacerbated by the ecological isolation that prevents these cenoses from being able to trade with environments of equal naturalistic value. The degradation of the forest vegetation appears more marked in relation to the total surface but above all in relation to the shape and distance between the border of the forest formation. If great importance for the maintenance of cenosis is linked to the area covered, greater importance is assumed by the shape of the forest formation. From a preliminary analysis of the data reported in the database, the ecological value of cenosis seems to decrease with the increase in the jaggedness of the formation perimeter. Finally, on the basis of the preliminary analysis of the data contained in the database, particularly important for the maintenance of cenosis appear to be the presence of intact ecotonal structures. In fact, where these are present, the floristic composition and the vegetation naturalness of the forest appear to be in better conditions

Ecological isolation and Mesofauna

(conference proceedings - published)

During the initial phases of the project, the effect of the ecological insulation on the mesofauna was assessed. The results of the study were presented at the 41st national congress of the Italian society of soil science, held in Ancona from 5 to 7 December 2016, winning the national award for best scientific poster. Below is the extended version of the abstract published in the congress proceedings.

Introduction

From the last post-war period to today in the rural low hilly and lowland belt the Italian landscape suffered an environmental simplification followed by qualitative and quantitative impoverishment of plant biodiversity, especially all in the non-productive semi-natural areas. The main causes of this process are due to agricultural mechanization, the expansion of urban areas and an erroneous vision of abandonment as a guarantee of maintaining biodiversity. In this context, the strips of forest vegetation represent islands of potential vegetation. These areas from the 1950s assumed a delicate position: the expansion of neighbouring agricultural areas has placed them in conditions of ecological isolation, while the loss of economic interest for the fire wood that can be drawn from them has meant that, after centuries of management, these areas were abandoned. This situation has led to an ever greater structural, vegetational and ecosystem simplification, as well as a reduction in the landscape usability of these environments. However, there are still scarce studies and data on the impact of this phenomenon on the pedosphere. The aim of this study was to focus on the effect of Ecological isolation on *Ostrya carpinifolia* forests. The study analyzes the effects of ecological isolation and management abandonment on the forest mesofauna at the cenoses scale.

Materials and methods

Within residual forests that can be traced back to Asparagus acutifolii-Ostryetum carpinifoliae, two transects consisting of three sampling sites 10 m apart from each other were tracked . In each of these, the horizons O and A present within a 30 x 30 cm frame were double sampled . The mesofauna extraction was carried out using Berlese-Tullgren extractors, separately for both types of horizon. The taxonomic determination was limited to the identification of the taxa up to the order level. For each sample was evaluated: 1) the taxa number; 2) the number of individuals per taxa; 3) the balance between the various taxa.

Results

The analysis of the taxa has shown for these formations a strong inconstancy in the distribution and balancing of the same. These imbalances were particularly evident especially in the most external sampling sites, despite belonging to the same vegetation association. The analysis of the quali-quantitative trends of the mesofauna along the transects has then highlighted for the horizon O a decrease in the number of taxa in favor of their better and more stable balancing. A situation which was found, even if less clearly, also for the A horizons, in which, however, the trend of the trends is more difficult to interpret.

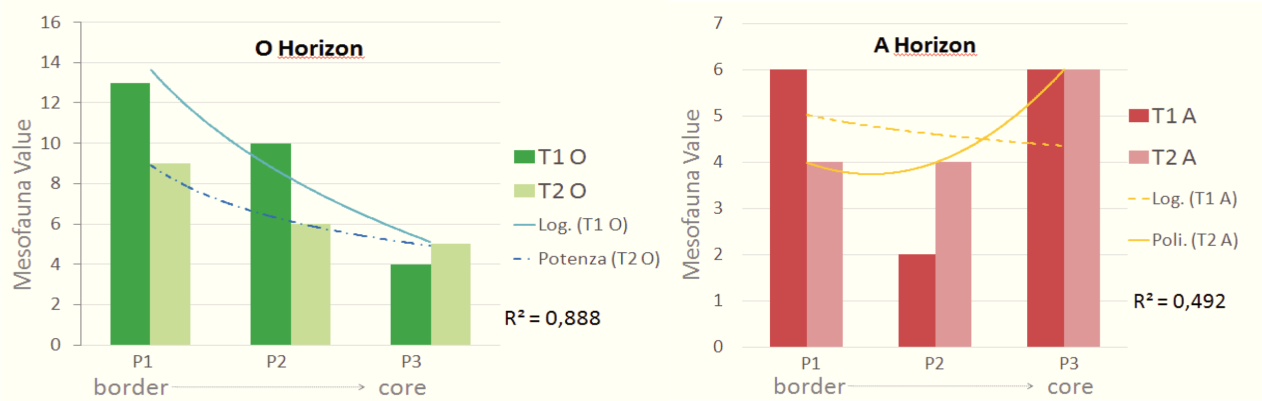


Fig. 27 - graphing of the compositional trends of the mesofauna along the transects and of the relative mathematical model

Conclusions

The analysis of the taxa has shown for these isolated forests a strong inconstancy in the distribution and balancing of the same. This inconstancy highlights a less stable situation than that characterizing the forest formations not in ecological isolation. Therefore, this inconstancy would seem to be entirely attributable to the ecological isolation suffered. The analysis of the qualitative and quantitative trends of the mesofauna has also revealed different ecological conditions within the vegetation association considered due to environmental pressure and has allowed us to highlight the trend. These imbalances were in fact particularly evident especially in the most external sampling sites, despite there is not differences in terms of vegetational composition. The analysis of the quali-quantitative trends of the mesofauna along the transects has then highlighted for the horizon O a decrease in the number of taxa in favour of their better and more stable balancing. A situation which was found, even if less clearly, also for the A horizons, in which, however, the trend of the trends is more difficult to interpret.

V

Floristic studies

"Nomina si nescis, perit et cognitio rerum."

(C.N. Linnaeus)

Introduction

During the three years of the Pd.D. several thousand plant species were determined from the various surveys carried out in Italy, Croatia, Istria, Bosnia, Montenegro as a part of the research project, as well as in the Principality of Andorra and Belgium, during the training schools attended. Once determined, the samples were dried and prepared as herbarium tables. About 900 samples are currently waiting to be erborized in the herbarium of the university of Ancona (ANC), another 150 are being prepared to be sent to the herbarium of the Biology Department of the University of Zagreb (ZA). Eight samples were sent to the central herbarium in Florence (FI), where they are currently stored, as they concern critical groups, rare or new species for certain geographical areas. Finally, five samples concerning studies carried out in collaboration or of particular interest for taxonomic review studies currently underway by researchers of this institute (Gen. Oxalys & Centaurea), are stored in the herbarium of the University of Naples (NA). This part of the work has led to the collaboration with several national (Ancona, Camerino, Naples, Pesaro, Florence, etc. ..) and international (Zagreb, Paris, etc ..) Herbaria with whom collaboration relationships have been undertaken that often led to the publication of scientific articles, in quality of first author, corresponding author or or co-author. The main results of this part of the research work are essentially two:

Review and upgrade of the floristic knowledges of forest formations in *Ostrya carpinifolia*.

As we have already discussed in the previous chapters, *Ostrya carpinifolia* forest formations have been little investigated. As already discussed, various concomitant aspects have meant that these formations were always considered uninteresting. Relatively scarce is therefore also the floristic information available today in the literature for these formations, commonly considered not very interesting also from this point of view. The studies carried out instead highlighted a very different situation. From the first analysis of the examined flora contingent, about 250 species appears in fact to be identifiable as stable species in these formations. Based on a series of cross studies on the surveys carried out and on those available in the bibliography, these species in fact were present in a fairly stable manner in the various vegetational associations characterizing the *Ostrya carpinifolia* forest formationsat the European level. From the first screening has also emerged how only within the first 150 species currently undergoing cross-checking, no less than 19 are endemic and 25 international conventions have been included to protect biodiversity (Tab. 3).

Even the first results obtained clearly show how these forest formations are particularly interesting from the floristic point of view and could even be included among the richest forest formations in terms of plant biodiversity.

Taxa	Type of Interest
Abies alba Miller	International Protection Programs
Anemone trifolia ssp. *brevidentata* Ubaldi et Puppi.	ENDEMIC
Aremonia agrimonoides (L.)Dc.	ENDEMIC
Campanula tanfanii Podlech	ENDEMIC; International Protection Programs
Cephalantera damasonium (Miller) Druce	International Protection Programs
Cephalantera longifolia (Hudson)Fritsch	International Protection Programs
Cephalantera rubra (L.) L.C.Rich	International Protection Programs
Cerinthe minor ssp. *auricolata* Tenore	ENDEMIC
Cirsium alpis-lunae Brilli-Cattarini et Gubell.	ENDEMIC; International Protection Programs
Corydalis lutea (L.)Dc.	ENDEMIC
Cyclamen hederifolium Aiton	International Protection Programs
Cyclamen purpurascens Miller	International Protection Programs
Cynoglossum apenninum L.	ENDEMIC
Dactylorhiza fuchsii (Druce)Soo	International Protection Programs
Dactylorhiza maculata (L.)Soo	International Protection Programs
Digitalis lutea ssp. australis (Ten)Arcang.	ENDEMIC
Digitalis micrantha Roth	ENDEMIC
Epipactis atrorubens (Hoffm)Schultes	International Protection Programs
Epipactis helleborine (L.)Crantz	International Protection Programs
Epipactis leptochilla Godfrey	International Protection Programs
Epipactis microphylla (Ehrh.)Swartz	International Protection Programs
Festuca dimorpha Guss.	ENDEMIC
Galanthus nivalis L.	International Protection Programs
Helleborus bocconei Ten	ENDEMIC
Iris croatica Horvat & Horvat	ENDEMIC International Protection Programs
Iris graminea (L.)Medic.	International Protection Programs
Limodorum abortivum (L.)Swartz	International Protection Programs
Listera ovata (L.)R.Br.	International Protection Programs
Malcomia Orsiniana (Ten.) Ten.	ENDEMIC International Protection Programs
Melampyrum nemorosum L.	ENDEMIC
Neottia nidus-avis (L.)L.C.Rich.	International Protection Programs
Orchis simia Lam.	International Protection Programs
Peonia mascula (L.)Miller	ENDEMIC
Phalantera chlorantha (Custer)Rchb.	International Protection Programs
Pulmonaria vallarsae subsp. *apennina* (Cristof. & Puppi) L. Cecchi & Selvi.	ENDEMIC International Protection Programs
Pulmonaria vallarsae subsp. *vallarsae Kerner*	ENDEMIC
Ribes multiflorum Kit.	International Protection Programs
Ruscus aculeatus L.	International Protection Programs
Salix apennina Skvortsov	ENDEMIC
Sesleria nitida Ten.	ENDEMIC

Tab. 3 - preliminary list of species endemic or protected by international conventions

Reporting of new species for some regions or for entire geographical areas.

These are research articles and short communications through which we have contributed to the updating of national and international floristic checklists and to the study of the expansion or regression phenomena of Exotic, Invasive and Native species. This miscellany of articles published or under publication does not lend itself to being reorganized as a single body. In this context it was therefore preferred to provide a general overview of the published works, fully reported in the annexes. These are subdivided into two macrogroups of interest:

<u>*Updates to the national checklist*</u>

These papers are the result of collaboration with various research groups belonging to the Italian Botanical Society, aimed at the study of critical taxonomic groups and the study of indigenous and invasive flora. Given the common objective of increasing the floristic knowledge at the national level, in order to streamline the text of the articles as much as possible, increase scientific reliability and speed up the publication process, it was decided at national level to collectively publish all the floristic reports carried out on Italian territory. Before submitting the report each author, in addition to determining the species on the basis of the keys and descriptions available in the literature, must make detailed morphometric measurements, on the basis of which to describe the sample in question. Ecological-stational, vegetational and, if possible pedological, information regarding the detection site must also be provided. The examined sample should be dried, made phytosanitary safe and fixed as an official herbarium sample. The sample prepared in this way must be sent to the central herbarium of Florence (FI). Once at the central herbarium, measurements and description will be checked and revised by one or more specialists of the genus in question. Once the revision phase has been completed, information on the area of discovery and a brief description of the population will be extracted from the posted article. Only these parts will in fact be included in the text of the article sent in community to the journal. This fact allows us on the one hand to streamline the text of the article and speed up the reading, and on the other to improve the reliability of the information contained. The original descriptions are stored with the sample at the central herbarium in Florence in order to allow free consultation.

Four published articles fall within this area of interest:

1) *Galasso G., Domina G., Ardenghi N.M.G., Assini S., Banfi E., Bartolucci B., Bigagli V., Bonari B., Bonivento E., Cauzzi P., D'Amico F.S., D'Antraccoli M., Dinelli D., Ferretti G.,*

Gennai M., Gheza G., Guiggi A., Guzzon F., Iamonico D., Iberite M., Latini M., Lonati M., ***Mei G.****, Nicolella G., Olivieri N., Peccenini S., Peraldo G., Perrino E.V., Prosser F., Roma-MarzioF., Russo G., Selvaggi A., Stinca A., Terzi M. Tison J., Vannini J., Verloove F., Wagensommer P., Wilhalm T., Nepi C. – 2017,* ***Notulae to the Italian alien vascular flora: 3.*** *Italian Botanist 3: 49–71 doi: 10.3897/italianbotanist.3.13126 http://italianbotanist.pensoft.net*

2) *Bartolucci F., Domina G., Ardenghi N.M.G., Banfi E., Bernardo L., Bonari G., Buccomino G., Calvia G., Carruggio F., Cavallaro V., Chianese G., Conti F., Facioni L., Del Vico E., Di Gristina E., Falcinelli F., Forte L., Gargano D., Mantino M., Martino M.,* ***Mei G.****, Mereu G., Olivieri N., Passalacqua N.G., Pazienza G., Peruzzi L., Roma-Marzio F., Scafidi F., Scoppola A., Stinca A., Nepi C. – 2018.* ***Notulae to the Italian native vascular flora: 5.*** *Italian Botanist 5: 71–81 (2018) doi: 10.3897/italianbotanist.5.25892 http://italianbotanist.pensoft.net journal*

3) *Galasso G., Domina G., Alessandrini A., Ardenghi N.M.G., Bacchetta G., Ballelli S., Bartolucci F., Brundu G., Buono S., Busnardo G., Calvia G., Capece P., D'Antraccoli M., Di Nuzzo L., Fanfarillo E., Ferretti G., Guarino R., Iamonico D., Iberite M., Latini M., Lazzaro L., Lonati M., Lozano V., Magrini S., Mei G., Mereu G., Moro A., Mugnai M., Nicolella G., Nimis P.L., Olivieri N., Pennesi R., Peruzzi L., Podda L. , Probo M., Prosser F., Ravetto Enri S., Roma-Marzio F., Ruggero A., Scafidi F., Stinca A., Nepi C. – 2018.* ***Notulae to the Italian alien vascular flora: 6.*** *Italian Botanist 6: 65–90 doi: 10.3897/italianbotanist.6.30560 http://italianbotanist.pensoft.net*

4) *Bartolucci F., Domina G., Ardenghi N.M.G., Bacchetta G., Bernardo L., Buccomino G., Buono S., Caldararo F., Calvia G., Carruggio F., Cavagna A., D'Amico F.S., Da Pozzo M., Di Carlo F., Festi F., Forte L., Galasso G., Gargano D., Gottschlich G., Lasen C., Lazzaro L., Magrini S., Maiorca G., Medagli P.,* ***Mei G.****, Mennini F., Mereu G., Miserocchi D., Olivieri D., Passalacqua N.G., Pazienza G., Peruzzi L., Prosser F., Rempicci M., Roma-Marzio F., Rossi G., Ruggero A., Sani A., Saulle D., Steffanini C., Stinca A., Terzi M., Tondi G., Trenchi M., Viciani D., Wagensommer R.P., Nepi C. – 2018.* ***Notulae to the Italian native vascular flora: 6.*** *Italian Botanist 6: Italian Botanist 6: 45–64 doi: 10.3897/italianbotanist.6.30575 http://italianbotanist.pensoft.net*

New species for large biogeographic areas

These are papers concerning the discovery, the determination, the taxonomic and chorological study of species reported for the first time at the level of large bio-geographical territories. The findings of these species has led to significant changes or upgrades to the information currently present in the literature. For these reasons, these species were the subject of entire articles in which an updated picture of the present literature, of the biogeographic distribution and of the ecological characteristics is provided and updated. These papers are also accompanied by original descriptions based on the morphometric measurements made on the samples subject of the study and the comparison of these with measurements taken on several known reference samples and stored in internationally accredited herbaria.

Four articles in publishing are included in this area of interest:

1) ***Mei G.***, *Šegota V., Vukelić J., Baričević D., Taffetani F., Alegro A. –submitted.* ***Cystopteris dickieana R.Sim (Cystopteridaceae), a new specie in Croatian flora.*** *Hacquetia.*

2) *Stinca A. &* ***Mei G.*** *– submitted.* ***First observation of Ehrharta erecta (Poaceae, Ehrhartoideae) in Sicily and its distribution in Italy.*** *Phytotaxa.*

3) *Nobis M., Chernova O.D., Denysenko M., Ebel A.L.,* ***Mei G.****, Nejfeld P., Nowak A., Paszko B., Piwowarczyk R., Király G., Kushunina M., , Kipriyanova L.M., Seregin A.P., Stinca A., Sukhorukov A.P. Zalewska-Gałosz J., Stebel A. & Gudkova P.D. – accepted.* ***Contribution to the flora of Asian and European countries: new national and regional vascular plant records, 8****. Botany letters.*

4) *Lazare J., Piñar Fuentes J.C., Allegrezza M., Luque Martínez S.,* ***Mei G.,*** *Raposo M. & Thébaud G. – in press.* ***Observation de Salix × aurigerana Lapeyr. en Andorre.*** *Botanique.*

Conclusions

"The mathematician is a blind man who looks for a black cat in a dark room."

(C. Darwin)

The *Ostrya carpinifolia* forests are one of the most widespread forest formations in the eastern Mediterranean regions and certainly the most characteristic among these. Due to their traditional coppice management, the limited continental spread, and the collapse of the economic interest of fire wood linked to the diffusion of fossil fuels, these forest formations have, however, always had a very limited scientific interest. To date, in fact, even though in Italy the O. carpinifolia forests cover an area of over 852200 hectares, equal to 12.52% of the Italian forest area and they qualify hundreds of thousands of hectares in the Balkan peninsula, these formations have never been reported to the European Commission. None of the 14 categories and none of the 79 types of forest habitat described for the territory of the European Union actually includes these cenosis. In order to provide new elements useful for the evaluation of the ecological value of these formations, to identify their potentiality and the threats to which they are subjected, this research project was designed, the initial phases of which were developed during the three-year Ph.D. Conscious of the fact that a forest system is not reducible to a group of trees and shrubs, the research activities carried out concerned various components of the forest ecosystem. In particular, vegetation, Flora, Soil and Pedofauna were identified and adopted as indicators of the ecological status and dynamics of these formations. The research activities were mainly aimed at investigating and relating the responses of these ecosystem components to management changes and ecological isolation. Furthermore, a first descriptive screening of the different *Ostrya carpinifolia* forest formations was carried out through the analysis of these components at the level of the entire geographical distribution area. The studies conducted have shown that these forest formations, contrary to what is believed, show great value in terms of biodiversity and ecological complexity. All the formations studied result characterized by a very rich flora and qualified by numerous species of high or very high interest. The study of vegetation has also highlighted how the floristic composition is not only particularly stable but also characterized by a high resilience. High resilience brought to light also at the level of the biological component of the soil through the study of mesofauna. The study of this component has in fact allowed us to observe an immediate recovery in terms of composition and abundance, already after a few months from the coppicing. To this evident symptom of excellent adaptation, is added the high biological value identified through the attribution of indices of ecological complexity, which indicates a mature cenosis and in perfect dynamic balance. This ecological complexity is revealed at the pedological level also by the allocation of all the Top-soil sampled within the formations analyzed in Italy, Croatia, Istria and Montenegro to the class of the Hanfymull. This class of forest humus is characterized by an articulated structuring of horizons due to the complex and complete re-elaboration and incorporation of the organic material implemented from arthropropauna, annelids and fungi. This situation is very interesting, as it is a symptom of conditions of equilibrium which allow the simultaneous and balanced presence of all the components of the biological component of the soil. Taking into account the complete soil profile then, most of the analyzed soils were found to belong to the Mollisols class (Phaozems class for FAO). These classes include the most fertile soils in the world, characterized by a melanic A horizon. For their formation they need from hundreds to thousands of years under conditions of constant thermal and water regime. On the contrary, a few tens of years under non-optimal conditions are sufficient for their complete degradation. Their presence therefore shows how the pedoclimatic conditions and then also the vegetational ones, to which these are closely linked, were stable for at least some hundreds years. Although no differentiation was detected at the level of Subsoil, which confirms the fairly recent origin of the phenomenon, changes in the composition of the flora, vegetation, mesofauna and a morphological-structural simplification were found after the abandonment of management. Some rather clear previsions about the possible evolutions of the increasingly widespread phenomenon of management abandonment were obtained from the study of the soil seed bank. If this, in fact, remains rather constant in terms of quali-quantitative content in the regularly managed cenosis, composition and vitality change strongly after abandonment. This causes the loss of numerous species that are present in the vegetative phase only at specific stages of development of the examined coenosis and which remain latent in the seed bank during the unfavorable periods. The loss of the seed bank therefore entails a change in the vegetation composition of the cenosis. This triggers a series of negative feedback that causes the shift from the resilient to resistant system. The situation would then seem to worsen when these formations are located in a situation of ecological isolation. In this case the phenomenon of degradation of the cenosis is accentuated by the impossibility that the lost species will be replaced by external re-inoculum. On the contrary, in these environments the disappearance of a species creates favourable conditions for the entry of species of other environments, often invasive, that occupy the free ecological niches. This pressure is well expressed by the response of the mesofauna which shows an increasing simplification approaching the edges of the forest surface. The simplification of the composition of the mesofauna triggers a simplification in the structuring of the topsoil that as one moves away from the core-area becomes therefore more conducive to the establishment of species extraneous to the cenosis, speeding up the invasion process. A series of micro-environmental and vegetational changes trigger a chain of negative feedback that leads to the gradual and inexorable degradation of cenosis. In the light of the data that emerged, it is therefore now possible to state that the forests of *Ostrya carpinifolia* are one of the richest forest formations in terms of biodiversity and ecological complexity at the European level. These forest formations, like the secondary prairies, have been shaped by traditional management activities. As for the secondary prairies, abandonment triggers a slow process of transformation which, on the basis of the information available today, would seem to lead to a strong simplification and loss of biodiversity. As for the secondary prairies, described and protected throughout the European territory also through the allocation of funds aimed at maintaining active management, it appears essential for these forest formations, in addition to the inclusion in the protected forest habitats at European level, the organization of a system of facilitation for the active maintenance of the traditional management methods, at least in the most deserving cenosis of interest. Inclusion in the forest categories and the active management of the forests of *Ostrya carpinifolia* appear in fact today essential for the purpose of maintaining biodiversity of the European territory.

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Annexes

Standard Survey Format

Italian

Parametri stazionali:

sito:____

____

quota:______________________

esposizione:________________________

pendenza :_________________________

Area Plot : __________m^2

Età accertata ________________anni
(ultimo intervento)

_____T

ID rilievo vegetazionale:__________________

coordinate: ___________________

____

Posizione fisiografica

3 Alto versante

1 Crinale o Cresta
2 Dosso o Displuvio
4 Medio versante
6 versante
7 impluvio
8 espluvio
fondovalle 9
pianura 10
Terrazzo o 11 Ripiano

5 Basso versante

12 ***Accessibilità***

inufficiente sul__________% buona sul________________%

Dissesto	**assente**	**<5%**	**<1/3**	**>1/3**	**pericolo di peggioramento**
13 Erosione superficiale o incanalata	○	○	○	○	○
14 Erosione catastrofica o calanchiva	○	○	○	○	○
15 landslaides (surface)	○	○	○	○	○
16 Rotolamento massi	○	○	○	○	○
17 Altri fattori di dissesto	○	○	○	○	○

Limiti allo sviluppo delle Radici	**assente**	**<5%**	**<1/3**	**>1/3**	**pericolo di peggioramento**
18 Superficialità del suolo	○	○	○	○	○
19 Rocciosità affiorante	○	○	○	○	○
20 Pietrosità	○	○	○	○	○
21 Ristagni d'acqua	○	○	○	○	○
22 Altri fattori limitanti	○	○	○	○	○

Danni

	assente	<5%	<1/3	>1/3	pericolo di peggioramento
23 Bestiame	○	○	○	○	○
24 Selvatici	○	○	○	○	○
25 Fitopatgeni e Parassiti	○	○	○	○	○
26 Agenti meteorici	○	○	○	○	○
27 Movimento di neve	○	○	○	○	○
28 Inendio	○	○	○	○	○
29 Utilizzazioni o esbosco	○	○	○	○	○
30 Attivitò turistico-ricreative	○	○	○	○	○
31 Altre cause	○	○	○	○	○

Ostacoli agli interventi

32 Assenti o Irrilevanti
33 Scarsi o facilmente superabili
34 Numerosi e rilevanti ma superabili
35 Non superabili

Condizionamenti eliminabili

Nessuno
Eccesso di Pascolo
Eccesso di Selvatici
Contestazioni proprietà
Altre cause…

Fatti Particolari

Nessuno

Pascolo in bosco

36 bovini
37 ovini
38 caprini
39 equini
40 Altro..

41 Emergenze storico-Naturalistiche
42 Sorgenti o fonti
43 Usi Civici
Altri fatti…

Opere e Manufatti

44 Assenti
45 edifici
46 Tracciati per mezzi agricoli minori
47 Piste trattorabili
48 Strade trattorabili
49 Piste camionabili
50 Strade camionabili
51 Piazzali di carico
52 Sistemazi
53 Gradonamenti
54 Muri / recinti
55 Paravalanghe
56 elettrodotti
57 Tracciati teleferiche
58 Condotte idriche
59 Cave
60 Aree di sosta
61 Parcheggi
62 Sentieri guidati
63 Impianti sciistici
Altro… 64

Struttura e Svilupo

Ceduo

65 Semplice
68 a sterzo
69 salturario
70 Sotto fustaia
66 Matricinato
67 Intensamente matricinato

71 appena tagliato
72 Immaturo
73 Maturo
74 Invecchiato
75 fortemente invecchiato

76 Fustaia transitoria

Fustaia Monoplana

78 Tagliata a raso
79 Novelleto o posticcia
80 Spessina
81 Perticaia
82 Giovane
83 adulta
84 Matura
85 Stramatura
86 In rinnovazione

Fustaia Stratificata

Adulta su..
87 ceduo
88 perticaia

Matura su…
89 ceduo
90 Perticaia
91 Giovane fustaia

Stramatura su…
92 ceduo
93 Perticaia
94 Giovane fustaia
95 Fustaia matura

Fustaia pluriplana

Per…

96 Piede d'albero

97 Gruppi

eccesso diametri:

98 Nessuno (Equilibrata)

99 Piccoli

100 Medi

101 Grandi

102 Stratificata su ceduo

Origine

103 Naturale

104 Artificiale

105 Agamica

106 Neoformazione

Vigoria

107 scarsa

108 media

109 elevata

Vuoti e lacune

110 assenti

111 presenti

112 ____________%

Densità

113 scarsa

114 buona

115 eccessiva

Novellame

116 assente

117 sporadico

118 diffuso

119 libero

120 Sotto Copertura

Rinnovazione sp. principale

121 scarsa

122 sufficiente

123 buona

Rinnovazione altre ssp.

124 scarsa

125 sufficiente

126 buona

Specie principali:_____________

____

____

____

____

Composizione specifica

80% o più:____

50% o più:____

____

20% o più:____

____

____

meno del

20%____

____

____

____

Interventi Recenti

127 Nessuno

128 ceduazione

129 sterzo

130 Avviamento

131 Cure colturali

132 Taglio raso

133 Taglio a buche

134 spalcature

135 Ceduazione sotto fustaia

136 Preparazione avviamento

137 Sementazione fustaia transitoria

138 sfollo

139 diradamento

140 Tagli successivi

141 rimboschimento

142 Coniferamento - rinfoltimento

143 Interventi fitosanitari

144 Ampliamento viabilità forestale

145 Realizzazione viabilità forestale

146 Consolidamento, regimazione, ingegneria naturalistica…

147 Altro______ ___________

Funzione

148 Legna da opera

149 Legna da fuoco

150 Altre produzioni dagli alberi

151 Prodotti del suolo e dl sottobosco

152 Protezione idrogeologica

153 funzione turistico-ricreativa

funzione naturalistica

154 conservare

155 migliorare

Orientamento selvicolturale

156 mantenimento governo ceduo

157 Conversione a fustaia

158 Mantenimento gestione a fustaia

159 Abbandono gestionale

160 Evoluzione naturale guidata

ipotesi intervento futuro

161 Nessuno
162 ceduazione
163 sterzo
164 Avviamento
165 Cure colturali
166 Taglio raso
167 Taglio a buche
168 spalcature
169 Ceduazione sotto fustaia
170 Preparazione avviamento
171 Sementazione fustaia transitoria
172 sfollo
173 diradamento
174 Tagli successivi
175 rimboschimento
176 Coniferamento - rinfoltimento
177 Interventi fitosanitari
178 Ampliamento viabilità forestale
179 Realizzazione viabilità forestale
180 Consolidamento, regimazione, ingegneria naturalistica…
181 Altro______ ___________

Priorità e condizionamenti

182 Immediata
183 Entro primo periodo
184 Entro secondo periodo
185 Differibile
→
186 Subordinata alla viabilità

Copertura del suolo:

187 strato arboreo (> 4m)________________%

188 strato arbustivo (da 0,6 a 4 m)________________%

189 strato erbaceo (<0.6m + megaforbie)________________%

190 graminoidi________________%

191 spermatofite________________%

192 pteridofite________________%

193 briofite________________%

194 licheni________________%

195 necromasse________________%

Composizione necromasse :

196 volume totale________________m steri/plot

197 sull'albero________________m steri /plot

198 a terra________________m steri /plot

199 andane________________m steri /plot

Ø < 1 cm________________% 200

1 < Ø < 3 cm________________% 201

3 < Ø < 6 cm________________% 202

6 < Ø < 15 cm________________% 203

Ø > 15 cm________________% 204

Ceppaie :

205 Ceppaie/plot ________________

206 vive_____________________

207 morte____________________

208 ribaltate_________________

Polloni :

209 Età : __________anni

210 Polloni/plot ________________

211 Polloni/ceppaia________________
(Numero medio)

216 dominanti____________________

217 dominati____________________

218 schiantati__________________

219 morti__________________

212 Altezza media________________m

213 Altezza dominante________________m

214 Diametro medio________________cm

215 Diametro dominante______________cm

Matricine (o piante d'alto fusto) :

☐ Matricine (220)
☐ Piante d' Altofusto (230)
/plot ________________

vive_____________________ (226 o 236)

morte____________________ (227 o 237)

schiantate_________________ (228 o 238)

ribaltate__________________ (239 o 239)

221 o 231 Età: (1)__________ (2)___________ (3)___________ anni

222 o 232 Altezza media________________m

223 o 233 Altezza dominante________________m

224 o 234 Diametro medio________________cm

225 o 235 Diametro dominante______________cm

Area basimentrica (G): _________________________m^2/plot

240 **(popolamento)**

Descrizione Hums forestale:

(XS S M L XL -> scala di quantificazione)

\- +

241

☐ **OLn** _______*cm*

(**n** = **n**uovo)
Foglie giunte al suolo da meno di un anno, ancora intere, riconoscibili e non (o poco) decolorate e trasformate.

Attività prevalente: Lombrichi

ife ☐ artropodi ☐ esuvie ☐ anellidi ☐

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Note:

radici	foglie	perule	rametti	semi	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

244

☐ **OLv** _______*cm*

((**v** = **v**ecchio)
Foglie intere o solo poco frammentate (ancora ben riconoscibile la specie) ma con colore e consistenza differente e disposte in strati compatti

Attività prevalente: Funghi

ife ☐ artropodi ☐ esuvie ☐ anellidi ☐

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Note:

radici	foglie	perule	rametti	semi	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

247

☐ **OLt** _______*cm*

(**t** = **t**rasformazione)
Foglie giunte al suolo da meno di un anno, ancora intere, riconoscibili e non (o poco) decolorate e trasformate MA frammentate dall'azione dei lombrichi.

Attività prevalente: Lombrichi

ife ☐ artropodi ☐ esuvie ☐ anellidi ☐

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Stratificazione:

Note:

radici	foglie	perule	rametti	semi	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

250

☐ **OFr** ______*cm*

(**r** = **r**esidui)
Residui vegetali sminuzzati, trasformati, ma ancora riconoscibili a occhio nudo e spesso riuniti in densi pacchetti, mescolati a una quantità di S.O. fine < 30%

Attività prevalente: mesofauna

ife	artropodi	esuvie	anellidi	radici	foglie	perule	rametti	semi	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
				☐	☐	☐	☐	☐	Carpinus
				☐	☐	☐	☐	☐	Fagus
				☐	☐	☐	☐	☐	Acer
				☐	☐	☐	☐	☐	Quercus
				☐	☐	☐	☐	☐	Sorbus
				☐	☐	☐	☐	☐	Cornus
				☐	☐	☐	☐	☐	Crataegus
				☐	☐	☐	☐	☐	Ulmus
				☐	☐	☐	☐	☐	Pinus
				☐	☐	☐	☐	☐	Abies
				☐	☐	☐	☐	☐	Herbs

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Note:

253

☐ **OFm** ______*cm*

(**m** = **m**isto)
Residui vegetali trasformati e fortemente sminuzzati, ma ancora riconoscibili a occhio nudo. Pacchetti non comuni. 30% < S.O. fine < 70% (frammenti e S.O. fine in proporzioni simili)

Attività prevalente: mesofauna

ife	artropodi	esuvie	anellidi	radici	foglie	perule	rametti	semi	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
				☐	☐	☐	☐	☐	Carpinus
				☐	☐	☐	☐	☐	Fagus
				☐	☐	☐	☐	☐	Acer
				☐	☐	☐	☐	☐	Quercus
				☐	☐	☐	☐	☐	Sorbus
				☐	☐	☐	☐	☐	Cornus
				☐	☐	☐	☐	☐	Crataegus
				☐	☐	☐	☐	☐	Ulmus
				☐	☐	☐	☐	☐	Pinus
				☐	☐	☐	☐	☐	Abies
				☐	☐	☐	☐	☐	Herbs

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Note:

256 - 262

☐ **OH** ______*cm*

S.O. fine > 70%, l'origine dei residui più grandi ancora presenti (<30%) è difficilmente riconoscibile ad occhio nudo. Si presenta come un materiale omogeneo molto scuro.

256 **OHr** = residui tra il 30 e il 10%
259 **OHf** = residui inferiori al 10%
262 **OHc** = abbondanza miceli e ife

Attività prevalente: mesofauna

ife	**muffe**	artropodi	esuvie	anellidi	radici	foglie	rametti	semi	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
					☐	☐	☐	☐	Carpinus
					☐	☐	☐	☐	Fagus
					☐	☐	☐	☐	Acer
					☐	☐	☐	☐	Quercus
					☐	☐	☐	☐	Sorbus
					☐	☐	☐	☐	Cornus
					☐	☐	☐	☐	Crataegus
					☐	☐	☐	☐	Ulmus
					☐	☐	☐	☐	Pinus
					☐	☐	☐	☐	Abies
					☐	☐	☐	☐	Herbs

Coproliti Anellidi ☐
Coproliti Artropodi ☐

Note:

265

☐ **Abiomacro** _______*cm*

Ricco di coproliti di lombrico più o meno rimaneggiati; materiale organico finemente incorporato a quello minerale, principalmente ad opera del rimaneggiamento ad opera dei lombrichi.

Presenza di **complessi Umo-Argillosi**

Struttura grumosa/glomerulare più o meno espressa in funzione dell'attività biologica presente.

268

☐ **Ainsolubilizzazione** _______*cm*

Condizioni fisico-chimiche sfavorevoli all'attività della pedofauna e degli anellidi a favorire una notevole attività fungina.

Struttura microgrumosa con aggregati di piccole dimensioni (3 – 5 mm) più o meno spalmati di Sostanza organica.

Rari i complessi Umo-Argillosi

271

☐ **Agiustapposizione** _______*cm*

Debole attività biologica; non si ha incorporazione del materiale organico con quello minerale. I granuli minerali sono giustapposti al materiale organico (principalmente coproliti di artropodi ed enchitredi)

<u>Assenti o rarissimi</u> i complessi Umo-Argillosi

Descrizione orizzonte A

Colore: ___________________________

Scheletro ->	assente	scarso	diffuso	abbondante	molto abbondante ->
	274	275	276	277	278

Ø mm	(279)
Ø cm	(280)
Ø dm	(281)

Tessitura ->	argillosa (c)	limosa (si)	sabbiosa (s)	franca (l)
	282	283	284	285

Struttura ->

286	287	288	
debole (1)	moderata (2)	forte (3)	
289 sottile (th)	290 fine (f)	291 media (m)	292 grossolana(c)
blocchi angolari (abk)	blocchi sub angolari (sbk)	schiacciata (pl)	
293	294	295	

Consistenza ->	umida (m)	friabile (fr)	dura (fi)	bagnata (w)	leggermente appiccicosa (ss)
	296	297	298	299	300

Plasticità ->	bagnata (w)	leggermente plastica (ps)
	301	302

Radici ->

303	304	305	306	307
assenti (0)	molto poche (v1)	poche (1)	diffuse (2)	abbondanti (3)
micro (m)	molto fini (vf)	fini (f)	medie (m)	grosse (co)
308	309	310	311	312

Funghi e Ife ->	assenti (0)	pochi (+)	diffuse (++)	abbondanti (+++)
	313	314	315	316

Limite ->	brusco (a)	chiaro (c)	rotto (b)	ondulato (w)	sfumato (s)
	317	318	319	320	321

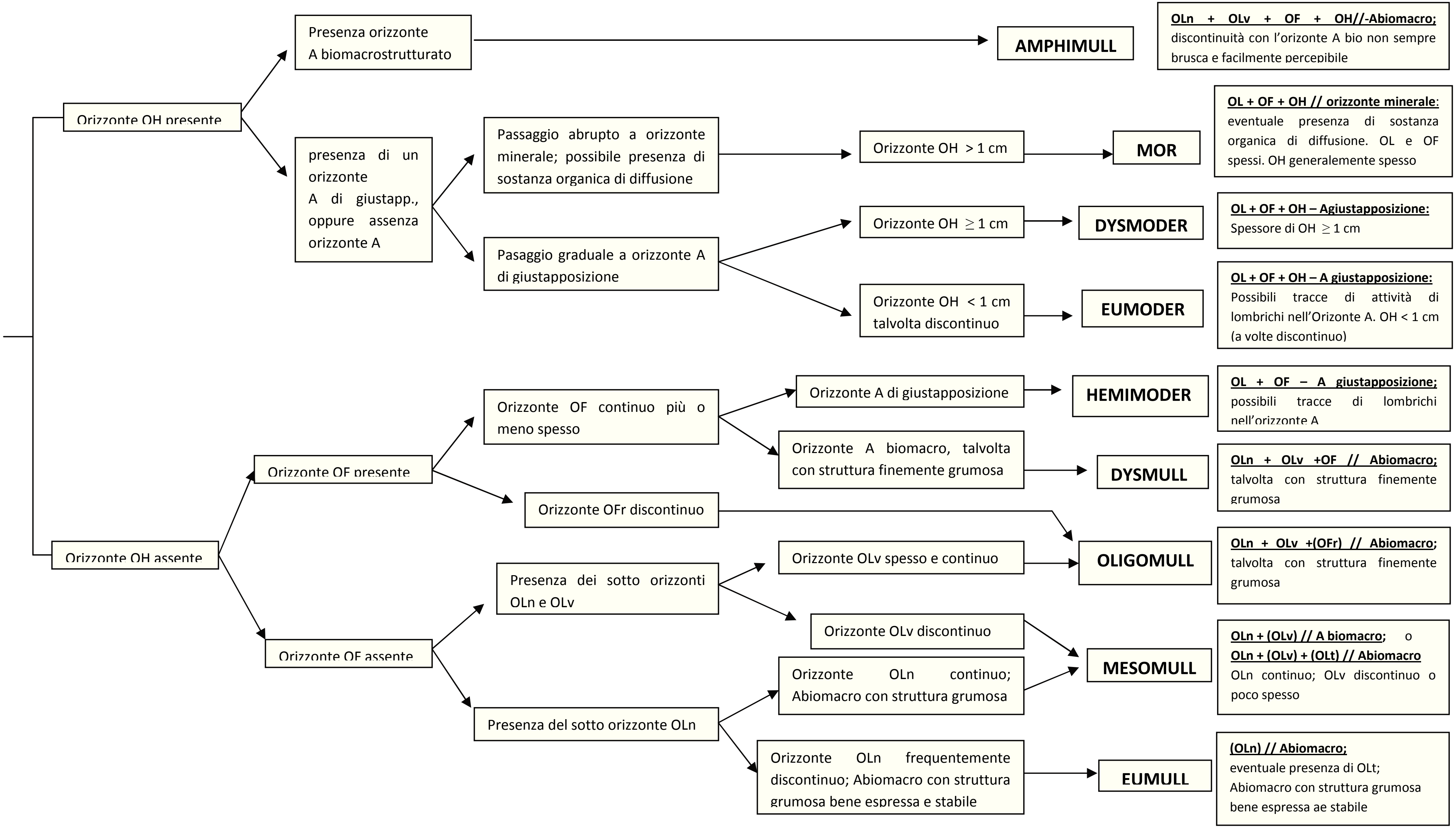
---

322 - 329 **Tipo di Humus:**

____

____

____



Orizzonte OH presente

Presenza orizzonte A biomacrostrutturato

AMPHIMULL

<u>OLn + OLv + OF + OH//-Abiomacro;</u> discontinuità con l'orizzonte A bio non sempre brusca e facilmente percepibile

presenza di un orizzonte A di giustapp., oppure assenza orizzonte A

Passaggio abrupto a orizzonte minerale; possibile presenza di sostanza organica di diffusione

Orizzonte OH > 1 cm

MOR

<u>OL + OF + OH // orizzonte minerale</u>: eventuale presenza di sostanza organica di diffusione. OL e OF spessi. OH generalemente spesso

Pasaggio graduale a orizzonte A di giustapposizione

Orizzonte OH ≥ 1 cm

DYSMODER

<u>OL + OF + OH – Agiustapposizione:</u> Spessore di OH ≥ 1 cm

Orizzonte OH < 1 cm talvolta discontinuo

EUMODER

<u>OL + OF + OH – A giustapposizione:</u> Possibili tracce di attività di lombrichi nell'Orizzonte A. OH < 1 cm (a volte discontinuo)

Orizzonte OH assente

Orizzonte OF presente

Orizzonte OF continuo più o meno spesso

Orizzonte A di giustapposizione

HEMIMODER

<u>OL + OF – A giustapposizione;</u> possibili tracce di lombrichi nell'orizzonte A

Orizzonte A biomacro, talvolta con struttura finemente grumosa

DYSMULL

<u>OLn + OLv +OF // Abiomacro;</u> talvolta con struttura finemente grumosa

Orizzonte OFr discontinuo

OLIGOMULL

<u>OLn + OLv +(OFr) // Abiomacro;</u> talvolta con struttura finemente grumosa

Orizzonte OF assente

Presenza dei sotto orizzonti OLn e OLv

Orizzonte OLv spesso e continuo

Orizzonte OLv discontinuo

MESOMULL

<u>OLn + (OLv) // A biomacro;</u> o **<u>OLn + (OLv) + (OLt) // Abiomacro</u>** OLn continuo; OLv discontinuo o poco spesso

Presenza del sotto orizzonte OLn

Orizzonte OLn continuo; Abiomacro con struttura grumosa

Orizzonte OLn frequentemente discontinuo; Abiomacro con struttura grumosa bene espressa e stabile

EUMULL

<u>(OLn) // Abiomacro;</u> eventuale presenza di OLt; Abiomacro con struttura grumosa bene espressa ae stabile

English

Stational parameters:

site:____

____

altitude:____________________m (a.s.l.)

esposition:______________________

slope :______________________

Plot area : __________m^2

Age ascertained ______________years
(last cut)

_____**T**

vegetation relief (ID) :________________

coordinates: _________________

____

Physiographic position

Ridge/ Crest	Interfluve	upper third mountainflank center third mountainflank lower third mountainflank	Side Slope	Head slope	Nose slope	Valley floor	Flat land	Terrace / Flood plain step

Accessibility

insufficient on ___________% good on ________________%

hydrogeological instability	**absent**	**<5%**	**<1/3**	**> 1/3**	**deterioration danger**
Surface (or channeled) erosion	○	○	○	○	○
Catastrophic erosion	○	○	○	○	○
superficial landslides	○	○	○	○	○
Falling rocks	○	○	○	○	○
Other factors of instability	○	○	○	○	○

Limits to the development of roots	**absent**	**<5%**	**<1/3**	**>1/3**	**deterioration danger**
Scant soil	○	○	○	○	○
Rocky outcropping	○	○	○	○	○
Rockiness	○	○	○	○	○
Water stagnation	○	○	○	○	○
Other limiting factors	○	○	○	○	○

Damage

	absent	<5%	<1/3	>1/3	deterioration danger
livestock	○	○	○	○	○
wild animals	○	○	○	○	○
Phytopatgens and Parasites	○	○	○	○	○
Meteoric agents	○	○	○	○	○
Avalanches and Snow movement	○	○	○	○	○
Fire	○	○	○	○	○
Forestry or Logging	○	○	○	○	○
Tourist-Recreational activities	○	○	○	○	○
Other causes	○	○	○	○	○

Obstacles to interventions

Absent or Irrilevant	Poor or easily surmountable	Numerous and relevant but surmountable	Not surmountable

Eliminable conditionings

None	Overgrazing	Wild animals	property disputes	Other causes…

Other characterizing facts

None	Pastures in the woods					Naturalistic and Historical aspects	Springs and Sources	Common properties	Other aspects
	Bovines	Ovines	Caprine	Equines	Other				

Works and artifacts

Absent
Buildings
Minor roads for agricultural vehicles
Tracks for tractors
Roads for tractors
Tracks for truck
Roads for truck
Timber loading areas
works for water and soil management
Quarries
Water pipelines
Rest areas
Artificial terraces
Walls /Fences
Parking lots
Avalanche barriers
Marked trails
Power lines
Sky area
Cableways
Other…

Forest structure and development

Coppice

clearcut
sheredding
casual
Under high forest
With standards
With a lots of standards

Freshly cutted	immature Mature

aged

Under active conversion

Monoplane High forest

Clearcut	Stand inititation	Stem exclusion	Understory reinitiation	Young stand	Adult stand	Mature stand	Renovation cut	Over-aged stand

Stratified High Forest

Adult on…..

coppice	Stem exclusion

Mature on….

coppice	Understory reinitiation	Young stand

Over-aged on…..

coppice	Understory reinitiation	Young stand	Mature stand

Pluriplane High Forest

as...

Single trees

Groups

excess of diameters:

No excess (good distribution)

Small

Medium

Large

Stratified on coppice

Origin

Natural

Artificial

vegetative

Neo-formation

Vigor

Low

Medium

High

Gaps in the coverage

Yes

No

___________%

Density

Low

Good

Excessive

Young plants

Absent

Sporadic

Widespread

Unrestricted

Under restrictions

Seedlings (main species)

Low

Sufficient

Abundant

Seedlings (other ssp.)

Low

Sufficient

Abundant

Main species:______________________

Main composition:

80% or more: ____

50% or more: ____

20% or more: ____

Less than 20%____

Recent interventions

None

Coppicing

Shredding

Conversion cut

Pruning and thinning

Clear cut

Hole cut

Cutting of lower branches

Coppicing under high forest

Preparation to Conversion

Transitory high forest Seeds dispersal

Density reduction

Thinning

Successive cuts

Reforestation

Density increasing (by planting)

Plant health intervention

forest infrastructure expansion

Forest infrastructure construction

Works of Consolidation, regimation, naturalistic engineering ...

other..

Forest function

Timber wood prodution

Fire wood prodution

Other productions from trees

Soil and underwood products

Hydrogeological protection

Tourist-recreational functions

Naturalistic function

preservation

improvement

Silvicultural orientation

Managed coppice maintenance

Conversion to high forest

Managed High forest maintenance

Management abandonment

Guided natural evolution

Hypothesis for future interventions

None
Coppicing
Shredding
Conversion cut
Pruning and thinning
Clear cut
Hole cut
Cutting of lower branches
Coppicing under high forest
Preparation to Conversion
Transitory high forest Seeds dispersal
Density reduction
Thinning
Successive cuts
Reforestation
Density increasing (by planting)
Plant health intervention
forest infrastructure expansion
Forest infrastructure construction
Works of Consolidation, regimation, naturalistic engineering ...
Altro..

Priorities and Conditionings

Immediate
As soon as possible
As possible
Deferrable priority
→
Subject to road conditions

Soil coverage:

Tree layer (> 4m)________________%

Shrub layer (da 0,6 a 4 m)________________%

Herb layers (<0.6m + tall herbs)________________%

Graminoids________________%

Spermatophytes________________%

Pteridophytes________________%

Briophytes________________%

Lichens________________%

Necromasses________________%

Necromasses composition :

Total volume________________stere/plot

On the tree________________stere/plot

On the ground________________stere/plot

Logging residue________________stere/plot

Ø < 1 cm________________%

1 < Ø < 3 cm________________%

3 < Ø < 6 cm________________%

6 < Ø < 15 cm________________%

Ø > 15 cm________________%

Stumps :

Stumps/plot ________________

live_____________________

dead____________________

overturned_________________

Sprouts :

age : __________years

Sprouts/plot ________________

Sprouts/stumps________________
(everage number)

dominant_____________________

dominated____________________

crashed_________________

dead_________________

Average height________________m

Dominant height________________m

Average diameter________________cm

Dominant diameter______________cm

Standards (or high forest trees) :

☐ standards
☐ high forest trees /plot ________________

live_____________________

dead___________________

crashed_________________

overturned_________________

Age: (1)__________   (2)___________   (3)___________ years

Average height________________m

Dominant height________________m

Average diameter________________cm

Dominant diameter______________cm

Basal area (G): ___________________________ m^2/plot
(stand)

Humus description:

(XS S M L XL -> quantification scale)
- → +

hyphae	arthropods	exuviae	anellids
☐	☐	☐	☐

☐ **OLn** _______*cm*

(**n** = **n**ew)
Leaves that has been in the ground for less than a year, still whole, recognizable and not (or little) bleached and transformed.

Main activity: Earthworms

anellids coprolites ☐
arthropods coprolites ☐

Notes:

roots	leaves	buds	twigs	seeds	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

hyphae	arthropods	exuviae	anellids
☐	☐	☐	☐

☐ **OLv** _______*cm*

(**v** = **v**ecchio = old)
Leaves whole or only slightly fragmented (still recognizable species) but with different color and consistency and arranged in compact layers

Main activity: Fungi

anellids coprolites ☐
arthropods coprolites ☐

Notes:

roots	leaves	buds	twigs	seeds	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

hyphae	arthropods	exuviae	anellids
☐	☐	☐	☐

☐ **OLt** _______*cm*

(**t** = **t**rasformation)
Leaves that has been in the ground for less than a year, still whole, recognizable and not (or little) bleached and transformed

BUT fragmented by the action of earthworms.

Main activity: Earthworms

anellids coprolites ☐
arthropods coprolites ☐

Stratification:

Notes:

roots	leaves	buds	twigs	seeds	
☐	☐	☐	☐	☐	Ostrya
☐	☐	☐	☐	☐	Carpinus
☐	☐	☐	☐	☐	Fagus
☐	☐	☐	☐	☐	Acer
☐	☐	☐	☐	☐	Quercus
☐	☐	☐	☐	☐	Sorbus
☐	☐	☐	☐	☐	Cornus
☐	☐	☐	☐	☐	Crataegus
☐	☐	☐	☐	☐	Ulmus
☐	☐	☐	☐	☐	Pinus
☐	☐	☐	☐	☐	Abies
☐	☐	☐	☐	☐	Herbs

hyphae	arthropods	exuviae	anellids	roots	leaves	buds	twigs	seeds	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
				☐	☐	☐	☐	☐	Carpinus
				☐	☐	☐	☐	☐	Fagus
				☐	☐	☐	☐	☐	Acer
				☐	☐	☐	☐	☐	Quercus
				☐	☐	☐	☐	☐	Sorbus
				☐	☐	☐	☐	☐	Cornus
				☐	☐	☐	☐	☐	Crataegus
				☐	☐	☐	☐	☐	Ulmus
				☐	☐	☐	☐	☐	Pinus
				☐	☐	☐	☐	☐	Abies
				☐	☐	☐	☐	☐	Herbs

☐ **OFr** _______*cm*

(**r** = **r**esidue)

Plant residues crumbled, transformed, but still recognizable by naked eye and often combined in dense packages, mixed with a quantity of S.O. end <30%

Prevailing activity: mesofauna

anellids coprolites ☐

arthropods coprolites ☐

Notes:

hyphae	arthropods	exuviae	anellids	roots	leaves	buds	twigs	seeds	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
				☐	☐	☐	☐	☐	Carpinus
				☐	☐	☐	☐	☐	Fagus
				☐	☐	☐	☐	☐	Acer
				☐	☐	☐	☐	☐	Quercus
				☐	☐	☐	☐	☐	Sorbus
				☐	☐	☐	☐	☐	Cornus
				☐	☐	☐	☐	☐	Crataegus
				☐	☐	☐	☐	☐	Ulmus
				☐	☐	☐	☐	☐	Pinus
				☐	☐	☐	☐	☐	Abies
				☐	☐	☐	☐	☐	Herbs

☐ **OFm** _______*cm*

(**m** = **m**ixed)

Plant residues that have been transformed and heavily crumbled, but still recognizable by naked eye. Packages are uncommon . 30% <S.O. end <70%

(fragments and S.O. fine in similar proportions)

Prevailing activity: mesofauna

anellids coprolites ☐

arthropods coprolites ☐

Notes:

hyphae	**molds**	arthropods	exuviae	anellids	roots	leaves	twigs	seeds	
☐	☐	☐	☐	☐	☐	☐	☐	☐	Ostrya
					☐	☐	☐	☐	Carpinus
					☐	☐	☐	☐	Fagus
					☐	☐	☐	☐	Acer
					☐	☐	☐	☐	Quercus
					☐	☐	☐	☐	Sorbus
					☐	☐	☐	☐	Cornus
					☐	☐	☐	☐	Crataegus
					☐	☐	☐	☐	Ulmus
					☐	☐	☐	☐	Pinus
					☐	☐	☐	☐	Abies
					☐	☐	☐	☐	Herbs

☐ **OH** _______*cm*

fine S.O.> 70%, the origin of the largest residuals still present (<30%) is hardly recognizable by naked eye. It appears as a very dark homogeneous material.

OHr = residues between 30 and 10%
OHf = residues of less than 10%
OHc = abundance of mycelia and hyphae

Prevailing activity: mesofauna

anellids coprolites ☐

arthropods coprolite ☐

Notes:

☐ **A biomacro** _______*cm*

Rich of more or less restructured earthworms coprolites; organic material finely incorporated into the mineral one, mainly by rewinding by earthworms.

Presece of **Umo-Clay Complexes**

More or less expressed lumpy / glomerular structure depending on the biological activity present.

☐ **A insolubilizzations** _______*cm*

Physico-chemical conditions unfavorable to the activity of the pedofauna and of the annelids to favor a remarkable fungal activity.

Microgrous structure with small aggregates (3 - 5 mm) more or less coated with organic substance.

Umo-Clay complexes rare

☐ **A juxtaposition** _______*cm*

Weak biological activity; there is no incorporation of organic material with mineral material. The mineral granules are juxtaposed to the organic material (mainly arthropods and enchitredi coprolites)

Umo-Clay complexes absent or very rare

Horizon A description

Color: _________________________ (according to the Munsell Soil Color Charts)

Ø mm

Sheletton -> absent few plentifull abundandt very abundant -> Ø cm

Ø dm

Texture -> clay (c) silt or silty (si) sandy (s) loam (l)

Structure -> weak (1) moderate (2) strong (3)
thin (th) fine (f) medium (m) coarse(c)
angular blocky (abk) sub-angular blocky (sbk) platy (pl)

Consistency -> moist (m) friable (fr) firm (fi) wet (w) slighty sticky (ss)

Plasticity -> wet (w) slighty plastic (ps)

Roots -> absent (0) very few (v1) few (1) plentiful (2) abundant (3)
micro (m) very fine (vf) fine (f) medium (m) coarse (co)

fungi an hiphae -> absent (0) few (+) plentifull (++) abundant (+++)

Limits -> abrupt (a) clear (c) broken (b) wavy (w) smooth (s)

Humus type diagnosis:

____

____

____

Organic Horizons

OLn (**n** = **n**ew)

Leaves that has been in the ground for less than a year, still whole, recognizable and not (or little) bleached and transformed.

Main activity: Earthworms

OLt (**t** = **t**rasformation)

Leaves that has been in the ground for less than a year, still whole, recognizable and not (or little) bleached and transformed

BUT fragmented by the action of earthworms.

Main activity: Earthworms

OLv (**v** = **v**ecchio = old)

Leaves whole or only slightly fragmented (still recognizable species) but with different color and consistency and arranged in compact layers

Main activity: Fungi

OFr (**r** = **r**esidue)

Plant residues crumbled, transformed, but still recognizable by naked eye and often combined in dense packages, mixed with a quantity of S.O. end <30%

Prevailing activity: mesofauna

OFm (**m** = **m**ixed)

Plant residues that have been transformed and heavily crumbled, but still recognizable by naked eye. Packages are uncommon . 30% <S.O. end <70%

(fragments and S.O. fine in similar proportions)

Prevailing activity: mesofauna

OH

fine S.O.> 70%, the origin of the largest residuals still present (<30%) is hardly recognizable by naked eye. It appears as a very dark homogeneous material.

OHr = residues between 30 and 10%
OHf = residues of less than 10%
OHc = abundance of mycelia and hyphae

Prevailing activity: mesofauna

Organo-mineral Horizons

A biomacro

Rich of more or less restructured earthworms coprolites; organic material finely incorporated into the mineral one, mainly by rewinding by earthworms.

Presece of **Umo-Clay Complexes**
More or less expressed lumpy / glomerular structure depending on the biological activity present.

A insolubilizzations

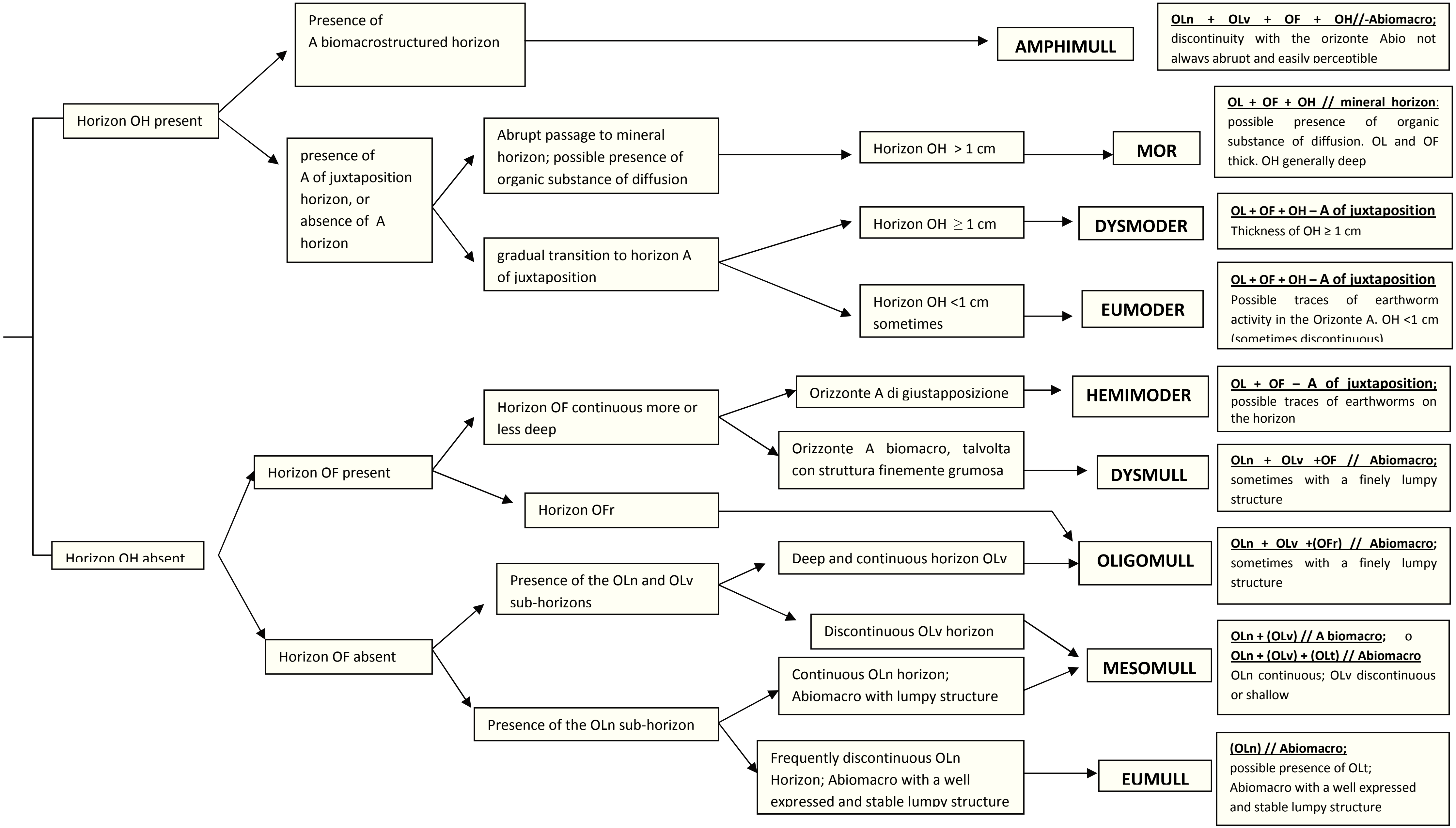
Physico-chemical conditions unfavorable to the activity of the pedofauna and of the annelids to favor a remarkable fungal activity.
Microgrous structure with small aggregates (3 - 5 mm) more or less coated with organic substance.

Umo-Clay complexes rare

A juxtaposition

Weak biological activity; there is no incorporation of organic material with mineral material. The mineral granules are juxtaposed to the organic material (mainly arthropods and enchitredi coprolites)

Umo-Clay complexes absent or very rare


Horizon OH present
Presence of A biomacrostructured horizon
AMPHIMULL
OLn + OLv + OF + OH//-Abiomacro; discontinuity with the orizonte Abio not always abrupt and easily perceptible
presence of A of juxtaposition horizon, or absence of A horizon
Abrupt passage to mineral horizon; possible presence of organic substance of diffusion
Horizon OH > 1 cm
MOR
OL + OF + OH // mineral horizon: possible presence of organic substance of diffusion. OL and OF thick. OH generally deep
gradual transition to horizon A of juxtaposition
Horizon OH ≥ 1 cm
DYSMODER
OL + OF + OH – A of juxtaposition Thickness of OH ≥ 1 cm
Horizon OH <1 cm sometimes
EUMODER
OL + OF + OH – A of juxtaposition Possible traces of earthworm activity in the Orizonte A. OH <1 cm (sometimes discontinuous)
Horizon OH absent
Horizon OF present
Horizon OF continuous more or less deep
Orizzonte A di giustapposizione
HEMIMODER
OL + OF – A of juxtaposition; possible traces of earthworms on the horizon
Orizzonte A biomacro, talvolta con struttura finemente grumosa
DYSMULL
OLn + OLv +OF // Abiomacro; sometimes with a finely lumpy structure
Horizon OFr
OLIGOMULL
OLn + OLv +(OFr) // Abiomacro; sometimes with a finely lumpy structure
Horizon OF absent
Presence of the OLn and OLv sub-horizons
Deep and continuous horizon OLv
Discontinuous OLv horizon
MESOMULL
OLn + (OLv) // A biomacro; o OLn + (OLv) + (OLt) // Abiomacro OLn continuous; OLv discontinuous or shallow
Presence of the OLn sub-horizon
Continuous OLn horizon; Abiomacro with lumpy structure
Frequently discontinuous OLn Horizon; Abiomacro with a well expressed and stable lumpy structure
EUMULL
(OLn) // Abiomacro; possible presence of OLt; Abiomacro with a well expressed and stable lumpy structure

Papers

Plant Biosystems

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Vegetation, topsoil and seed-bank modification during coppice rotation and after ten years of abandonment in a *Ostrya carpinifolia* forest in central Italy.

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Vegetation, soil and seed-bank modification during coppice rotation and after ten years of abandonment in a *Ostrya carpinifolia* forest in central Italy.

Ostrya carpinifolia forests are formations traditionally managed as coppice, with a high biodiversity and ecological complexity that characterize much of the Italian and Balkan low mountain and hill landscapes. Here, we applied a synchronic approach to analyze changes in vegetation, seed-bank, soil and litter at six different stages during the coppicing rotation and after 10 years of abandonment of a *Ostrya carpinifolia* forest located in the central Apennines. Data show that the dynamism characterizing this coenose during traditional coppice rotation alters after cessation of the management practices. Although from the phytosociological point of view all the forest stands belonged to the same association, the highest ecological complexity were achieved in the early stages after cutting. This was ascribed to the canopy removal, which creates favourable conditions for the germination of pre-mantels and mantels species stored in the soil seed-bank, while suitable conditions for the nemoral flora are maintained around the tree stumps. In later years, a reduction of non-strictly forest species occurred, reaching the maximum around 18 years after cutting. With the abandonment, the number of species increased, but the quality of the vegetation did not. At the slope level, with the abandonment, ecological simplification was observed.

Keywords: European hop-hornbeam; coppice management; land-use change; forest dynamics; biodiversity; forest soil; refuge habitats; Scutellario columnae-Ostryetum carpinifoliae

Introduction

Coppice is an ancient practice that has shaped and characterized the European lowland forest landscape over the centuries (Buckley 1992; Altman et al. 2013). This practice nowadays remains fairly widespread especially throughout the Mediterranean area (Piussi and Alberti 2015), and in Italy it still characterizes much of the low mountain and hill landscapes (Bernetti and La Marca 2012). Coppice usually takes place in fragmented properties, and is used to produce mainly firewood, and not quality timber (Ciancio and Nocentini 2004; Angelini et al. 2013). For this reason, coppice forestry has always been considered to be simple and inexpensive (Buckley 1992; Ciancio and Nocentini 2004), and as such in the past it has aroused less scientific interest compared to the high forest. Moreover, after the middle of the 20thcentury the competitiveness triggered by the fast and diffused use of fossil fuels caused a great loss of interest in wood energy (Fabbio and Cutini 2017), with a widespread abandonment of these formations (McGrath et al. 2015). In Italy this circumstance involved that coppice woods close to the end of the rotation or aged were 85% of the total coppice area in 2015 (FAO 2015). However, the socio-economic and cultural changes occurred in the recent decades have shifted the interest of the forest management from timber production to ecosystem services, landscaping, and hydrogeological protection. Therefore, in the last 20 years there has been a renewed interest in the study of coppice forest formations, with the flourishing of investigations dealing with ecological and economic effects resulting from forest aging (e.g., Cervellini et al. 2017; Rolecek et al. 2017; Campetella et al. 2011) or conversion modalities (e.g., Ciancio et al. 2006; Kirby et al. 2017; Scolastri et al. 2017). In most cases the studies dealt with beech and chestnut formations (e.g., Bartha et al. 2008; Mattioli et al. 2015; Šipoš et al. 2017), but also oaks formations were considered (e.g., Rey et al. 2002; Salomòn et al. 2017; Tardella et al. 2017). The dismissal of coppice management has led to substantial changes in these forest environments in both Europe and Italy, producing considerable changes in plant communities (Baeten et al. 2009; Kopecky et al. 2013; Müllerová et al. 2015), invertebrate population (Benes et al., 2006; Freese et al., 2006; Konvicka et al., 2008), and soil characteristics (Corti et al., 2013; Holscher et al., 2001). As noticed by Kopecky et al. (2013), changes of the European forests have been extensively documented, but the ecological processes and dynamics behind the changes are still poorly understood. European hophornbeam woods constitute one of the most widespread Italian (Tabacchi and Gasparini 2012) forest type and are typically managed by coppicing. Nevertheless, to date no studies analyze the effect of this management practice on this forest formation.

The aim of the present study was to investigate the long-term effects on forest vegetation, seed-bank, and soil properties of the traditional coppice management, the rotation lengthening, and the coppice practice abandonment in a specific European hophornbeam stand extending for 85 ha that was uninterruptedly management as coppice since the Middle Ages. In particular, we tested the hypotheses that i) forest vegetation, seed-bank, and soil properties mutate in different moments of the traditional coppice rotation, but they alter with lengthening and abandonment of the coppice rotation, and ii) these alterations involve biodiversity, coenoses stability, and ecological maturity of the forest.

Materials and methods

Study site

For the Italian peninsula, the main distribution area of *Ostrya carpinifolia* forests is in the northern-central Apennines (Tabacchi and Gasparini 2012). Based on geological, ecological, management and property data provided by the technical offices of Regions, Provinces, Municipalities, and National Forest Service, the area of Mt. Nerone massif (43 ° 33 'N, 12 ° 30' E) was selected as it ensured an uninterrupted coppice management longer than 350 years (Fig. 1). Here, in an area of 85 ha, the uninterrupted management as coppice with standards was documented in the historical booklet of the common property since 1656.

[Figure 1 here]

The Mt. Nerone massif covers an area over 60 km^2, reaches the height of 1525 m above sea level, and is considered as the limit between the northern and central Apennines. The study area is located on the north-eastern slope of the massif, at an altitude between 600 and 1000 m. The mean annual air temperature is about 12°C, with a mean annual precipitation of about 1700 mm. The bioclimatic definition of the area derived from the bioclimatic map of Italy (Pesaresi et al. 2014, 2017) is as a temperate oceanic bioclimate, humid ombrotype, supratemperate thermotype (Rivas-Martinez et al. 2011). The geology of the area is dominated by calcareous marl, and the soils are mostly represented by Mollisols. Syntaxonomically, the vegetation of the area belongs to the association *Scutellario columnae - Ostryetum carpinifoliae* (Ballelli et al. 1982), as indicated in maps of the vegetation (Biondi et al. 1989). On the bases of the historical booklet of the common property, the traditional 12 year coppice rotation was extended to 18-year coppice rotation around the 18th century, and to 28-year rotation in the 1980s.

Forest management units and plot selection

Using QGIS_2.8 Wien (QGIS development Team 2015), we merged the information obtained from the Military Geographic Institute, the Land Registry offices, and other historic and collective property records. In this way we constructed a detailed map of the forest management units (FMUs) area that included geo-morphological and historic management information. Then, standardized forms (Bianchi et al. 2006) for the description of the environmental, management, and infrastructural aspects were obtained during the inspections of the FMUs on this mountainside, from the bottom of the valley to the summit meadows. The map was then completed with the insertion of this collected information. Based on this map, seven management units with similar extension (about 2 ha), morpho-physiographic characteristics, and silvicoltural conditions (Fig. 2) were selected in function of the different times from cutting. These units were object of surveys for three years. Five of these units defined different stages of the traditional management, one represented the elongation of the coppice rotation, and one exemplified the post-abandonment condition (Fig. 2).

[Figure 2 here]

Data collection

During the first year of the study, within each of the seven units, two permanent plots of 200 m^2 each were randomly defined for the monitoring of the forest coenoses development. A soil survey was conducted inside these seven FMUs, with the opening of auger holes and mini-pits to assess soil average conditions inside these permanent plots. Then, a soil profile was dug in each plot, down to the parent rock. The soils were morphologically described according to Schoeneberger et al. (2012), but for the organic horizons we followed Baize and Girard (2008). The morphological observations of the soil profiles are reported in Supplemental Materials Appendix A. In each plot, soil cover was evaluated separately for tree, shrub and herb layers by estimation of the proportion of the sky obscured by vegetation when viewed from a single point (Jennings et al. 1999). From 2015 to 2017, inside each plot the topsoil was opened and described. The topsoil description was repeated in Spring and Autumn, to follow the seasonal changes in thickness and structure.

A quantification of the soil seed-bank was carried out through seed counting, identification, and evaluation of seed viability, for the seeds recovered from a soil volume of about 3.375 cm^3 collected using a 15 ×15 cm frame hammered into the soil to a depth of 15 cm starting from the OLf horizon. The viability evaluation was carried out using the cutting test, with confirmation of viability using Lugol solution (Bacchetta et al. 2006).

During the late springs 2015, 2016 and 2017, the vegetation was analyzed in each plot according to the Braun-Blanquet method (1928). Plant species nomenclature followed Conti et al. (2005). Furthermore, for the vascular plant species we selected the following plant functional traits: the Ellenberg indicator values (Pignatti et al. 2006), and the Maturity Coefficients (Taffetani and Rismondo 2009). The Ellenberg indicator values express both climatic (L, light; T, temperature; C, continentality) and micro-edaphic (U, soil moisture; R, soil reaction; N, availability of soil nutrients) conditions of the species. The Maturity Coefficients express the dynamic and evolutionary grade of the vegetation in terms of the vegetation series (Lancioni and Taffetani 2011). These coefficients are related to the ecological environment (open-environment, ecotone, forest) and to the class of the Italian syntaxonomic vegetation scheme (Biondi et al. 2014).

Data analysis

Species and functional composition

To analyze the silvicultural system management effects on species and functional composition, an analysis of the floristic composition and an indirect gradient analysis were performed. The Braun-Blanquet values of the 21 paired vegetation relevè were converted to the Van der Maarel scale (Westoff and Maarel 1978), and mean species composition was calculated for each FMU. The matrix "FMU x mean abundance species" was obtained. This matrix was taken through the correspondence analysis (CA) sorting technique. Thus, the matrix of mean traits values of the FMUs "FMU x mean traits values" was obtained by multiplying the binary (presence-absence) matrix ‘‘FMU x species" with the matrix "species x functional traits values" (Ellenberg and ecological

Maturity)”, and dividing by the specie number of FMU. To interpret (indirectly) the vegetation composition variation in functional terms, the correlation between the main vegetation composition gradients extracted from the CA (CA axis), and the mean traits values of the FMUs were calculated, tested by the modified permutation test of Zeleny and Schaffers (2012), and fitted into the CA space. Similarly, to interpret the relation between vegetation composition and dendrometric-silvicultural aspects, the correlation among number of stumps, diameter at breast height (DBH), basal area (G) (Fig. 2) and the CA axis were calculated and tested by permutation test. We also performed indicator species analyses (ISA) to identify the species significantly associated (*phi* coefficient > 0.4, $p<0.05$) with a particular FMU or FMUs combinations (De Càceres and Legendre 2009).

[Table 1 here]

Soil seed-bank

To estimate the variation and mortality of the seed-bank for each sample in relation to the temporal distance from the cutting, the seed density (viable seeds m^{-2} soil surface) and seed viability (viable seeds as a proportion of the total number of seeds) were calculated. To obtain the means for each FMU, the variations were evaluated by frequency and quantity analysis on the means of two samples taken for each FMU.

Soil morphological characterization

To determine the management effect on the soil, the topsoil was considered as the ensemble of the O and A horizons (De Feudis et al. 2017), being the topsoil the soil portion most sensitive to human disturbance and climate change (Baize and Girard 2008). For each FMU, the mean topsoil thickness of the Spring samples was compared to that of the Autumn samples. As there were no significance variations in the structures of the topsoils, the thickness of the Spring and Autumn samplings were combined together so as to have solid annual replicates. The main variations in the topsoil for the different plots were then analyzed for the thickness of the topsoil running a principal component analysis (PCA).

Soil - vegetation relationships

To interpret the soil-vegetation relationships, correlations between the main vegetation composition gradients extracted from CA (CA axis) and the mean thicknesses of the O and A horizons described for the FMUs were calculated, tested by permutation test and fitted into the CA space. Thus, the non-randomness ('significant') co-variation between the main composition gradient of the vegetation (CA1, CA2) and the main topsoil gradients (PC1, PC2) was tested by Procrustes analysis (Peres-Neto and Jackson 2001). The Procrustes analysis rotated the PC1 and PC2 soil configuration to maximum similarity with the CA1 and CA2 vegetation configuration, and tested the significance by permutation test. The measure of fit provided (m^2) is the square root of (1 – SS), where SS is the sum of squared differences between vegetation configuration (CA1 and CA2 scores) and the soil rotated configuration (PCA1 and PCA2 scores).

Statistical analyses

All the statistical analyses were performed using the R software (R Core Team 2014). The 'vegan' (Oksanen et al. 2015) package for PCA, CA, Procrustes analysis, and permutation tests for the indirect gradient analysis was used.

Results

Species and functional composition

Overall, 203 species were collected and defined (see Supplemental Materials Appendix B). FMUs 1, 2, and 7 showed the highest species richness (88, 158, and 115 species, respectively), with the lowest for FMUs 5 and 6 (67 and 66 species, respectively). At an examination of all the flora, the open-environment species were the most numerous (82), followed by the forest (76) and ecotonal (42) species (Supplemental Materials Appendix B). However, 48.8 % of the open-environment species and 31.0% of the ecotonal species were exclusive to FMUs 1 and 2, and although the forest species were stable and complete in all the FMUs, they showed greater completeness in FMUs 2, 3, 4, and 5 (Supplemental Materials Appendix B). The only alien species identified was *Setaria italica* (L.) P. Beauv., which was the exclusive of FMU 7.

The CA analysis ordered the FMUs in terms of the main vegetation composition gradients (variation represented by CA1 and CA2: 55% and 22%, respectively; Fig. 3). In terms of functional traits values, the indirect gradient analysis showed that CA1 is positively correlated with forest species environment and Maturity coefficients, and inversely correlated with the Ellenberg light (L) index and the open species environment. In terms of dendrometric-silvicultural aspects, instead, CA1 is positively correlated with G and C. The CA1 axis is also related to the thickness of the mollic A soil horizon (Fig. 3). In terms of topsoil thickness, the indirect gradient analysis revealed a significant relationship between the CA1 axis and the mollic A soil horizon only. All results of the indirect gradient analysis are reported in the Supplemental Materials Appendix C. The procrustean analysis (see paragraph Soil and vegetation relationships) showed significant correlation among CA1 and PC2 (determined by OH and mollic A horizons), while CA2 is inversely correlated with PC1 (determined by OFr, OLn, and OLv horizons). The first vegetation gradient (CA1) separated FMUs 1 and 2 from all the others. The 1 and 2 stages immediately followed the cutting and were largely characterized by low M, G, and C values, species typical of open environments (e.g., *Bromus erectus*, *Campanula rapunculus*, *Cerinthe minor* subsp. *auriculata*, *Brachypodium ruperstre*, *Fragaria vesca*), and a thin mollic A horizon. The FMUs 3, 4, 5, and 6 were mainly characterized by forest species (e.g., *Hepatica nobilis*, *Melittis melissophyllum*, *Euphorbia amygdaloides* subsp *amygdaloides*, *Arum maculatum*), high values of M, G, C, and a relatively thick mollic A horizon. The FMU 7, representing the post-abandonment stage, occupied an intermediate position in the CA1 gradient. Although forest species were abundant in FMU 7, this stage was characterized by a high presence of open-environment species, intermediate M, G, and C values, and therefore showed some affinities with FMUs 1 and 2. The second vegetation gradient (CA2) separated the FMUs 2, 3, 4 and 5 from the other three. The group of FMUs 2, 3, 4, and 5 corresponded to the central and final stages of the traditional coppice rotation, and were characterized by high C values, a high number of sciaphilous forest species (e.g., *Mercurialis perennis*, *Cephalantera longifolia, Lathyrus venetus*) and higher thickness of OLn, OLv, and OFr horizons. The other group of FMUs was represented by those related to the initial stage of the traditional rotation (FMU 1), the lengthened rotation (FMU 6), and the post-abandonment stage (FMU 7), all qualified by the lowest C values.

[Figure 3 here]

Among the species collected, the indicator species analysis identified 66 species associated with a particular FMU or FMUs combination (see Supplemental Materials Appendix D). Of these species, 20 open-environments species, 5 forest species, and 3 ecotonal species were characteristic of the first years after the cut (FMU 1 and 2), 9 forest species and 2 ecotonal species appeared to be related to the central and final stages of the coppice rotation (FMUs 3, 4, 5, and 6), and only *Setaria italica* was found as characteristic of the post-abandonment stage (FMU 7).

Soil seed-bank

The soil seed-bank of FMU 1 highlighted lower density and higher viability with respect to the FMU 7 (Table 2). FMUs 2 and 3 had seed-banks characterized by very high viability (96% ±1%) that tended to decrease with increasing time at a rate of about 2% per year until FMU 5. A marked decreasing trend in viability occurred in FMUs 6 and 7 (Fig. 4). Indeed, for the post-abandonment stage (FMU 7), the seed-bank was characterized by the lowest viability (≈5%), with seeds located at a greater depth than in the other FMUs. Furthermore, unlike all the other FMUs, FMU 7 did not include any viable seeds of *Cerinthe minor* subsp *auriculata* or *Atropa bella-donna*, which are ecotonal species that can grow and develop only in forest areas with reduced coverage and that were found in vegetative phase only in the FMUs 1 and 2.

[Table 2 here]

[Figure 4 here]

Soil morphological characterization

In all the FMUs the soil was a Rendzic Leptic Phaeozem (skeletic) according to the IUSS (2015), or a Mollisol according to the SSS (2014) (see Supplemental Materials Appendix A). Even though in the various FMUs the topsoils showed different morpho-structural characteristics, they all belonged to the Hamphimus class (Baize and Girard 2008).

The PCA ordered the FMUs according to the thicknesses of the horizons forming the topsoil (Fig. 5). PC1 and PC2 represented 57% and 29%, respectively, of the total variation. PC1 was mostly determined by the covariation of the OLn, OLv, and OFr horizons, which contrasted the central stages of the traditional coppice rotation (FMUs 3 and 4) and the first stage immediately following cutting and those subsequent at traditional coppice rotation (FMUs 1, 6, and 7). PC2 was determined by the covariation of the OH and mollic A horizons, which contrasted the most recent stages after the cutting (FMUs 1 and 2) and the other FMUs (Fig. 5).

[Figure 5 here]

Soil and vegetation relationships

The correlation between soil horizons thickness data of the topsoil and the main variation gradients of the vegetation (CA1, CA2) was significant only for the mollic A horizon. In particular, the mollic A horizon was mainly related to CA1 (Fig. 3). The Procrustes analysis, instead, showed a global significant relation ($m^2 = 0.40$, $P = 0.0323$) among the main gradients of the soil (PC1 and PC2 rotated) and the main gradients derived from the analysis of the vegetation composition, and especially between CA1 and PCA2 (Fig. 6).

[Figure 6 here]

Discussion

Species and functional composition

The synchronous study of this coenose during its management and post-abandonment stages has revealed that the length of the coppice rotation have effects in terms of vegetational composition, seed bank vitality and topsoil structure. Indeed, in this case the vegetation shows a peak in terms of species numbers in the first years after cutting, which was then reduced approaching the maximum canopy closure. Subsequently, we observed a gradual re-increase in the number of species. This increase culminated in the post-abandonment stage, which was characterized by a diffuse decrease in tree layer cover. At this stage, the number of species assumed the level of the first years after coppicing.

The analysis of the various FMUs, however, demonstrated that the increase in the number of species in the post-abandonment stage does not correspond to an increase in qualitative terms. The elimination of the tree layer due to the coppicing provides sudden removal of soil coverage, with modification of microclimatic conditions. This makes it possible to achieve optimum germination conditions for the soil seed-bank, whose species create an almost complete herbaceous coverage over the first two years from cutting. As observed in other studies (Mason and Macdonald 2002; Broome et al. 2011), in the first five years after cutting, the growth and seeding of these species is continuous and abundant. This allows rapid reconstitution of a seed-bank characterized by a well-defined species pull, which reaches its highest values in terms of number and viability by the third year after cutting. The immediate regrowth of suckers greatly amplifies ecotonal environments and create, in correspondence of the stumps, refuge habitats suitable for the maintenance of the forest species. Although our areas were pedologically homologous, the topsoil in the early stages of coppicing is marked by simplification of the topsoil horizons and reduced variability in terms of its relative thickness (Annexes A and E). The central and final stages of the traditional coppice rotation are here characterized by reduction of ecotonal and loss of open-environment species. The vegetation composition is characterized by shade-adapted forest species, which highlight a strong stability in terms of composition. The number and the viability of the seeds in the seed-bank showed a small decrease that then remains stable for over a decade. The topsoil is characterized by the presence of all types of organic horizons, which creates a high number of ecological niches that are suitable to host a complex soil fauna (Hättenschwiler and Gasser 2005), with an increase in the relative thicknesses of the more superficial horizons.

The lengthening of the coppice rotation did not produce large changes in the vegetation composition, but highlighted a simplification of the topsoil morphology. This was accompanied by relatively stable numbers of seeds in the seed-bank compared to the stages of the traditional coppice rotation, although these showed significantly lower proportions of viable seeds.

Subsequently, the abandonment shows in this case a reduction of the ecological maturity of the coenoses. Here, the number of suckers collapsed due to the increasing competition and the physiological characteristics of the species. This caused a soil cover reduction and allowed the formation of areas where the conditions become suitable for the development of ecotonal and open-environment species, which are responsible for the increase in the number of species. However, the viability of the seeds in the seed-bank after abandonment was practically null (Annex E). This involved the loss of about 50% of the open-environment species and 31% of the ecotonal species that can grow and seed only in the years immediately after coppicing, which are therefore present in the seed-bank only. On the other hand, this extends the ground uncover period, and aggravates soil loss, which can allow entry of species from neighboring environments. This implies a reduced and less varied floristic contingent at the slope level, which is particularly serious as most of the post-abandonment area are surrounded by strongly anthropized or degraded environments.

The dynamics that in this case characterized lengthening of coppice rotation, and especially the post-abandonment stage, contrasted partly to what has been reported in other studies for other forest formations (Kopecky et al. 2013; Müllerová et al. 2015). This can be attributed to the dynamic and physiological characteristics of *O. carpinifolia*, which assumes a structural, functional and dynamic importance in this coenoses and must be considered as the key species (Zhao Hua et al. 2001). Nevertheless, in line with the same studies, it is highlighted that the species that here suffer the most significant losses are those typical of open woodlands, which abound in the years immediately following the cutting, and the seeds for which are present only in the seed-bank. In line with several studies (e.g., Molder et al. 2014; Kopecky et al. 2013), we argue that the prolonged period of canopy closure is the most probable cause of decline and represents a threats for biodiversity.

Global effects at the slope scale

Coppice management is traditionally characterized by reduced forest management units sizes, which constitute an environmental mosaic at the slope level that includes the simultaneous presence of all the different stages of coppice rotation in a relatively small area, as in this case. This peculiarity provides a large number of refuge habitats that are constantly present, from both the faunistic (e.g.. Spitzer et al. 2008; Maccol et al. 2014; Kosulic et al. 2016) and floristic (e.g., Cervellini et al. 2017; Decocq et al. 2005; Hédl et al. 2017) points of view. As many other studies have emphasized for other forest formations, also in this case the maintenance of traditional forestry management is the basis for the structural complexity and stability of the system (e.g., Baeten et al. 2009; Campetella et al. 2016; Cervellini et al. 2017).

Indeed, contextualization of the FMUs in this study at the slope level shows how biological and micro-environmental aspects that characterize the different stages of coppice rotation provide a unique and complex ecological system where the dynamic balance is strictly related to the fullness of all these stages. Given the high number of interactions and feedback effects, the separate analysis of one or more of these stages in coppice management does not provide a real evaluation of their ecological and biological value, their degree of resilience and resistance, and the level of naturalness provided by the whole system. The presence of all coppice stages can maintain an ecological system characterized by stability in terms of species composition and environmental characteristics over large surfaces, albeit marked by microevolution over limited areas, with variability of even conspicuous aspects. This stability seems to be supported by the seed-bank and by the soils type present in the whole study area. In fact, all soils belonged to the Mollisol order, the formation and conservation of which are mainly related to the process of melanization. This requires constant water and soil thermal regimes, and favors accumulation, incorporation and protection of organic matter into the soil, for which only a few decades are necessary for complete mineralization (SSS 2014).

Implications for coppice management

Based on the data here presented, it is possible to argue that in this case, from an ecological point of view, lengthening of rotation does not involve any real increase in naturalness, and could have negative effects on the viability of the seed-bank. Alterations to all the aspects investigated are observable within the first decade from abandonment. In a few decades, this results in structural and ecological simplification at the slope level, with consequent reduction in biodiversity.

Conclusions

In this study several components of the forest ecosystem were analyzed through an interdisciplinary approach, to follow the dynamism that characterize an *Ostria carpinifolia* wood in central Italy during traditional coppice rotation period, its lengthening and following management abandonment. The results here obtained have shown that traditional coppice management is key to maintain of a high level of biodiversity and ecological maturity. This seems to be due to the frequent soil uncover at local level and to the coexistence of different refuge habitats al the slope level. With the lengthening of the coppice rotation period and moreover after the abandonment, a simplification of the topsoil morphology and vegetation composition was observed. Although the study was conducted in a restricted territory qualified by conditions of singular management constancy, we analyzed one of the most widespread Italian and

Balkan forest type. We underline the need for further studies on this forest formation in order to extend the results obtained to other areas. However, on the basis of the results obtained, we suggest to considering carefully the consequences that could derive from management decisions that today seems to be increasingly oriented towards a lengthening of the rotation period up to conversion for abandonment, with the aim of protecting biodiversity.

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Table 1. Details of the vegetation evolution stages and ecological conditions, with the corresponding coefficients of maturity (modified from Taffetani and Rismondo 2009).

Ecological condition	**Vegetation typology**	**Coefficient of maturity**
Open environment	Adventitious	1
	Annual pioneer grasses	2
	Perennial nitrophilous ruderals and grassy margins	3
	Grassland and perennial herbaceous margins	4
	Pastures and grassland of herbaceous perennials	5
Ecotonal	Nitrophilous and mesophilous herbaceous perennials and ruderal vines	6
	Edges and forest glades of herbaceous perennials	7
	Shrub and chamaephytes	8
Forest	Generally climatophilous forest	9

Table 2. Main data characterizing the seed-bank according to years from cutting. Mt. Nerone, Italy.

FMU	**Visible seeds for sample**	**Visible seeds/m^2**	**Viability (%)**	**Prevailing depth (cm)**
1	348	1706.7	33.2	0 - 8
2	1053	4680.0	96.9	0 - 2
3	785	3488.9	95.0	1 - 4
4	573	2546.7	82.0	2 - 6
5	528	2346.7	75.9	2 - 8
6	435	1933.3	50.0	3 - 7
7	187	831.1	4.8	5 - 10

Figure 1. Map of Europe and Italy with inset the localization of the study area, Mt. Nerone massif.

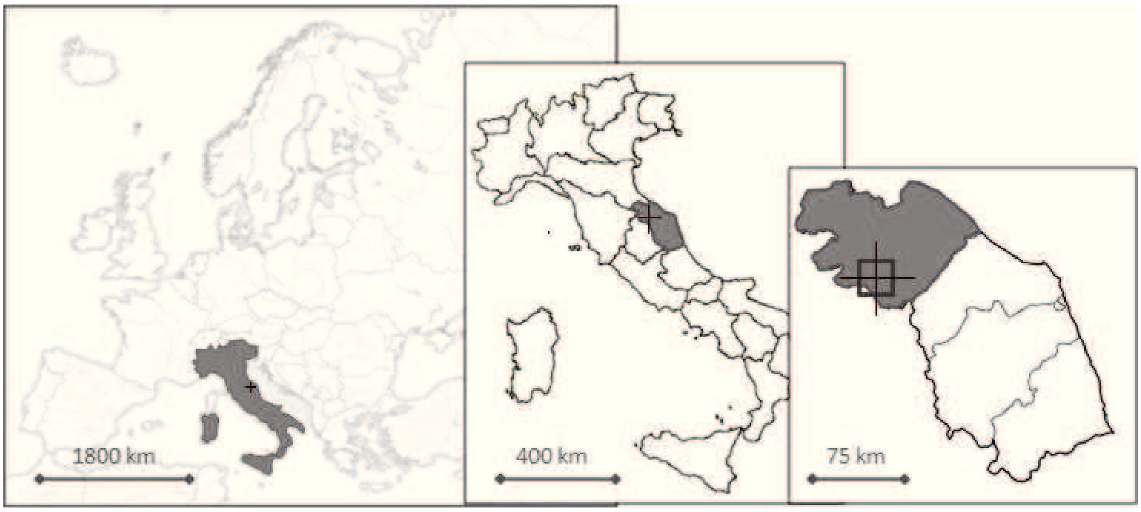


Figure 2. Scheme of the seven studied forest management units according to the years from the coppice cutting. Mt. Nerone massif, Italy. (DBH: diameter at breast height;)

	Traditional rotation					Elongation	Abandonment
Forest Management Unit (FMU)	1	2	3	4	5	6	7
Years from the logging	0,1,2	3,4,5	7,8,9	12,13,14	17,18,19	27,28,29	36,37,38
Silvicultural stage	suckers emission	suckers elongation	canopy closure	young coppice stand	mature coppice stand	extramature coppice stand	aged coppice stand
Altitude (m a.s.l.)	698	730	721	733	698	731	700
Exposure	N-NE	N-NE	N-NE	N-NE	N-NE	N-NE	N-NE
Slope	35°	30°	33°	32°	32°	35°	35°
Bedrock	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone	Limestone
Soil type	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol	Mollisol
Soil cover (%)	14.0	135.5	118.0	111.5	102.0	98.5	82.0
tree layer	2.5	51.0	75.0	76.5	74.0	56.0	42.0
shrub layer	2.0	3.5	8.0	5.0	2.5	2.5	4.5
herb layer	9.5	81.0	35.0	30.0	25.5	40.0	38.5
Stumps/ha	2400	2350	2350	2400	2350	2400	2350
Standards/ha	250	250	250	250	250	250	250
DBH (cm)	10.2	10.8	11.0	10.9	11.1	11.4	11.7
height (m)	11.0	11.5	11.5	12.0	11.6	11.8	12.0
Suckers/ha	---	28435	24610	14880	13160	10580	4620
DBH (cm)	---	0.5	2.6	4.4	4.8	5.2	7.3
height (m)	---	1.8	5.3	10.4	10.7	11.5	11.8
Basal area (m^2/ha)	2.163	3.018	13.697	20.281	21.038	20.591	17,883

Figure 3. Correspondence analysis ordination plots of the mean vegetation abundance data for the seven studied forest management units. Mt. Nerone, Italy.

(A) The seven forest management units according to the identification numbers given in Figure 1. Arrows represent the correlation of the significant ($p < 0.05$) ecological parameters (L, Ellenberg Light index; M, Maturity index; Op, open-environment species; For, forest species; Amollic, thickness of the mollic A soil horizon; C, tree layer cover (%); G, Basal Area. **(B)** Species ordination plot that shows the main indicator species of the forest management units. SetIta, *Setaria italica;* TanCor, *Tanacetum corymbosum;* LeuVul, *Leucanthemum vulgare;* AtrBel, *Atropa bella-donna;* GerNod, *Geranium nodosum;* CerMin, *Cerinthe minor* subsp. *auriculata;* AneNem, *Anemone nemorosa;* CepDam*,* *Cephalanthera damasonium;* DacMac, *Dactylorhiza maculata* subsp. *maculata;* HepNob*,* *Hepatica nobilis;* LatVen*,* *Lathyrus venetus;* CepLon*,* *Cephalanthera longifolia;* MerPer, *Mercurialis perennis;* GalOdo*,* *Galium odoratum;* SteMed, *Stellaria media s*ubsp. *Media;* PotMic*,* *Potentilla micrantha;* AruMac*,* *Arum maculatum;* SteNem, *Stellaria nemorum* subsp. *montana;*

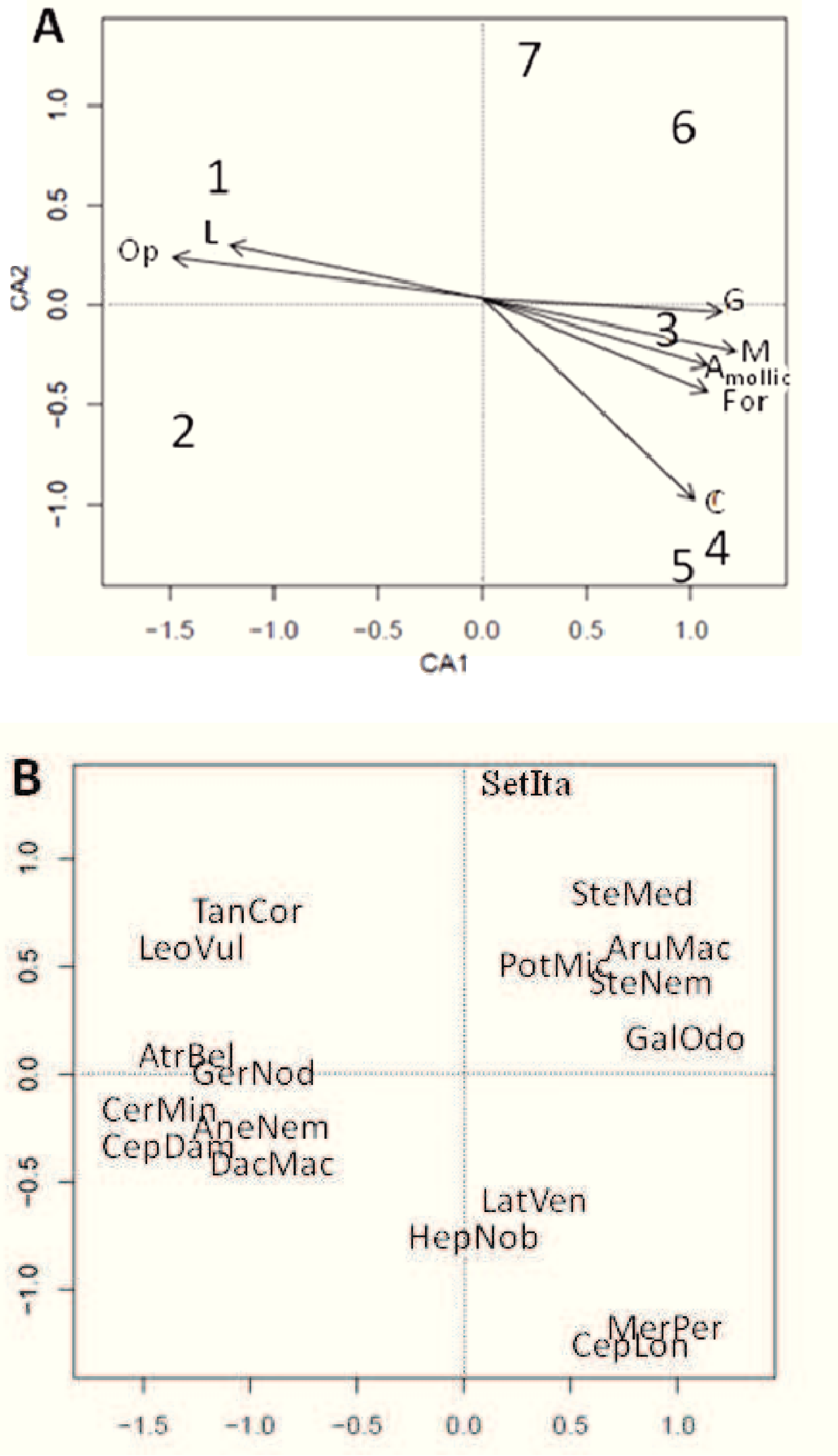

A
7
6
1
L
Op
G
3
M
A
mollic
For
2
C
4
5
1.0
0.5
0.0
-0.5
-1.0
CA2
-1.5
-1.0
-0.5
0.0
0.5
1.0
CA1
B
SetIta
SteMed
TanCor
LeoVul
PotMic
AruMac
SteNem
GalOdo
AtrBel
GerNod
CerMin
AneNem
CepDam
DacMac
LatVen
HepNob
MerPer
CepLon
1.0
0.5
0.0
-0.5
-1.0
-1.5
-1.0
-0.5
0.0
0.5
1.0

Figure 4. Total and viable seed numbers for the soil seed-bank according to years from cutting. Mt. Nerone, Italy.

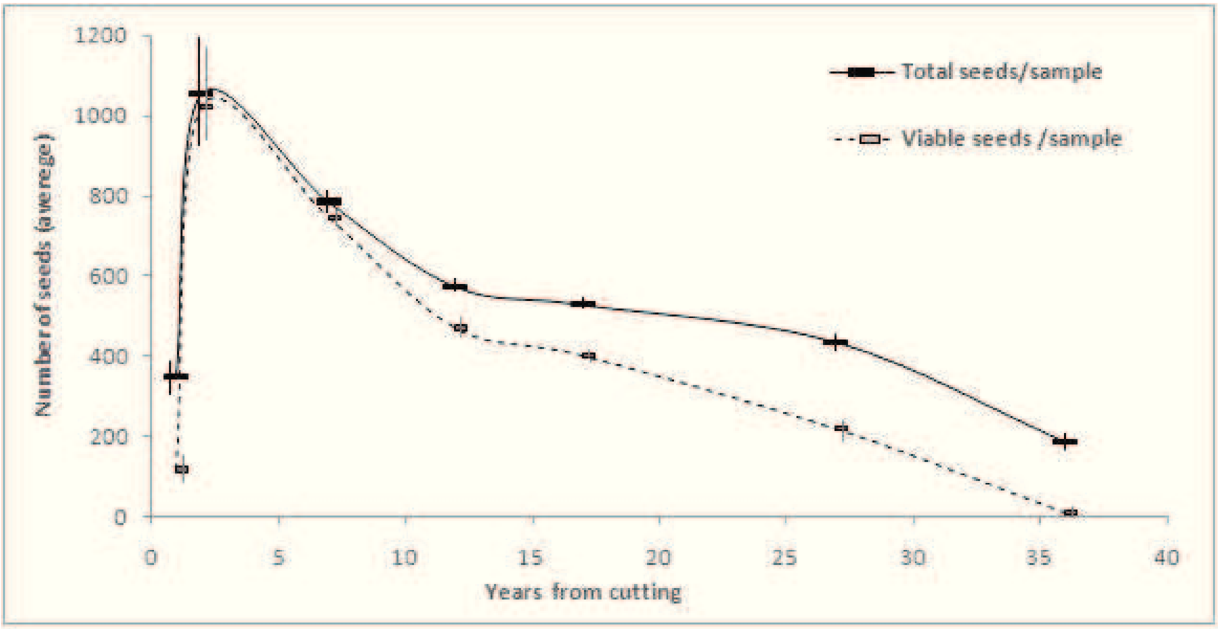


Figure 5. Principal component analysis biplot for the topsoil horizon thickness data. Mt. Nerone, Italy. PC1 and PC2 represent 57% and 29%, respectively, of the total variation. The numbers indicate the seven forest management units defined in Figure 1. OLn, OLv, OFr, and OH horizons referred to Baize and Girard (2008), A*mollic* represented the mollic A horizon as for Shoeneberger *et al.* (2012).

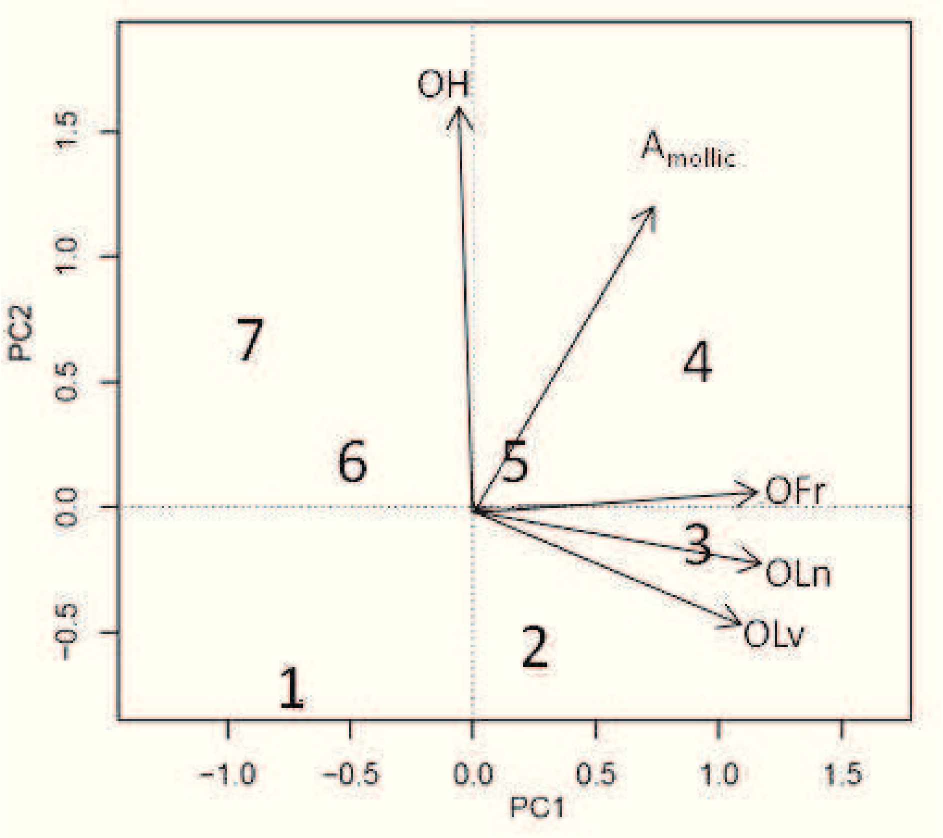
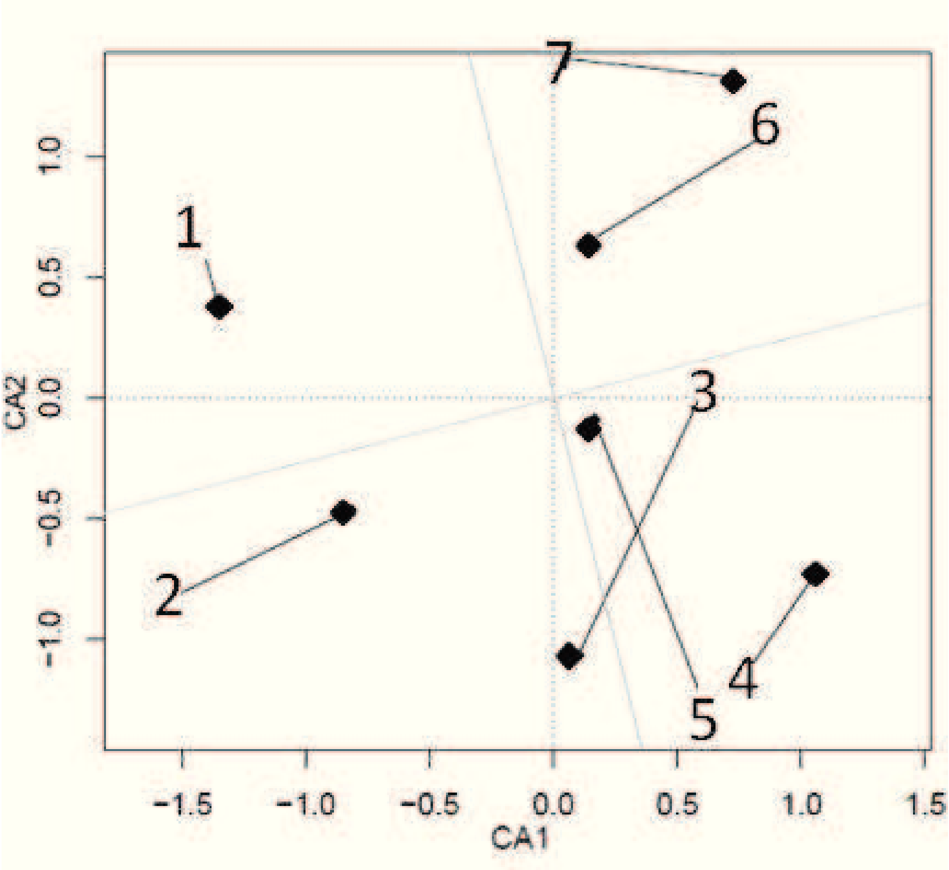


Figure 6. Procrustean superimposition plot of the forest management units based on two different configurations obtained from the two first axes of the principal component analysis of the topsoil horizons thickness data (diamonds) and the two first axis of the correspondence analysis of the vegetation abundance data (bold numbers). Black solid lines are the Procrustes residuals from the two different configurations. Grey dotted lines are the CA axes (CA1, CA2) and the grey solid lines the rotated PCA axes (PC1, PC2).



Appendix A. Morphological description of the soil profiles developed on calcareous marl under coppice at different time since the last cut. Mt. Nerone massif, Italy.

Horizon (Shoeneberger et al.2012)	Horizon (Baize and Girard 2008)	Depth	Colour[a]	Structure[b]	Skeleton		Roots[c]	Boundary[d]	Thickness	Other observations
		cm			%	size			cm	
Plot "Bucata del Pisciarello1", 1 year after the cut										
Inclination of the rock layers: cross-dip; slope: 75%; exposure: N-NW. Soil cover: 20%; stone cover: 20%; grass cover: 10% (*Seslerianitida*, *Mycelismuralis*, *Daucuscarota*, *Carduusnutans*, *Cerinthe minor* subsp. *auriculata*). Soil: Lithic Haprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).										
Oi1	OLn	4-2	-	-	0	-	0	cb	0-5	leaves of beech, maple, hornbeam, oak
Oi2	OLv	2-1	-	-	0	-	0	cb	0-2	leaves of beech, maple, hornbeam, oak
Oa	OHr	1-0	7.5YR 3/2	-	20	mm&cm	0	cb	0-1	-
A	-	0-2	7.5YR 3/2	3f&msbk, fr	20	mm&cm	2mi,vf,f	cw	2-4	-
Bw	-	2-18	10YR 3/2	1m sbk, fr	25	dm	2mi,vf,f	cw	15-22	cutans of secondary carbonates; some clast is angular, others are smooth
C	-	18-42+	7.5YR 2.5/3	3msbk,fr	90	dm	1m,co	-	-	flintstoneclasts
Plot "Acquaghiacciata", 2 years after the cut										
Inclination of the rock layers: cross-dip; slope: 50%; exposure: N. Soil cover: 100; stone cover: 25%; grass cover: 70% (*Seslerianitida*, *Tanacetumcorymbosum*, *Rubushirtus*, *Saniculaeuropaea*, *Dactylisglomerata*,*Carex flacca*, *Veronica prostrata*, *Dactylorhizamaculata* subsp. *fuchsii*, *Geranium nodosum*). Soil: IncepticHaprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).										
Oi1	OLn	9-7	-	-	0	-	0	cw	1-3	leaves & stems of beech, maple, hornbeam
Oi2	OLv	7-4	-	-	0	-	0	cw	1-4	leaves & stems of maple, hornbeam, oak
Oi3	OFr	4-2	-	-	0	-	3mi, vf	cw	1-3	leaves & stems of beech, maple, hornbeam
Oe	OHr1	2-1	-	-	0	-	3mi, vf	cb	0-1	leaves & stems of beech, maple, hornbeam
Oa	OHr2	1-0	10YR 2/2	-	0	-	3mi,vf;1f	cb	0-1	leaves & stems of beech, maple, hornbeam
A	-	0-3	10YR 2/1	2f&msbk, fr	25	cm	2mi,vf,f,m	cw	1-3	clasts are angular
Bw	-	3-19	7.5YR 3/2	2f&msbk,fr	50	mm&cm	2mi,vf,f;3m,co	cw	14-17	clasts are not imbricated
2Bw&C	-	19-43+	7.5YR 4/4	2m sbk, fr	70	dm&cm	1mi,vf,f,m,co	-	-	cutans of secondary carbonates; some clast is angular, others are smooth
Plot "Val Celdinella", 7 years after the cut										
Inclination of the rock layers: cross-dip; slope: 60%; exposure: N-NE. Surface rock: 30%;soil cover: 100%; stone cover: 50%; grass cover: 60% (*Daphne laureola*, *Hedera helix*, *Gallium odoratum*, *Saxifragarotundifolia*,*Saniculaeuropaea*, *Melicauniflora*,*Polysticumsetiferum*). Soil: TypicHaprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).										

Oi1	OLn	9-7	-	-	40	cm	0	cw	2-5	leaves &stems of maple, hornbeam, beech
Oi2	OLv	7-4	-	-	40	cm	0	cw	1-4	leaves &stems of maple, hornbeam, beech
Oe	OFr	4-2	-	-	40	cm	3mi,vf,f;2m; 1co	aw	1-4	insect feces; hyphae: scarce; imbricated leaves & stems of hornbeam, beech, maple
Oa	OHr	2-0	7.5YR 3/2	-	40	cm	3mi,vf,f;2m; 1co	aw	1-3	mesofauna: common
A	-	0-7	7.5YR 2.5/2	3mabk,fr	40	cm	3mi,vf,f;2m; 1co	aw	7-9	-
A/C1	-	7-27	7.5YR 2.5/2	3m abk,fr	90	cm&dm	2mi,vf,f,m,co	cw	15-21	open-work (10%)
A/C2	-	27-65	7.5YR 2.5/2	3m abk,fr	90	cm&dm	2mi,vf,f,m,co	aw	33-41	open-work (10%)
2AC	-	65-85+	7.5YR 2.5/2	2m abk,fr	80	mm&cm&dm	2mi,vf,f,m,co	-	-	open-work (5%);silt caps; earthworms

Plot "Piand'la casa", 12 years after the cut

Inclination of the rock layers: cross-dip; slope: 50%; exposure: N-NE.

Soil cover: 90%; stone cover: 20%; grass cover: 20% (*Mercurialisannua*, *Festuca heterophylla*, *Primulaacaulis*, *Daphne laureola*).

Soil: IncepticHaprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).

Oi1	OLn	12-8	-	-	0	-	3mi,vf	cw	2-5	leaves & stems of maple, hornbeam, beech, oak
Oi2	OLv1	8-6	-	-	0	-	3mi,vf; 1f	cw	1-3	leaves & stems of maple, hornbeam, beech, oak; ants, insect feces; hyphae: scarce
Oi3	OLv2	6-5	-	-	20	cm	3mi,vf,f	cw	1-2	imbricated leaves & stems of hornbeam, beech, maple; mesofauna: common; snails; hyphae: abundant
Oi4	OFr	5-3	-	-	20	cm	2-3mi,vf,f	cw	1-3	leaves are brown; mesofauna: common; hyphae: abundant and coarse (~0.5-1 mm)
Oa	OHr	3-0	7.5YR 3/2	-	20	cm	2-3mi,vf,f	cw	1-4	mesofauna: common; hyphae: abundant and coarse (~0.5-1 mm)
A	-	0-6	7.5YR3/2	2-3msbk, fr	20	cm	2mi,vf,f; 1m,co	cw	2-6	hyphae: scarce
AB	-	6-11	10YR 3/2	2f-m sbk&abk,fr	30	cm	2mi,vf,f; 3m; 1co	cw	4-6	-
Bw	-	11-19	10YR 3/3	2f&m sbk&abk,fr	40	dm	2mi,vf,f; 3m; 1co	cw	8-10	-
2Bwb	-	19-44	7.5YR 3/3	3f&msbk, fr	75	dm	3mi,vf,f,m,co	cw	17-26	cutans of secondary carbonates; some clast is angular, others are smooth
3Bwb	-	44-52	7.5YR 3/2	3mabk&sbk,fr	50	dm	1mi,vf,m,co; 2f	aw	8-15	cutans of secondary carbonates; some clast is angular, others are smooth
4Bwb	-	52-64+	10YR3/3	2f&m abk,fr	85	dm	1mi,vf,m,co; 2f	-	-	cutans of secondary carbonates; some clast is angular, others are smooth

Plot "Orzarella", 17 years after the cut

Inclination of the rock layers: anti-dip; slope: 70%; exposure: N-NE.

Soil cover: 60-70%;stone cover: 0%; grass cover: 40% (*Daphne laureola*, *Melicauniflora*, *Polysticumsetiferum*, *Saniculaeuropaea*, *Tamuscommunis*, *Festuca heterophylla*).

Soil: IncepticHaprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).

Oi1	OLn	9-6	-	-	0	-	0	cw	1-6	leaves & stems of beech, maple,

										hornbeam
Oi2	OLv	6-3	-	-	20	mm	0	cw	2-4	leaves & stems of service tree, beech
Oe1	OFr	3-2	-	-	20	mm	2-3mi,vf,f	cw	1-2	
Oe2	OHr	2-0	-	-	20	mm	2mi,vf,f,m	cw	1-2	-
A	-	0-3	10YR 2/1	3msbk, fr	20	mm&cm	2mi,vf,f,m	cb	0-4	-
AB	-	3-7	10YR 3/2	3f&msbk, fr	30	mm&cm	2mi,vf,f,m,co	cw	6-9	-
Bw1	-	7-28	10YR 4/3	3m&csbk, fr	50	mm&cm&dm	2mi,vf,f;3m,co	cw	19-22	-
Bw2	-	28-53	10YR 4/4	2f&m sbk, fr	50	cm&dm	2mi,vf,f,m,co	cw	23-28	-
Bw3	-	53-69+	10YR 5/3	3msbk, fr	60	cm&dm	2mi,vf,f,m,co	cw	-	-

Plot “Bucata del Pisciarello2”, 27 years after the cut

Inclination of the rock layers: cross-dip; slope: 75%; exposure: N-NW.

Soil cover: 100%; stone cover: 20%; grass cover: 40% (*Seslerianitida*, *Mycelismuralis*, *Tamuscommunis*,*Clinopodiumvulgare*,*Arabisturrita*).

Soil: Lithic Haprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).

Oi1	OLn	8-5	-	-	0	-	0	cw	1-3	leaves & stems of maple, hornbeam, oak
Oi2	OLv	5-3	-	-	0	-	0	aw	1-2	leaves & stems of maple, hornbeam, oak
Oe	OFr	3-0	-	-	0	-	2mi,vf,f	ab	0-3	leaves & stems of beech, maple, hornbeam
Oa	OHr	3-0	7.5YR 2.5/3	-	20	cm	3mi,vf,f	ab	0-3	stones are imbricated with the grass stems
A	-	0-3	7.5YR 3/2	3f&msbk, fr	20	mm&cm	3mi,vf,f	cw	2-4	-
Bw	-	3-18	10YR 3/2	1m sbk, fr	25	dm	3mi,vf,f	cw	15-22	cutans of secondary carbonates; some clast is angular, others are smooth
C	-	18-42+	7.5YR 2.5/3	3msbk,fr	90	dm	1m,co	-	-	flintstoneclasts

Plot “Bucata del Pisciarello3”, 37 years after the cut

Inclination of the rock layers: cross-dip; slope: 75%; exposure: N-NW.

Surface rock: 30%; soil cover: 70%; stone cover: 30%; grass cover: 50% (*Seslerianitida*, *Polysticumsetiferum*, *Melicauniflora*, *Digitalis lutea*subsp. *lutea*, *Tamuscommunis*, *Rosa micrantha*, *Daphne laureola*, *Geranium robertianum*).

Soil: Lithic Haprendoll, loamy-skeletal, mixed, mesic (Soil Survey Staff 2014); RendzicLepticPhaeozem (Skeletic) (IUSS2015).

Oi	OLn	6-0	-	-	0	-	0	ab	0-7	leaves & stems of maple, hornbeam, beech, oak
Oa	OHr	1-0	7.5YR 3/2	-	0	-	2mi,vf,f; 1m	cb	0-5	-
A	-	0-8	7.5YR 3/2	2f&m sbk&cr, fr	30	dm	2mi,vf,f; 1m	cw	4-10	-
Bw1	-	8-23	10YR 3/3	3m sbk, fr	30	dm&cm	2mi,vf,f,m,co	cw	10-18	-
Bw2	-	23-45	10YR 3/3	3m sbk, fr	60	dm&cm	1mi,vf,v,m,co	aw	18-31	-
C	-	45-56	-	3m abk, fr	95	dm&cm	1vf,v	aw	10-11	roots are in the cracks
R	-	56-68+	-	-	-	-	v1vf,f	-	-	-

[a] moist and crushed, according to the Munsell Soil Color Charts.

[b] 1=weak, 2=moderate, 3=strong; th=thin, f=fine, m=medium, c=coarse; cr=crumb, abk=angular blocky, sbk=sub-angular blocky; fr=friable.

[c] 0=absent, v1=very few, 1=few, 2=plentiful, 3=abundant; mi=micro, vf=very fine, f=fine, m=medium, co=coarse.

[d] a=abrupt, c=clear; b=broken, w=wavy.

Appendix B. Floristic list of the investigated areas. Mt. Nerone, Italy.

Ecological, phytogeographical and phytosociological data of the 203 species considered in this study.

Family (Peruzzi, 2010)	**Reference Flora: Conti *et al.,* 2005**	**Forest Management Units**							**Biological type**	**Chorological type**	**Ellenberg values**							**Attributed syntaxonomic class**	**Coeff. Of Maturity**
		FMU 1	**FMU 2**	**FMU 3**	**FMU 4**	**FMU 5**	**FMU 6**	**FMU 7**			**L**	**T**	**C**	**U**	**R**	**N**	**S**		
Amaryllidaceae	*Allium pendulinum* Ten.			3	4	5	6	7	G bulb	W-STENOMEDIT.	6	9	4	4	6	8	0	Querco-Fagetea	9
Amaryllidaceae	*Allium ursinum* L. ssp. *ursinum*						6	7	G bulb	EURASIAT.	2	X	5	6	7	8	0	Querco-Fagetea	9
Amaryllidaceae	*Galanthus nivalis* L.			3	4			7	G bulb	EUROP.-CAUC.	5	7	4	X	7	7	0	Querco-Fagetea	9
Apiaceae	*Chaerophyllum temulum* L.		2						T scap	EURASIAT.	5	6	5	5	X	8	0	Galio-Urticetea	6
Apiaceae	*Daucus carota* L.	1	2						H bienn	PALEOTEMP.	8	6	5	4	5	4	0	Artemisietea vulgaris	3
Apiaceae	*Laserpitium latifolium* L.		2						H scap	EUROP.	7	X	5	X	7	4	0	Trifolio-Geranietea	7
Apiaceae	*Orlaya daucoides* (L.) Greuter		2						T scap	STENOMEDIT.	8	8	4	3	7	5	0	Stellarietea mediae	1
Apiaceae	*Pastinaca sativa* L. subsp. *urens* (Req. ex Godr.) Celak.		2						H bienn	EUROSIB.	8	6	5	4	8	5	0	Artemisietea vulgaris	3
Apiaceae	*Sanicula europaea* L.	1	2	3	4	5	6	7	H scap	PALEOTEMP.	4	5	5	5	8	6	0	Querco-Fagetea	9
Apiaceae	*Torilis arvensis* (Hudson) Link ssp. *arvensis*		2						T scap	SUBCOSMOP.	7	8	5	4	7	6	0	Stellarietea mediae	1
Araceae	*Arum maculatum* L.			3			6	7	G rhiz	CENTRO-EUROP.	3	6	5	7	7	8	0	Querco-Fagetea	9
Araliaceae	*Hedera helix* L. subsp. *helix*	1	2	3	4	5	6	7	P lian	EURIMEDIT.	4	5	4	5	X	X	0	Querco-Fagetea	9
Asparagaceae	*Ornithogalum etruscum* Parl.	1	2					7	G bulb	ENDEM.	.	.	.	.	.	.	.	Artemisietea vulgaris	3
Asparagaceae	*Ornitogallum pyrenaicum* L. subsp *pyrenaicum*				4	5	6	7	G bulb	EURIMEDIT.	5	5	5	6	5	5	0	Querco-Fagetea	9
Asparagaceae	*Ruscus aculeatus* L.				4				G rhiz	EURIMEDIT.	4	8	5	4	5	5	0	Quercetea-Illicis	9
Aspleniaceae	*Asplenium adiantum-nigrum* L.						6	7	H ros	PALEOTEMP.	6	7	2	4	2	3	0	Asplenietea tricomanis	5
Aspleniaceae	*Asplenium onopteris* L.			3	4	5	6	7	H ros	SUBTROP. NESICOLA	3	9	4	3	5	3	0	Quercetea-Illicis	9
Aspleniaceae	*Asplenium trichomanes* L. ssp. *quadrivalens* D. E. Meyer	1	2	3	4	5	6	7	H ros	COSMOP.	5	X	5	5	X	4	0	Asplenietea tricomanis	5
Aspleniaceae	*Ceterach officinarum* Willd. subsp. *officinarum*				4	5		7	H ros	EURASIAT. TEMP.	9	7	5	2	7	3	0	Asplenietea tricomanis	5
Asteraceae	*Arctium minus* (Hill) Bernh.		2						H bienn	EURIMEDIT.	11	5	5	5	8	9	0	Artemisietea vulgaris	3
Asteraceae	*Carduus nutans* L.	1	2					7	H bienn	W-EUROP.	8	X	5	3	8	6	0	Artemisietea vulgaris	3
Asteraceae	*Carlina corymbosa* L.	1	2						H scap	STENOMEDIT.	6	X	4	2	X	4	0	Artemisietea vulgaris	3
Asteraceae	*Centaurea nigrescens* Willd. subsp. n*eapolitana* (Boiss.)		2						H scap	ENDEM. ALP.	7	6	5	4	5	4	0	Molino-Arrhenatheretea	4
Asteraceae	*Cirsium italicum* (Savi) DC.	1	2					7	H bienn	SE-EUROP.	7	6	6	3	6	5	0	Artemisietea vulgaris	3
Asteraceae	*Cirsium vulgare* (Savi) Ten. ssp. *vulgare*	1	2						H bienn	PALEOTEMP.	8	5	5	5	X	8	0	Artemisietea vulgaris	3
Asteraceae	*Crepis leontodontoides* All.				4			7	H ros	W-MEDIT.-MONT.	5	8	4	4	3	7	0	Cisto-Lavanduletea	8
Asteraceae	*Dipsacus fullonum* L.	1	2						H bienn	EURIMEDIT.	6	8	5	7	5	5	0	Artemisietea vulgaris	3
Asteraceae	*Hieracium pilosella* L.		2					7	H ros	EUROP.-CAUC.	8	X	4	3	4	2	0	Festuco-Brometea	5
Asteraceae	*Hypochoeris achyrophorus* L.		2				6	7	T scap	STENOMEDIT.	11	9	4	2	X	2	0	Tuberarietea guttatae	2
Asteraceae	*Inula conyzae* (Griess.) Meikle	1	2	3	4	5	6	7	H bienn	EUROP.-CAUC.	6	6	4	4	7	3	0	Trifolio-Geranietea	7
Asteraceae	*Lactuca muralis* (L.) Gaertn.	1	2	3	4	5	6	7	H scap	EUROP.-CAUC.	4	5	4	5	X	6	0	Querco-Fagetea	9
Asteraceae	*Lapsana communis* L.		2						T scap	PALEOTEMP.	5	X	5	5	X	7	0	Galio-Urticetea	6
Asteraceae	*Leucanthemum vulgare* Lam. Subsp. *vulgare*		2						H scap	EUROSIB.	7	X	4	4	X	3	0	Festuco-Brometea	5
Asteraceae	*Picris hieracioides* L. subsp *hieracioides*		2					7	H scap	EUROSIB.	8	X	5	4	8	4	0	Artemisietea vulgaris	3
Asteraceae	*Reichardia picroides* (L.) Roth	1	2						H scap	STENOMEDIT.	7	8	4	3	6	2	0	Stellarietea mediae	1
Asteraceae	*Solidago virgaurea* L. ssp. *virgaurea*	1	2						H scap	CIRCUMBOR.	5	X	X	5	X	5	0	Epilobietea angustifoliae	7
Asteraceae	*Sonchus asper* (L.) Hill ssp. *asper*	1						7	T scap	EURASIAT.	7	5	X	4	7	7	0	Stellarietea mediae	1
Asteraceae	*Tanacetum corymbosum* (L.) Sch.-Bip.		2					7	H scap	EURIMEDIT.	7	6	5	3	8	4	0	Trifolio-Geranietea	7
Betulaceae	*Carpinus betulus* L.				4	5			P scap	C-EUROP.-CAUCAS.	4	6	4	X	X	X	0	Querco-Fagetea	9
Betulaceae	*Corylus avellana* L.	1	2	3	4	5	6	7	P caesp	EUROP.-CAUC.	6	5	4	5	5	8	0	Querco-Fagetea	9
Betulaceae	*Ostrya carpinifolia* Scop.	1	2	3	4	5	6	7	P caesp	CIRCUMBOR.	4	8	4	4	X	X	0	Querco-Fagetea	9
Boraginaceae	*Buglossoides purpurocaerulea* (L.) Johnston			3	4				H scap	PONTICA	5	7	6	4	8	4	0	Trifolio-Geranietea	7
Boraginaceae	*Cerinthe minor* L. subsp. *auriculata* (Ten.) Domac	1	2						H bienn	ENDEM.	5	4	4	5	5	7	0	Querco-Fagetea	9
Brassicaceae	*Arabis collina* Ten.		2					7	H scap	MEDIT.-MONT.	7	5	3	4	8	3	0	Festuco-Brometea	5
Brassicaceae	*Arabis turrita* L.	1	2	3	4	5	6	7	H bienn	S-EUROP.-SUDSIB.	6	7	6	6	7	3	0	Trifolio-Geranietea	7
Brassicaceae	*Cardamine bulbifera* (L.) Crantz		2						G rhiz	CENTRO-EUROP.	3	5	4	5	7	6	0	Querco-Fagetea	9
Brassicaceae	*Cardamine flexuosa* With.		2						H scap	CIRCUMBOR.	6	5	4	8	X	5	0	Montio-Cardaminetea	6
Brassicaceae	*Cardamine graeca* L.		2						T scap	N-MEDIT.-MONT.	5	4	4	7	7	7	0	Cardamino -Geranietea	6
Brassicaceae	*Cardamine impatien*s L.		2						T scap	EURASIAT.	5	5	5	6	7	8	0	Querco-Fagetea	9
Brassicaceae	*Cardamine kitaibelii* Becherer		2					7	G rhiz	OROF. SE-EUROP.	3	5	5	5	7	7	0	Querco-Fagetea	9
Brassicaceae	*Erysimum pseudorhaeticum* Polatschek		2					7	H scap	ENDEM.	9	7	6	2	7	3	0	Festuco-Brometea	5
Campanulaceae	*Campanula micrantha* Bertol.	1						7	H scap	ENDEM.	6	4	4	4	7	3	0	Querco-Fagetea	9
Campanulaceae	*Campanula persicifolia* L.	1					6	7	H scap	EURASIAT.	5	5	5	4	8	3	0	Trifolio-Geranietea	7
Campanulaceae	*Campanula rapunculus* L.	1	2					7	H bienn	PALEOTEMP.	7	7	5	4	6	4	0	Festuco-Brometea	5
Campanulaceae	*Campanula tanfanii* Podlech			3	4			7	H scap	ENDEM.	6	5	4	3	7	2	0	Asplenietea tricomanis	5
Campanulaceae	*Campanula trachelium* L.	1	2	3	4	5	6	7	H scap	PALEOTEMP.	4	5	5	5	8	8	0	Querco-Fagetea	9
Caprifoliaceae	*Knautia arvensis* (L.) Coulter		2						H scap	EURASIAT.	7	5	5	4	5	3	0	Molino-Arrhenatheretea	4
Caprifoliaceae	*Knautia purpurea* (Vill.) Borbas		2						H scap	W-MEDIT.-MONT.	7	4	4	4	X	2	0	Querco-Fagetea	9
Caprifoliaceae	*Lonicera xylosteum* L.			3	4	5	6	7	P caesp	EUROP.-CAUC.	5	5	4	5	7	X	0	Querco-Fagetea	9
Caprifoliaceae	*Scabiosa columbaria* L.	1	2						H scap	EURASIAT.	8	5	5	4	8	2	0	Festuco-Brometea	5
Caprifoliaceae	*Scabiosa uniseta* Savi		2					7	H scap	ENDEM.	7	5	4	3	6	2	0	Festuco-Brometea	5
Caprifoliaceae	*Valerianella locusta* (L.) Laterrade		2						T scap	EURIMEDIT.	7	5	5	5	7	X	0	Stellarietea mediae	1
Caryolyllaceae	*Stellaria media* (L.) Vill. ssp. *media*			3	4			7	T rept	COSMOP.	6	X	X	4	7	8	0	Stellarietea mediae	1
Caryophyllaceae	*Cerastium brachypetalum* Desportes et Pers.		2					7	T scap	EURIMEDIT.	11	7	5	3	7	2	0	Sedo-Scleranthetea	5
Caryophyllaceae	*Cerastium glomeratum* Thuill.						6	7	T scap	EURIMEDIT.	7	X	5	5	5	5	0	Stellarietea mediae	1
Caryophyllaceae	*Dianthus monspessulanus* L.		2						H scap	OROF. S-EUROP.	6	7	5	4	2	5	0	Festuco-Brometea	5
Caryophyllaceae	*Moehringia pentandra* Gay		2	3				7	T scap	EURIMEDIT.	4	7	5	6	4	8	0	Quercetea-Illicis	9
Caryophyllaceae	*Moehringia trinervia* subsp *trinervia* (L.) Clairv.		2	3				7	T scap	EURASIAT.	4	5	5	5	6	7	0	Querco-Fagetea	9
Caryophyllaceae	*Silene vulgaris* (Moench) Garcke subsp. *prostrata* (Gaudin) Schinz & Thell.	1	2					7	H ros	OROF. SE-EUROP.	8	X	X	4	7	2	0	Thalspietea rotundifolii	5

Lamiaceae	*Clinopodium vulgare* L. ssp. *arundanum* (Boiss.) Nyman			3	4	5	6		H scap	CIRCUMBOR.	.	.	.	.	.	.	.	Trifolio-Geranietea	7
Lamiaceae	*Clinopodium vulgare* L. ssp. *vulgare*	1	2	3				7	H scap	CIRCUMBOR.	7	5	4	4	7	3	0	Trifolio-Geranietea	7
Lamiaceae	*Lamium galeobdolon* L. subsp. *flavidum* (F. Herm.) A. Löve & D. Löve			3	4	5	6	7	H scap	EUROP.-CAUC.	2	4	5	5	7	5	0	Querco-Fagetea	9
Lamiaceae	*Melittis melissophyllum* L.		2	3	4	5		7	H scap	C-EUROP.	5	6	5	4	7	3	0	Querco-Fagetea	9
Lamiaceae	*Prunella laciniata* (L.) L.	1	2						H scap	EURIMEDIT.	8	8	5	3	7	2	0	Festuco-Brometea	5
Lamiaceae	*Prunella vulgaris* L.		2						H scap	CIRCUMBOR.	7	6	4	6	4	X	0	Festuco-Brometea	5
Lamiaceae	*Scutellaria columnae* All. ssp. *columnae*			3	4	5	6		H scap	NE-MEDIT.-MONT.	6	8	4	4	3	5	0	Querco-Fagetea	9
Lamiaceae	*Teucrium chamaedrys* L.	1	2					7	Ch suffr	EURIMEDIT.	7	6	5	2	8	1	0	Festuco-Brometea	5
Liliaceae	*Lilium bulbiferum* L.	1	2				6	7	G bulb	OROF. CENTRO-EUROP.	6	4	4	6	X	X	0	Trifolio-Geranietea	7
Linaceae	*Linum catharticum* L.	1	2					7	T scap	EURIMEDIT.	7	X	5	X	X	1	0	Festuco-Brometea	5
Linaceae	*Linum viscosum* L.		2						H scap	OROF. S-EUROP.	7	X	5	4	8	3	0	Festuco-Brometea	5
Oleaceae	*Fraxinus ornus* L.	1	2	3	4	5	6	7	P scap	S-EUROP.-SUDSIB.	5	8	6	3	8	3	0	Querco-Fagetea	9
Onagraceae	*Epilobium montanum* L.				4	5			H scap	EURASIAT.	6	4	5	5	4	4	0	Epilobietea angustifoliae	7
Orchidaceae	*Cephalanthera damasonium* (Miller) Druce		2	3	4	5	6		G rhiz	EURIMEDIT.	2	5	4	4	7	4	0	Querco-Fagetea	9
Orchidaceae	*Cephalanthera longifolia* (Hudson) Fritsch				4	5			G rhiz	EURASIAT.	4	5	5	3	8	3	0	Querco-Fagetea	9
Orchidaceae	*Cephalanthera rubra* (L.) L. C. Rich.					5	6		G rhiz	EURASIAT.	3	5	5	4	8	3	0	Querco-Fagetea	9
Orchidaceae	*Dactylorhiza maculata* (L.) Soó subsp. *fuchsii* (Druce) Hyl.		2			5			G bulb	PALEOTEMP.	.	.	.	.	.	.	.	Querco-Fagetea	9
Orchidaceae	*Dactylorhiza maculata* (L.) Soó subsp. *maculata*		2			5		7	G bulb	PALEOTEMP.	7	5	5	5	X	4	0	Molino-Arrhenatheretea	4
Orchidaceae	*Epipactis helleborine* (L.) Crantz subsp *helleborine*		2	3	4	5		7	G rhiz	PALEOTEMP.	3	5	5	5	7	5	0	Querco-Fagetea	9
Orchidaceae	*Limodorum abortivum* (L.) Swartz		2						G rhiz	EURIMEDIT.	X	7	5	4	8	0	0	Querco-Fagetea	9
Orchidaceae	*Listera ovata* (L.) R.Br.				4	5		7	G rhiz	EURASIAT.	4	4	5	6	7	5	0	Molino-Arrhenatheretea	4
Orchidaceae	*Orchis anthropophora* (L.) All.		2						G bulb	MEDIT.ATL.	.	.	.	.	.	.	.	Festuco-Brometea	5
Orobanchaceae	*Orobanche gracilis* Sm.		2						T par	EUROP.-CAUC.	8	X	4	4	X	4	0	Festuco-Brometea	5
Plantaginaceae	*Digitalis lutea* L. subsp. *australis* (Ten.) Arcang	1	2	3	4	5	6	7	H scap	ENDEM.	8	6	5	5	8	5	0	Trifolio-Geranietea	7
Plantaginaceae	*Linaria vulgaris* Miller subsp. *vulgaris*		2						H scap	EURASIAT.	8	5	5	3	7	3	0	Artemisietea vulgaris	3
Plantaginaceae	*Veronica cymbalaria* Bodard			3			6		T scap	EURIMEDIT.	7	7	5	4	3	2	0	Stellarietea mediae	1
Plantaginaceae	*Veronica officinalis* L.	1	2						H rept	EURASIAT.	5	X	5	4	2	3	0	Querco-Fagetea	9
Plantaginaceae	*Veronica prostrata* L. subsp. *prostrata*	1	2					7	H caesp	EURASIAT.	8	7	5	4	7	2	0	Querco-Fagetea	9
poaceae	*Anthoxanthum odoratum* L.	1	2					7	H caesp	EURASIAT.	X	X	5	X	5	3	0	Molino-Arrhenatheretea	4
Poaceae	*Brachypodium rupestre* (Host) Roem. & Schult	1	2					7	H caesp	SUBATL.	6	5	5	4	7	4	0	Festuco-Brometea	5
Poaceae	*Brachypodium sylvaticum* (Hudson) Beauv.	1	2	3				7	H caesp	PALEOTEMP.	4	5	5	5	6	6	0	Querco-Fagetea	9
Poaceae	*Bromus erectus* Hudson	1	2					7	H caesp	PALEOTEMP.	8	5	7	3	8	3	0	Festuco-Brometea	5
Poaceae	*Bromus ramosus* Hudson		2	3	4	5	6	7	H caesp	EURASIAT.	6	5	5	6	8	6	0	Epilobietea angustifoliae	7
Poaceae	*Dactylis glomerata* L.	1	2	3		5		7	H caesp	PALEOTEMP.	7	6	5	4	5	6	0	Molino-Arrhenatheretea	4
Poaceae	*Elymus caninus* (L.) L. s.l.		2					7	H caesp	CIRCUMBOR.	5	4	4	6	7	8	0	Querco-Fagetea	9
Poaceae	*Festuca heterophylla* Lam.	1	2	3	4	5	6	7	H caesp	EUROP.-CAUC.	5	5	4	4	5	4	0	Querco-Fagetea	9
Poaceae	*Melica uniflora* Retz.	1	2	3	4	5	6	7	H caesp	PALEOTEMP.	3	5	5	5	6	X	0	Querco-Fagetea	9
Poaceae	*Poa sylvicola* Guss.		2						H caesp	EURIMEDIT.	3	5	5	5	4	6	0	Querco-Fagetea	9
Poaceae	*Poa trivialis* L.		2						H caesp	EURASIAT.	6	X	5	7	X	7	0	Molino-Arrhenatheretea	4
Poaceae	*Sesleria nitida* Ten.	1	2	3	4	5	6	7	H caesp	ENDEM.	11	5	4	2	6	1	1	Festuco-Brometea	5
Poaceae	*Setaria italica* (L.) P.Beauv.							7	Tscap	COSMOP.	7	6	X	4	X	7	0	Stellarietea mediae	1
Polygalaceae	*Polygala nicaeensis* Risso ssp. *mediterranea* Chodat		2						H scap	EURIMEDIT.	8	6	5	3	7	2	0	Festuco-Brometea	5
Polygonaceae	*Rumex acetosa* L. subsp. *acetosa*	1	2						H scap	CIRCUMBOR.	8	X	X	X	4	5	0	Molino-Arrhenatheretea	4
Polygonaceae	*Rumex conglomeratus* Murray	1	2						H scap	EURASIAT.	8	7	5	7	X	8	0	Artemisietea vulgaris	3
Polypodiaceae	*Polypodium interjectum* Shivas	1	2	3	4	5	6	7	H ros	PALEOTROP.	3	7	5	3	3	5	0	Querco-Fagetea	9
Primulaceae	*Cyclamen hederifolium* Aiton			3	4	5	6	7	G bulb	N-STENOMEDIT.	4	8	5	5	5	5	0	Querco-Fagetea	9
Primulaceae	*Cyclamen repandum* S. et S.			3	4	5	6	7	G bulb	NW-STENOMEDIT.	4	9	5	3	X	5	0	Quercetea-Illicis	9
Primulaceae	*Primula vulgaris* Huds. subsp. *vulgaris*	1	2	3	4	5	6	7	H ros	EUROP.-CAUC.	6	5	4	5	7	5	0	Querco-Fagetea	9
Ranunculaceae	*Anemone nemorosa* L.		2						G rhiz	CIRCUMBOR.	X	X	4	X	5	X	0	Querco-Fagetea	9
Ranunculaceae	*Anemone trifolia* L.		2	3	4	5			G rhiz	OROF. S-EUROP.	4	5	5	6	6	7	0	Querco-Fagetea	9
Ranunculaceae	*Aquilegia vulgaris* L. subsp. *vulgaris*	1	2						H scap	PALEOTEMP.	6	6	5	4	7	4	0	Trifolio-Geranietea	7
Ranunculaceae	*Clematis vitalba* L.	1	2	3	4	5	6	7	P lian	EUROP.-CAUC.	7	7	4	5	7	7	0	Rhamno-Prunetea	8
Ranunculaceae	*Helleborus bocconei* Ten. ssp. *bocconei*			3	4		6	7	G rhiz	ENDEM.	5	5	4	6	7	6	0	Trifolio-Geranietea	7
Ranunculaceae	*Hepatica nobilis* Miller	1	2	3	4	5			G rhiz	CIRCUMBOR.	4	6	4	4	7	X	0	Querco-Fagetea	9
Ranunculaceae	*Ranunculus lanuginosus* L.	1	2					7	H scap	EUROP.-CAUC.	3	X	4	6	7	7	0	Querco-Fagetea	9
Ranunculaceae	*Ranunculus millefoliatus* Vahl		2					7	H scap	MEDIT.-MONT.	8	7	4	4	7	3	0	Festuco-Brometea	5
Rosaceae	*Crataegus laevigata* (Poiret) DC.			3	4	5	6	7	P caesp	CENTRO-EUROP.	6	6	5	5	5	4	0	Rhamno-Prunetea	8
Rosaceae	*Crataegus monogyna* Jacq. ssp. *monogyna*	1	2	3					P caesp	PALEOTEMP.	6	7	5	4	6	3	0	Rhamno-Prunetea	8
Rosaceae	*Fragaria vesca* L.	1	2					7	H rept	EUROSIB.	6	X	4	4	X	5	0	Epilobietea angustifoliae	7
Rosaceae	*Fragaria viridis* Duchesne		2	3	4			7	H rept	EUROSIB.	6	7	5	4	7	4	0	Trifolio-Geranietea	7
Rosaceae	*Geum urbanum* L.	1	2	3	4	5	6	7	H scap	CIRCUMBOR.	4	5	5	5	6	7	0	Galio-Urticetea	6
Rosaceae	*Potentilla micrantha* Ramond		2	3				7	H ros	EURIMEDIT.	5	6	5	4	8	4	0	Trifolio-Geranietea	7
Rosaceae	*Prunus spinosa* L.		2						P caesp	EUROP.-CAUC.	7	5	5	X	X	X	0	Rhamno-Prunetea	8
Rosaceae	*Rosa arvensis* Hudson		2						NP	S-MEDIT.-SUBATL.	5	5	5	5	7	5	0	Querco-Fagetea	9
Rosaceae	*Rosa corymbifera* Borkh.	1	2				6		NP	W-MEDIT.-MONT.	.	.	.	.	.	.	.	Rhamno-Prunetea	8
Rosaceae	*Rosa micrantha* Sm.	1		3	4		6	7	NP	S-EUROP.-SUDSIB.	7	5	5	3	5	3	0	Rhamno-Prunetea	8
Rosaceae	*Rubus hirtus* W. et K.	1	2	3	4	5		7	NP	S- E C-EUROP.	7	6	4	4	5	7	0	Rhamno-Prunetea	8
Rosaceae	*Sanguisorba minor* Scop. subsp. *balearica* (Bourg. ex Nyman) Muñoz Garm. & C. Navarro	1	2						H scap	PALEOTEMP.	7	6	5	3	8	2	0	Festuco-Brometea	5
Rosaceae	*Sorbus aria* (L.) Crantz	1	2	3	4	5	6	7	P caesp	PALEOTEMP.	6	5	5	4	7	3	0	Querco-Fagetea	9
Rosaceae	*Sorbus domestica* L.		2					7	P scap	EURIMEDIT.	4	7	5	3	8	3	0	Querco-Fagetea	9
Rubiaceae	*Asperula purpurea* (L.) Ehrend.		2						Ch suffr	OROF. SE-EUROP.	11	6	7	2	7	2	0	Festuco-Brometea	5
Rubiaceae	*Cruciata glabra* (L.) Ehrend.	1	2	3	4	5		7	H scap	EURASIAT.	5	6	5	5	6	6	0	Trifolio-Geranietea	7
Rubiaceae	*Cruciata laevipes* Opiz	1	2	3		5		7	H scap	EURASIAT.	7	6	5	5	5	5	0	Artemisietea vulgaris	3
Rubiaceae	*Galium aparine* L.		2						T scap	EURASIAT.	6	X	5	4	5	5	0	Galio-Urticetea	6
Rubiaceae	*Galium mollugo* L.	1	2						H scap	EURIMEDIT.	6	5	5	5	5	4	0	Molino-Arrhenatheretea	4
Rubiaceae	*Galium odoratum* (L.) Scop.			3			6		G rhiz	EUROP.-CAUC.	2	5	4	5	X	5	0	Querco-Fagetea	9

Ranunculaceae	*Ranunculus millefoliatus* Vahl		2					7	H scap	MEDIT.-MONT.	8	7	4	4	7	3	0	Festuco-Brometea	5
Rosaceae	*Crataegus laevigata* (Poiret) DC.			3	4	5	6	7	P caesp	CENTRO-EUROP.	6	6	5	5	5	4	0	Rhamno-Prunetea	8
Rosaceae	*Crataegus monogyna* Jacq. ssp. *monogyna*	1	2	3					P caesp	PALEOTEMP.	6	7	5	4	6	3	0	Rhamno-Prunetea	8
Rosaceae	*Fragaria vesca* L.	1	2					7	H rept	EUROSIB.	6	X	4	4	X	5	0	Epilobietea angustifoliae	7
Rosaceae	*Fragaria viridis* Duchesne		2	3	4			7	H rept	EUROSIB.	6	7	5	4	7	4	0	Trifolio-Geranietea	7
Rosaceae	*Geum urbanum* L.	1	2	3	4	5	6	7	H scap	CIRCUMBOR.	4	5	5	5	6	7	0	Galio-Urticetea	6
Rosaceae	*Potentilla micrantha* Ramond		2	3				7	H ros	EURIMEDIT.	5	6	5	4	8	4	0	Trifolio-Geranietea	7
Rosaceae	*Prunus spinosa* L.		2						P caesp	EUROP.-CAUC.	7	5	5	X	X	X	0	Rhamno-Prunetea	8
Rosaceae	*Rosa arvensis* Hudson		2						NP	S-MEDIT.-SUBATL.	5	5	5	5	7	5	0	Querco-Fagetea	9
Rosaceae	*Rosa corymbifera* Borkh.	1	2				6		NP	W-MEDIT.-MONT.	.	.	.	.	.	.	.	Rhamno-Prunetea	8
Rosaceae	*Rosa micrantha* Sm.	1		3	4		6	7	NP	S-EUROP.-SUDSIB.	7	5	5	3	5	3	0	Rhamno-Prunetea	8
Rosaceae	*Rubus hirtus* W. et K.	1	2	3	4	5		7	NP	S- E C-EUROP.	7	6	4	4	5	7	0	Rhamno-Prunetea	8
Rosaceae	*Sanguisorba minor* Scop. subsp. *balearica* (Bourg. ex Nyman) Muñoz Garm. & C. Navarro	1	2						H scap	PALEOTEMP.	7	6	5	3	8	2	0	Festuco-Brometea	5
Rosaceae	*Sorbus aria* (L.) Crantz	1	2	3	4	5	6	7	P caesp	PALEOTEMP.	6	5	5	4	7	3	0	Querco-Fagetea	9
Rosaceae	*Sorbus domestica* L.		2					7	P scap	EURIMEDIT.	4	7	5	3	8	3	0	Querco-Fagetea	9
Rubiaceae	*Asperula purpurea* (L.) Ehrend.		2						Ch suffr	OROF. SE-EUROP.	11	6	7	2	7	2	0	Festuco-Brometea	5
Rubiaceae	*Cruciata glabra* (L.) Ehrend.	1	2	3	4	5		7	H scap	EURASIAT.	5	6	5	5	6	6	0	Trifolio-Geranietea	7
Rubiaceae	*Cruciata laevipes* Opiz	1	2	3		5		7	H scap	EURASIAT.	7	6	5	5	5	5	0	Artemisietea vulgaris	3
Rubiaceae	*Galium aparine* L.		2						T scap	EURASIAT.	6	X	5	4	5	5	0	Galio-Urticetea	6
Rubiaceae	*Galium mollugo* L.	1	2						H scap	EURIMEDIT.	6	5	5	5	5	4	0	Molino-Arrhenatheretea	4
Rubiaceae	*Galium odoratum* (L.) Scop.			3			6		G rhiz	EUROP.-CAUC.	2	5	4	5	X	5	0	Querco-Fagetea	9
Saxifragaceae	*Saxifraga rotundifolia* L.			3	4				H scap	OROF. S-EUROP.	5	4	5	6	8	6	0	Querco-Fagetea	9
Solanaceae	*Atropa bella-donna* L.	1	2						H scap	OROF. S-EUROP.	6	6	5	5	8	8	0	Epilobietea angustifoliae	7
Spindaceae	*Acer campestre* L.	1		3	4	5	6	7	P scap	EUROP.-CAUC.	5	7	4	5	7	6	0	Querco-Fagetea	9
Spindaceae	*Acer monspessulanum* L.						6	7	P caesp	EURIMEDIT.	6	8	5	3	8	4	0	Querco-Fagetea	9
Spindaceae	*Acer opalus* Mill. subsp. *obtusatum* (Waldst. & Kit. ex Willd.) Gams	1	2	3	4	5	6	7	P scap	SE-EUROP.	5	5	6	6	7	7	0	Querco-Fagetea	9
Spindaceae	*Acer pseudoplatanus* L.			3			6	7	P scap	EUROP.-CAUC.	4	X	4	6	X	7	0	Querco-Fagetea	9
Thymelaceae	*Daphne laureola* L.	1	2	3	4	5	6	7	P caesp	SUBATL.	6	6	4	4	8	3	0	Querco-Fagetea	9
Violaceae	*Viola alba* Besser ssp. *dehnhardtii* (Ten.) W. Becker	1	2	3	4	5	6	7	H ros	STENOMEDIT.	5	8	5	5	7	6	0	Querco-Fagetea	9
Violaceae	*Viola reichenbachiana* Jordan ex Boreau	1	2	3	4	5	6	7	H scap	EUROSIB.	4	5	4	5	7	6	0	Querco-Fagetea	9
Violaceae	*Viola riviniana* Rchb.	1	2					7	H scap	EUROP.	5	X	5	5	3	X	0	Querco-Fagetea	9

	FMU 1	FMU 2	FMU 3	FMU 4	FMU 5	FMU 6	FMU 7
Total number of species found within the FMU	**88**	**158**	**81**	**74**	**67**	**66**	**115**

References :

Conti F., Abbate G., Alessandrini A., Blasi C., 2005 - An annotedcecklist of the Italian vascular flora. Roma: PalombiEditori. 420 pp.

Peruzzi L., 2010 - Checklist dei generi e delle famiglie della flora vascolare italiana. Informatore Botanico Italiano. 42 (1): 151-170

Appendix C. Results of the indirect gradient analysis. Mt.Nerone, Italy.

	CA1	CA2	r2	Pr(>r)
Ecotone_ species	0.36548	0.93082	0.7814	0.287
Forest_species	0.97670	-0.21461	0.9838	0.002 **
Open_enviroment_species	-0.99635	0.08532	0.9883	0.004 **
Light	-0.98276	0.18490	0.9535	0.021 *
Temperature	0.98762	-0.15684	0.5821	0.470
Continentality	-0.97000	-0.24310	0.9254	0.062 .
Soil Moisture	0.92152	0.38834	0.1937	0.890
Soil Reaction	0.93461	-0.35568	0.4953	0.601
Soil Nutrients	0.95869	-0.28446	0.7286	0.329
Maturity	0.99067	-0.13630	0.9851	0.006 **
FMU	0.85039	0.52615	0.5933	0.170
DBH	0.80714	0.59036	0.5413	0.184
G	0.99967	-0.02571	0.9093	0.033 *
Standards height	0.96425	0.26500	0.4136	0.337
Suckers height	0.97455	0.22415	0.6930	0.105
A mollic horizon	0.99277	-0.12000	0.8307	0.037 *
Time	0.69876	0.71536	0.5758	0.177
Tree layer cover (%)	0.87404	-0.48586	0.7359	0.034 *
Shrub layer cover (%)	0.99379	0.11129	0.1696	0.736
Herb layer cover (%)	-0.94954	-0.31363	0.0670	0.929
A mollic horizon	0.99277	-0.12000	0.8307	0.028 *
OH	0.98282	0.18457	0.3230	0.420
OFr	0.32921	-0.94426	0.4400	0.324
OLv	0.17085	-0.98530	0.7308	0.086 .
OLn	0.01549	-0.99988	0.2426	0.567

Signif. codes: ., p=0.1-0.05; *,p=0.05-0.01; **,p = 0.01-0.001; *** ,p=0.001-0

Number of permutations: 999

Appendix D. Species significantly associated with a particular FMU or with FMUs combinations.   Mt. Nerone, Italy

FMU or FMUs combination	Indicator species	Life form	Maturity value	Ecological conditions	phi	p value
1	*Linum catharticum* L.	T scap	5	Open Environment	0.873	0.004 **
1	*Medicago lupulina* L.	T scap	5	Open Environment	0.873	0.003 **
1	*Daucus carota* L.	H bienn	3	Open Environment	0.846	0.007 **
1	*Leucanthemum vulgare* Lam.	H scap	5	Open Environment	0.846	0.006 **
1	*Scabiosa uniseta* Savi	H scap	5	Open Environment	0.702	0.019 *
1	*Tanacetum corymbosum* (L.) Sch.-Bip.	H scap	7	Ecotone	0.702	0.019 *
3	*Saxifraga rotundifolia* L.	H scap	9	Forest	0.89	0.002 **
4	*Mercurialis perennis* L.	G rhiz	9	Forest	1	0.001 ***
7	*Setaria italica* (L.) P.Beauv.	T scap	1	Open Environment	0.656	0.044 *
1+2	*Acinos alpinus* (L.) Moench	Ch suffr	5	Open Environment	1.000	0.001 ***
1+2	*Anthoxanthum odoratum* L.	H caesp	4	Open Environment	0.890	0.001 ***
1+2	*Blackstonia perfoliata* (L.) Hudson ssp. *perfoliata*	T scap	3	Open Environment	0.890	0.001 ***
1+2	*Brachypodium rupestre* (Host) Roem. & Schult	H caesp	5	Open Environment	0.890	0.001 ***
1+2	*Bromus erectus* Hudson	H caesp	5	Open Environment	0.890	0.001 ***
1+2	*Campanula rapunculus* L.	H bienn	5	Open Environment	0.890	0.001 ***
1+2	*Centaurium erythraea* Rafn ssp. *erythraea*	H bienn	5	Open Environment	0.890	0.001 ***
1+2	*Sanguisorba minor* subsp. *balearica* (Nyman) Muñoz Garm. & C. Navarro	H scap	5	Open Environment	0.873	0.001 ***
1+2	*Hypericum perforatum* L. ssp. *perforatum*	H scap	5	Open Environment	0.802	0.003 **
1+2	*Cerastium brachypetalum* Desportes et Pers.	T scap	5	Open Environment	0.750	0.009 *
1+2	*Geranium nodosum* L.	G rhiz	9	Forest	0.750	0.009 **
1+2	*Lotus corniculatus* L.	H scap	4	Open Environment	0.750	0.009 **
1+2	*Ranunculus lanuginosus* L.	H scap	9	Forest	0.750	0.009 **
1+2	*Anemone nemorosa* L.	G rhiz	9	Forest	0.739	0.033 *
1+2	*Cephalanthera damasonium* (Miller) Druce.	G rhiz	9	Forest	0.739	0.036 *
1+2	*Genista tinctoria* L. ssp. *tinctoria*	Ch suffr	4	Open Environment	0.739	0.036 *
1+2	*Polygala nicaeensis* Risso ssp. *mediterranea* Chodat	H scap	5	Open Environment	0.739	0.036 *
1+2	*Rosa corymbifera* Borkh.	NP	8	Ecotone	0.739	0.036 *
1+2	*Trifolium campestre* Schreber	T scap	5	Open Environment	0.739	0.033 *
1+2	*Dactylorhiza maculata* (L.) Soó subsp. *maculata*	G bulb	4	Open Environment	0.656	0.044 *
1+2	*Cerinthe minor* L. subsp. a*uriculata* (Ten.) Domac	H bienn	9	Forest	0.656	0.044 *
1+2	*Atropa bella-donna* L.	H scap	7	Ecotone	0.656	0.044 *
1+6	*Lilium bulbiferum* L.	G bulb	7	Ecotone	0.781	0.007 **
2+7	*Moehringia pentandra* Gay	T scap	9	Forest	0.739	0.028 *
3+4	*Asplenium onopteris* L.	H ros	9	Forest	0.724	0.01 **
3+6	*Galium odoratum* (L.) Scop.	G rhiz	9	Forest	1	0.001 ***
3+7	*Potentilla micrantha* Ramond	H ros	7	Ecotone	0.919	0.001 ***
3+7	*Lamiastrum galeobdolon* ssp. *flavidum* (F.Hermann) Ehrend. et Pola.	H scap	9	Forest	0.748	0.010 **
4+5	*Cephalanthera longifolia* (Hudson) Fritsch	G rhiz	9	Forest	0.667	0.037 *
6+7	*Acer pseudoplatanus* L.	P scap	9	Forest	0.819	0.001 ***
6+7	*Stellaria nemorum* L. ssp. *montana* Murb.	H scap	9	Forest	0.781	0.003 **
6+7	*Acer monspessulanum* L.	P caesp	9	Forest	0.777	0.009 **
6+7	*Asplenium adiantum-nigrum* L.	H ros	5	Open Environment	0.777	0.010 **
1+2+3	*Brachypodium sylvaticum* (Hudson) Beauv.	H caesp	9	Forest	0.748	0.012 *
1+2+5	*Dactylorhiza maculata* (L.) Soó subsp. *fuchsii* (Druce) Hyl.	G bulb	9	Forest	0.667	0.027 *
1+2+7	*Fragaria vesca* L.	H rept	7	Ecotone	0.915	0.001 ***
1+2+7	*Arabis collina* Ten.	H scap	5	Open Environment	0.831	0.003 **
1+2+7	*Geranium rotundifolium* L.	T scap	3	Open Environment	0.831	0.001 ***
1+2+7	*Dactylis glomerata* L.	H caesp	4	Open Environment	0.781	0.004 **
3+4+7	*Stellaria media* (L.) Vill. ssp. *media*	T rept	1	Open Environment	0.665	0.032 *
3+5+6	*Emerus majus* Mill. s.l.	NP	8	Ecotone	0.761	0.002 **
3+6+7	*Arum maculatum* L.	G rhiz	9	Forest	1.000	0.001 ***
3+6+7	*Euonymus europaeus* L.	P caesp	8	Ecotone	0.921	0.001 ***
4+5+6	*Clinopodium vulgare* L. ssp. *arundanum* (Boiss.) Nyman	H scap	7	Ecotone	0.757	0.011 *
1+2+4+5	*Euphorbia amygdaloides* L. ssp. *amygdaloides*	Ch suffr	9	Forest	0.678	0.019 *
1+2+6+7	*Viola riviniana* Rchb.	H scap	9	Forest	0.678	0.017 *
1+3+4+5	*Hepatica nobilis* Miller	G rhiz	9	Forest	0.802	0.002 **
1+5+6+7	*Digitalis lutea* L. subsp. *australis* (Ten.) Arcang	H scap	7	Ecotone	0.678	0.019 *
2+3+4+5	*Lathyrus venetu*s (Miller) Wohlf.	G rhiz	9	Forest	0.919	0.001 ***

2+3+5+7	*Melittis melissophyllum* L.	H scap	9	Forest	0.704
2+3+5+7	*Tamus communis* L.	G rad	8	Ecotone	0.678
3+4+5+6	*Cephalanthera damasonium* (Miller) Druce *	G rhiz	9	Forest	0.612
3+4+5+7	*Lonicera xylosteum* L.	P caesp	9	Forest	0.802
3+4+6+7	*Helleborus bocconei* Ten. ssp. *bocconei*	G rhiz	7	Ecotone	1.000
3+4+6+7	*Polystichum setiferum* (Forssk.) T. Moore ex Woyn.	G rhiz	9	Forest	0.826
3+4+6+7	*Rosa micrantha* Sm.	NP	8	Ecotone	0.721
3+5+6+7	*Bromus ramosus* Hudson	H caesp	7	Ecotone	0.764

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Signif. codes: ., p=0.1-0.05; *,p=0.05-0.01; **,p = 0.01-0.001; *** ,p=0.001-0

Suummary (specie, indvalcomp = TRUE, alpha = 0,05)
multilevel pattern analysis

Associated function: r
significance level (alpha): 0,05

Appendix E. Datasets used for the statistical analysis.

_ E1. Vegetation dataset.
_ E2. Soil seed bank dataset.
_ E3. Topsoil dataset.
_ E4. Soil cover dataset

Appendix E1. Vegetation dataset. Mt. Nerone, Italy

		Ellenberg				Biological type	Chorological type	CLASS	M	FMU	1	1	1	1	1	1	2	2	2	2	2	2	3	3	3	3	3	3	4	4	4	4	4	4	5	5	5	5	5	5	6	6	6	6	6	6	7	7	7	7	7	7	1e	1e	1e	1e	1e	7e	7e	7e		FMU
										Years	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2016	2016	2017	2017	2015	2015	2015	2015	2016	2015	2016	2016		Years
										Age	0	0	1	1	2	2	3	3	4	4	5	5	7	7	8	8	9	9	12	12	13	13	14	14	17	17	18	18	19	19	27	27	28	28	29	29	37	37	38	38	39	39	0	0	0	0	1	37	38	39		Age
L	T	C	U	R	N					Elevation	750	745	750	745	750	745	770	755	770	755	770	755	732	720	732	720	732	720	720	740	720	740	720	740	710	690	710	690	710	690	745	750	745	750	745	750	710	706	710	706	710	706	780	768	748	796	782	710	710	710	tot	Elevation
5	7	4	5	7	6	P scap	EUROP.-CAUC.	QUFA	9	*Acer campestre* L.	2	2	2	2	2	2	0	0	0	0	0	0	2	0	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	0	0	0	0	0	0	0	2	0	2	2	2	2	2	31	*Acer campestre* L.
6	8	5	3	8	4	P caesp	EURIMEDIT.	QUFA	9	*Acer monspessulanum* L.	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	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	6	*Acer monspessulanum* L.
5	5	6	6	7	7	P scap	SE-EUROP.	QUFA	9	*Acer opalus* Mill. subsp. *obtusatum* (Waldst. & Kit. ex Willd.) Gams	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	2	2	2	2	2	2	48	*Acer opalus* Mill. subsp. *obtusatum* (Waldst. & Kit.
4		4	6		7	P scap	EUROP.-CAUC.	QUFA	9	*Acer pseudoplatanus* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	17	*Acer pseudoplatanus* L.
9		5	5	9	2	Ch suffr	OROF. S-EUROP.	FEBR	5	*Acinos alpinus* (L.) Moench	2	2	2	2	2	2	2	2	2	2	2	2	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	0	0	0	2	0	2	2	0	0	0	0	15	*Acinos alpinus* (L.) Moench
6		4	6		6	H rept	EUROP.-CAUC.	TRGE	7	*Ajuga reptans* L.	0	0	0	0	0	2	0	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	4	*Ajuga reptans* L.
6	9	4	4	6	8	G bulb	W-STENOMEDIT.	QUFA	9	*Allium pendulinum* Ten.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	2	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	0	0	0	0	0	0	2	0	15	*Allium pendulinum* Ten.
2		5	6	7	8	G bulb	EURASIAT.	QUFA	9	*Allium ursinum* L. ssp. *ursinum*	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	0	0	0	0	2	0	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	0	12	*Allium ursinum* L. ssp. *ursinum*
		4		5		G rhiz	CIRCUMBOR.	QUFA	9	*Anemone nemorosa* L.	0	0	0	0	0	0	0	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	5	*Anemone nemorosa* L.
4	5	5	6	6	7	G rhiz	OROF. S-EUROP.	QUFA	9	*Anemone trifolia* L.	0	0	0	0	0	0	2	2	2	2	2	2	2	0	0	0	0	0	2	0	0	0	0	2	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	*Anemone trifolia* L.
		5		5	3	H caesp	EURASIAT.	MOAR	4	*Anthoxanthum odoratum* L.	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	2	2	0	0	0	22	*Anthoxanthum odoratum* L.
6	6	5	4	7	4	H scap	PALEOTEMP.	TRGE	7	*Aquilegia vulgaris* L. subsp. *vulgaris*	0	0	2	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Aquilegia vulgaris* L. subsp. *vulgaris*
7	5	3	4	8	3	H scap	MEDIT.-MONT.	FEBR	5	*Arabis collina* Ten.	0	0	0	0	0	0	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	2	0	2	7	*Arabis collina* Ten.
6	7	6	6	7	3	H bienn	S-EUROP.-SUDSIB.	TRGE	7	*Arabis turrita* L.	0	2	0	2	0	0	2	2	2	2	2	2	2	2	2	2	2	0	2	0	2	2	2	0	2	2	2	0	2	0	2	2	2	2	0	2	2	2	2	2	2	2	0	0	0	0	0	2	0	2	35	*Arabis turrita* L.
11	5	5	5	8	9	H bienn	EURIMEDIT.	ARVU	3	*Arctium minus* (Hill) Bernh.	0	0	0	0	0	0	0	0	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	3	*Arctium minus* (Hill) Bernh.
3	6	5	7	7	8	G rhiz	CENTRO-EUROP.	QUFA	9	*Arum maculatum* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	0	0	2	2	2	20	*Arum maculatum* L.
11	6	7	2	7	2	Ch suffr	OROF. SE-EUROP.	FEBR	5	*Asperula purpurea* (L.) Ehrend.	0	0	0	0	0	0	2	0	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Asperula purpurea* (L.) Ehrend.
6	7	2	4	2	3	H ros	PALEOTEMP. SUBTROP.	ASTR	5	*Asplenium adiantum-nigrum* L.	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	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	6	*Asplenium adiantum-nigrum* L.
3	9	4	3	5	3	H ros	SUBTROP. NESICOLA	QUIL	9	*Asplenium onopteris* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	0	2	0	2	2	2	2	2	2	2	0	0	0	0	0	2	0	0	23	*Asplenium onopteris* L.
5		5	5		4	H ros	COSMOP.	ASTR	5	*Asplenium trichomanes* L. ssp. *quadrivalens* D. E. Meyer	2	2	2	2	2	2	0	0	2	0	2	0	2	0	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	42	*Asplenium trichomanes* L. ssp. *quadrivalens* D. E. Me
6	6	5	5	8	8	H scap	OROF. S-EUROP.	EPAN	0	*Atropa bella-donna* L.	0	0	0	2	2	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	5	*Atropa bella-donna* L.
8	7	5		9	4	T scap	EURIMEDIT.	ARVU	3	*Blackstonia perfoliata* (L.) Hudson ssp. *perfoliata*	2	2	2	2	2	2	2	2	2	2	2	2	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	0	0	0	2	2	2	2	2	0	0	0	17	*Blackstonia perfoliata* (L.) Hudson ssp. *perfoliata*
6	5	5	4	7	4	H caesp	SUBATL.	FEBR	5	*Brachypodium rupestre* (Host) Roem. & Schult	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	23	*Brachypodium rupestre* (Host) Roem. & Schult
4	5	5	5	6	6	H caesp	PALEOTEMP.	QUFA	9	*Brachypodium sylvaticum* (Hudson) Beauv.	2	2	2	2	2	2	2	0	2	2	2	2	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	2	2	0	0	0	26	*Brachypodium sylvaticum* (Hudson) Beauv.
8	5	7	3	8	3	H caesp	PALEOTEMP.	FEBR	5	*Bromus erectus* Hudson	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	23	*Bromus erectus* Hudson
6	5	5	6	8	6	H caesp	EURASIAT.	EPAN	7	*Bromus ramosus* Hudson	0	0	0	0	0	0	2	0	0	0	0	0	2	2	2	2	2	2	0	0	0	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	30	*Bromus ramosus* Hudson
5	7	6	4	8	4	H scap	PONTICA	TRGE	7	*Buglossoides purpurocaerulea* (L.) Johnston	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	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	0	0	0	2	*Buglossoides purpurocaerulea* (L.) Johnston
6	4	4	4	7	3	H scap	ENDEM.	QUFA	9	*Campanula micrantha* Bertol.	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0	0	0	9	*Campanula micrantha* Bertol.
5	5	5	4	8	3	H scap	EURASIAT.	TRGE	7	*Campanula persicifolia* L.	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	2	2	2	0	0	0	2	0	2	2	2	2	2	0	0	0	17	*Campanula persicifolia* L.
7	7	5	4	6	4	H bienn	PALEOTEMP.	FEBR	5	*Campanula rapunculus* L.	2	2	2	2	2	2	2	2	2	2	0	2	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	0	0	0	2	2	2	2	2	0	0	0	16	*Campanula rapunculus* L.
6	5	4	3	7	2	H scap	ENDEM.	ASTR	5	*Campanula tanfanii* Podlech	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	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	0	0	0	2	*Campanula tanfanii* Podlech
4	5	5	5	8	8	H scap	PALEOTEMP.	QUFA	9	*Campanula trachelium* L.	2	2	2	2	2	2	0	0	0	0	0	2	2	0	2	2	2	2	2	2	0	0	2	2	2	2	2	2	2	0	2	0	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	0	2	2	38	*Campanula trachelium* L.
3	5	4	5	7	6	G rhiz	CENTRO-EUROP.	QUFA	9	*Cardamine bulbifera* (L.) Crantz	0	0	0	0	0	0	0	0	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	3	*Cardamine bulbifera* (L.) Crantz
6	5	4	8		5	H scap	CIRCUMBOR.	MOCA	6	*Cardamine flexuosa* With.	0	0	0	0	0	0	0	0	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	3	*Cardamine flexuosa* With.
5	4	4	7	7	7	T scap	N-MEDIT.-MONT.	CHGP	6	*Cardamine graeca* L.	0	0	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Cardamine graeca* L.
5	5	5	6	7	8	T scap	EURASIAT.	QUFA	9	*Cardamine impatiens* L.	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Cardamine impatiens* L.
3	5	5	5	7	7	G rhiz	OROF. SE-EUROP.	QUFA	9	*Cardamine kitaibelii* Becherer	0	0	0	0	0	0	0	2	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	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Cardamine kitaibelii* Becherer
8		5	3	8	6	H bienn	W-EUROP.	ARVU	3	*Carduus nutans* L.	2	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	11	*Carduus nutans* L.
3	5	5	4		3	H caesp	EURASIAT.	QUFA	9	*Carex digitata* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	2	2	2	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	0	25	*Carex digitata* L.
7	5	5	6	8		G rhiz	EUROP.	MOAR	4	*Carex flacca* Schreber ssp. *flacca*	0	0	0	0	0	0	2	2	2	2	2	2	0	2	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	2	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	20	*Carex flacca* Schreber ssp. *flacca*
6		4	2		4	H scap	STENOMEDIT.	ARVU	3	*Carlina corymbosa* L.	0	0	2	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Carlina corymbosa* L.
4	6	4				P scap	C-EUROP.-CAUCAS.	QUFA	9	*Carpinus betulus* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	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	2	*Carpinus betulus* L.
7	6	5	4	5	4	H scap	ENDEM. ALP.	MOAR	4	*Centaurea nigrescens* Willd. subsp. *neapolitana* (Boiss.)	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Centaurea nigrescens* Willd. subsp. *neapolitana* (Boiss
8	6	5	5	6		H bienn	PALEOTEMP.	FEBR	5	*Centaurium erythraea* Rafn ssp. *erythraea*	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	23	*Centaurium erythraea* Rafn ssp. *erythraea*
2	5	4	4	7	4	G rhiz	EURIMEDIT.	QUFA	9	*Cephalanthera damasonium* (Miller) Druce	0	0	0	0	0	0	2	2	0	2	2	2	0	0	2	0	2	0	2	0	2	2	0	0	2	2	2	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	*Cephalanthera damasonium* (Miller) Druce
4	5	5	3	8	3	G rhiz	EURASIAT.	QUFA	9	*Cephalanthera longifolia* (Hudson) Fritsch	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	*Cephalanthera longifolia* (Hudson) Fritsch
3	5	5	4	8	3	G rhiz	EURASIAT.	QUFA	9	*Cephalanthera rubra* (L.) L. C. Rich.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Cephalanthera rubra* (L.) L. C. Rich.
11	7	5	3	7	2	T scap	EURIMEDIT.	SESC	5	*Cerastium brachypetalum* Desportes et Pers.	0	0	0	0	0	0	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	6	*Cerastium brachypetalum* Desportes et Pers.
7		5	5	5	5	T scap	EURIMEDIT.	STME	1	*Cerastium glomeratum* Thuill.	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	0	0	0	0	2	0	2	0	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	7	*Cerastium glomeratum* Thuill.
5	4	4	5	5	7	H bienn	ENDEM.	QUFA	9	*Cerinthe minor* L. subsp. *auriculata* (Ten.) Domac	0	0	0	2	2	2	0	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	6	*Cerinthe minor* L. subsp. *auriculata* (Ten.) Domac
9	7	5	2	7	3	H ros	EURASIAT. TEMP.	ASTR	5	*Ceterach officinarum* Willd. subsp. *officinarum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	8	*Ceterach officinarum* Willd. subsp. *officinarum*
5	6	5	5		8	T scap	EURASIAT.	GAUR	6	*Chaerophyllum temulum* L.	0	0	0	0	0	0	0	0	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	3	*Chaerophyllum temulum* L.
7	6	6	3	6	5	H bienn	SE-EUROP.	ARVU	3	*Cirsium italicum* (Savi) DC.	2	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	12	*Cirsium italicum* (Savi) DC.
8	5	5	5		8	H bienn	PALEOTEMP.	ARVU	3	*Cirsium vulgare* (Savi) Ten. ssp. *vulgare*	2	2	2	2	2	2	0	2	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	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	12	*Cirsium vulgare* (Savi) Ten. ssp. *vulgare*
7	7	4	5	7	7	P lian	EUROP.-CAUC.	RHPR	8	*Clematis vitalba* L.	0	0	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	2	39	*Clematis vitalba* L.
						H scap	CIRCUMBOR.	TRGE	7	*Clinopodium vulgare* L. ssp. *arundanum* (Boiss.) Nyman	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2	0	2	2	2	2	2	2	2	2	2	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	*Clinopodium vulgare* L. ssp. *arundanum* (Boiss.) Ny
7	5	4	4	7	3	H scap	CIRCUMBOR.	TRGE	7	*Clinopodium vulgare* L. ssp. *vulgare*	0	0	0	0	2	2	2	2	2	2	2	2	0	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	17	*Clinopodium vulgare* L. ssp. *vulgare*
6	7	6	5	8	4	P caesp	S-EUROP.-SUDSIB.	QUFA	9	*Cornus mas* L.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	*Cornus mas* L.
7	5	5	7	8		P caesp	EURASIAT.	RHPR	8	*Cornus sanguinea* L.	2	2	2	2	2	2	0	0	2	0	2	0	2	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	0	0	2	0	2	2	2	2	2	2	16	*Cornus sanguinea* L.
6	5	4	5	5	8	P caesp	EUROP.-CAUC.	QUFA	9	*Corylus avellana* L.	2	2	2	2	2	2	2	2	0	2	0	2	2	2	2	2	2	2	0	2	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	39	*Corylus avellana* L.
6	6	5	5	5	4	P caesp	CENTRO-EUROP.	RHPR	8	*Crataegus laevigata* (Poiret) DC.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	30	*Crataegus laevigata* (Poiret) DC.
6	7	5	4	6	3	P caesp	PALEOTEMP.	RHPR	8	*Crataegus monogyna* Jacq. ssp. *monogyna*	2	2	2	2	2	2	2	2	2	2	2	2	2	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	0	0	0	2	2	2	2	0	0	0	17	*Crataegus monogyna* Jacq. ssp. *monogyna*
5	8	4	4	3	7	H ros	W-MEDIT.-MONT.	CILA	8	*Crepis leontodontoides* All.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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	0	1	*Crepis leontodontoides* All.
5	6	5	5	6	6	H scap	EURASIAT.	TRGE	7	*Cruciata glabra* (L.) Ehrend.	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	0	0	2	2	2	2	2	2	2	2	0	0	2	0	0	0	0	0	0	2	0	0	0	2	2	2	2	2	2	2	2	2	2	36	*Cruciata glabra* (L.) Ehrend.
7	6	5	5	5	5	H scap	EURASIAT.	ARVU	3	*Cruciata laevipes* Opiz	2	2	2	2	2	2	0	0	0	2	2	0	2	0	2	2	0	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	2	2	2	20	*Cruciata laevipes* Opiz
4	8	5	5	5	5	G bulb	N-STENOMEDIT.	QUFA	9	*Cyclamen hederifolium* Aiton	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2	2	2	0	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	29	*Cyclamen hederifolium* Aiton
4	9	5	3		5	G bulb	NW-STENOMEDIT.	QUIL	9	*Cyclamen repandum* S. et S.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	2	0	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	28	*Cyclamen repandum* S. et S.
6	5	3	6	4	5	P caesp	OROF. SW-EUROP.	RHPR	8	*Cytisophyllum sessilifolium* (L.) O. Lang	0	0	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Cytisophyllum sessilifolium* (L.) O. Lang
7	6	5	4	5	6	H caesp	PALEOTEMP.	MOAR	4	*Dactylis glomerata* L.	2	2	2	2	2	2	2	2	2	2	2	2	0	0	2	2	0	2	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	30	*Dactylis glomerata* L.
						G bulb	Paleotemp.	(Druce)Hyl.		*Dactylorhiza maculata* subsp. *fuchsii*	0	0	0	0	0	0	0	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	*Dactylorhiza maculata* subsp. *fuchsii*
7	5	5	5		4	G bulb	Paleotemp.	(L.)Soò		*Dactylorhiza maculata* subsp. *maculata*	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	8	*Dactylorhiza maculata* subsp. *maculata*
6	6	4	4	8	3	P caesp	SUBATL.	QUFA	9	*Daphne laureola* L.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2	2	2	44	*Daphne laureola* L.
8	6	5	4	5	4	H bienn	PALEOTEMP.	ARVU	3	*Daucus carota* L.	2	2	2	2	2	2	2	0	2	0	0	2	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	0	0	0	2	2	2	2	0	0	0	0	13	*Daucus carota* L.
6	7	5	4	2	5	H scap	OROF. S-EUROP.	FEBR	5	*Dianthus monspessulanus* L.	0	0	0	0	0	0	0	0	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	2	*Dianthus monspessulanus* L.
8	6	5	5	8	5	H scap	ENDEM.	TRGE	7	*Digitalis lutea* L. subsp. *australis* (Ten.) Arcang	0	0	0	2	0	2	2	2	2	2	2	2	0	2	0	0	0	0	0	0	0	0	2	0	2	2	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	29	*Digitalis lutea* L. subsp. *australis* (Ten.) Arcang
6	8	5	7	5	5	H bienn	EURIMEDIT.	ARVU	3	*Dipsacus fullonum* L.	2	2	2	2	2	2	0	0	2	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	0	0	0	0	0	0	2	0	2	2	2	0	0	0	11	*Dipsacus fullonum* L.
7	8	5	3	7	2	Ch suffr	EURIMEDIT.	ROOF	8	*Dorycnium hirsutum* (L.) Ser.	0	0	0	0	0	0	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	3	*Dorycnium hirsutum* (L.) Ser.
5	4	4	6	7	8	H caesp	CIRCUMBOR.	QUFA	9	*Elymus caninus* (L.) L. s.l.	0	0	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Elymus caninus* (L.) L. s.l.
7	6	4	3	9	2	NP	CENTRO-EUROP.	RHPR	8	*Emerus majus* Mill. s.l.	2	2	2	2	2	2	0	0	0	0	0	0	2	0	2	2	2	2	2	0	0	0	0	0	2	2	2	0	2	0	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	0	0	0	27	*Emerus majus* Mill. s.l.
6	4	5	5	4	4	H scap	EURASIAT.	EPAN	7	*Epilobium montanum* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	*Epilobium montanum* L.
3	5	5	5	7	5	G rhiz	PALEOTEMP.	QUFA	9	*Epipactis helleborine* (L.) Crantz subsp *helleborine*	0	0	0	0	0	0	2	2	2	2	2	2	0	2	0	0	2	0	0	0	0	2	0	2	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	*Epipactis helleborine* (L.) Crantz subsp *helleborine*
9	7	6	2	7	3	H scap	ENDEM.	FEBR	5	*Erysimum pseudorhaeticum* Polatschek	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Erysimum pseudorhaeticum* Polatschek
6	5	5	5	8	5	P caesp	EURASIAT.	RHPR	8	*Euonymus europaeus* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	15	*Euonymus europaeus* L.
4	5	4	5	7	6	Ch suffr	EUROP.-CAUCAS.	QUFA	9	*Euphorbia amygdaloides* L. ssp. amygdaloides	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0	0	0	0	2	2	0	2	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	38	*Euphorbia amygdaloides* L. ssp. amygdaloides
4	5	5	5	8	5	G rhiz	CENTRO-EUROP.	QUFA	9	*Euphorbia dulcis* L. ssp. *purpurata* (Thuill.) Rothm.	0	0	0	0	0	0	0	2	2	0	2	0	2	2	0	0	2	0	2	2	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	20	*Euphorbia dulcis* L. ssp. *purpurata* (Thuill.) Rothm.
3	5	4	5		7	P scap	CENTRO-EUROP.	QUFA	9	*Fagus sylvatica* L.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	44	*Fagus sylvatica* L.
5	5	4	4	5	4	H caesp	EUROP.-CAUC.	QUFA	9	*Festuca heterophylla* Lam.	2	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	2	2	2	2	45	*Festuca heterophylla* Lam.
6		4	4		5	H rept	EUROSIB.	EPAN	7	*Fragaria vesca* L.	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	0	2	0	2	2	24	*Fragaria vesca* L.
6	7	5	4	7	4	H rept	EUROSIB.	TRGE	7	*Fragaria viridis* Duchesne	0	0	0	0	0	0	2	2	2	2	2	2	0	0	2	2	0	0	2	0	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	14	*Fragaria viridis* Duchesne
5	8	6	3	8	3	P scap	S-EUROP.-SUDSIB.	QUFA	9	*Fraxinus ornus* L.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	*Fraxinus ornus* L.
5	7	4		7	7	G bulb	EUROP.-CAUC.	QUFA	9	*Galanthus nivalis* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	0	0	0	0	0	0	0	0	6	*Galanthus nivalis* L.
7	8	7	6	5	6	H scap	E-EUROP.-PONTICA	ARVU	3	*Galega officinalis* L.	0	0	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Galega officinalis* L.
6		5	4	5	5	T scap	EURASIAT.	GAUR	6	*Galium aparine* L.	0	0	0	0	0	0	0	2	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Galium aparine* L.
6	5	5	5	5	4	H scap	EURIMEDIT.	MOAR	4	*Galium mollugo* L.	0	0	0	2	0	0	0	0	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Galium mollugo* L.
2	5	4	5		5	G rhiz	EUROP.-CAUC.	QUFA	9	*Galium odoratum* (L.) Scop.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	*Galium odoratum* (L.) Scop.
5	6	5	5	3	3	Ch suffr	EURASIAT.	MOAR	4	*Genista tinctoria* L. ssp. *tinctoria*	0	0	0	0	0	0	2	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Genista tinctoria* L. ssp. *tinctoria*
7	9	6	2	5	2	T scap	S-EUROP.-SUDSIB.	ARVU	3	*Geranium columbinum* L.	0	0	0	0	0	0	0	2	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Geranium columbinum* L.
7	8	5	2	5	2	T scap	EURASIAT.	STME	1	*Geranium dissectum* L.	0	0	0	0	0	0	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Geranium dissectum* L.
7	6	5	3	5	4	T scap	EURASIAT.	ARVU	3	*Geranium molle* L.	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Geranium molle* L.
4	4	4	6	6	6	G rhiz	N-MEDIT.-MONT.	QUFA	9	*Geranium nodosum* L.	0	0	0	0	0	0	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	6	*Geranium nodosum* L.
7	8	5	3	6	3	T scap	EURIMEDIT.	ARVU	3	*Geranium purpureum* Vill.	2	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	7	*Geranium purpureum* Vill.
4	6	5	4	5	5	T scap	SUBCOSMOP.	GAUR	6	*Geranium robertianum* L.	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	0	0	2	0	2	0	2	2	2	0	2	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	36	*Geranium robertianum* L.
7	8	5	3	6	3	T scap	PALEOTEMP.	ARVU	3	*Geranium rotundifolium* L.	0	0	0	2	0	0	2	0	2	2	2	2	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	2	2	2	2	0	0	0	0	0	2	2	2	13	*Geranium rotundifolium* L.
4	5	5	5	6	7	H scap	CIRCUMBOR.	GAUR	6	*Geum urbanum* L.	2	2	2	2	2	2	2	2	0	2	0	0	2	2	2	0	2	0	2	2	2	2	0	0	0	0	0	0	2	0	2	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	35	*Geum urbanum* L.
4	5	4	5			P lian	EURIMEDIT.	QUFA	9	*Hedera helix* L.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	*Hedera helix* L.
9		6	4	7	2	Ch suffr	EUROP.-CAUCAS.	FEBR	5	*Helianthemum nummularium* (L.) Miller ssp. *nummularium*	0	0	0	0	2	0	2	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Helianthemum nummularium* (L.) Miller ssp. *nummula*
5	5	4	6	7	6	G rhiz	ENDEM.	TRGE	7	*Helleborus bocconei* Ten. ssp. *bocconei*	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	27	*Helleborus bocconei* Ten. ssp. *bocconei*
4	6	4	4	7		G rhiz	CIRCUMBOR.	QUFA	9	*Hepatica nobilis* Miller	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	34	*Hepatica nobilis* Miller
8		4	3	4	2	H ros	EUROP.-CAUC.	FEBR	5	*Hieracium pilosella* L.	0	0	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	6	*Hieracium pilosella* L.
5	6	4	4	6	3	H caesp	EUROP.-CAUC.	QUFA	9	*Hypericum montanum* L.	0	0	0	0	0	0	2	2	2	2	2	2	2	0	2	2	0	2	2	2	2	0	0	0	2	0	0	2	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	0	0	2	2	2	20	*Hypericum montanum* L.
7	8	6				H scap	PALEOTEMP.	FEBR	5	*Hypericum perforatum* L.	2	2	2	2	2	2	2	2	2	2	2	2	0	2	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	0	2	2	0	2	0	0	0	0	16	*Hypericum perforatum* L.
11	9	4	2		2	T scap	STENOMEDIT.	TUGU	2	*Hypochoeris achyrophorus* L.	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	5	*Hypochoeris achyrophorus* L.
6	6	4	4	7	3	H bienn	EUROP.-CAUC.	TRGE	7	*Inula conyzae* (Griess.) Meikle	2	2	2	2	2	2	2	2	2	2	0	2	0	2	2	0	2	0	2	0	2	2	2	0	2	2	2	2	2	2	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	40	*Inula conyzae* (Griess.) Meikle
8	0	0	4	0	4	P caesp	CIRCUMBOR.	RHPR	8	*Juniperus communis* L.	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Juniperus communis* L.
7	5	5	4	5	3	H scap	EURASIAT.	MOAR	4	*Knautia arvensis* (L.) Coulter	0	0	0	0	0	0	0	2	2	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Knautia arvensis* (L.) Coulter
7	4	4	4		2	H scap	W-MEDIT.-MONT.	QUFA	9	*Knautia purpurea* (Vill.) Borbas	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	2	*Knautia purpurea* (Vill.) Borbas
5	4	5	6	6	5	P caesp	OROF. S-EUROP.	QUFA	9	*Laburnum alpinum* (Miller) Berchtold et Presl	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	0	0	2	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	0	0	0	7	*Laburnum alpinum* (Miller) Berchtold et Presl
5	6	6	5	7	7	P caesp	S-EUROP.-SUDSIB.	QUFA	9	*Laburnum anagyroides* Medicus	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	*Laburnum anagyroides* Medicus
4	5	4	5		6	H scap	EUROP.-CAUC.	QUFA	9	*Lactuca muralis* (L.) Gaertn.	2	2	2	2	2	2	2	2	0	2	0	2	2	2	2	2	2	2	0	0	0	2	2	2	0	0	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	42	*Lactuca muralis* (L.) Gaertn.
2	4	5	5	7	5	H scap	EUROP.-CAUC.	QUFA	9	*Lamiastrum galeobdolon* ssp. *flavidum* (F.Hermann) Ehrend. et Pola.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	2	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	11	*Lamiastrum galeobdolon* ssp. *flavidum* (F.Hermann) I
5		5	5		7	T scap	PALEOTEMP.	GAUR	6	*Lapsana communis* L.	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Lapsana communis* L.
7		5		7	4	H scap	EUROP.	TRGE	7	*Laserpitium latifolium* L.	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Laserpitium latifolium* L.
7	5		6	7	6	H scap	PALEOTEMP.	MOAR	4	*Lathyrus pratensis* L.	0	0	0	0	0	0	0	2	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Lathyrus pratensis* L.
4	7	6	5	7	7	G rhiz	S-EUROP.-SUDSIB.	QUFA	9	*Lathyrus venetus* (Miller) Wohlf.	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	*Lathyrus venetus* (Miller) Wohlf.
4	4	5	4	7		G rhiz	EURASIAT.	QUFA	9	*Lathyrus vernus* (L.) Bernh. ssp. *vernus*	0	0	0	0	0	0	2	0	0	2	0	2	0	2	0	2	0	2	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	0	0	0	0	0	6	*Lathyrus vernus* (L.) Bernh. ssp. *vernus*
7		4	4		3	H scap	EUROSIB.	FEBR	5	*Leucanthemum vulgare* Lam. Subsp. *vulgare*	0	0	0	0	0	0	2	2	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	4	*Leucanthemum vulgare* Lam. Subsp. *vulgare*
						G bulb	OROF. CENTRO-EUROP.	TRGE	7	*Lilium bulbiferum* L. ssp. *croceum* (Chaix)Nyman	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	2	2	2	2	2	0	0	0	16	*Lilium bulbiferum* L. ssp. *croceum* (Chaix)Nyman
	7	5	4	8	0	G rhiz	EURIMEDIT.	QUFA	9	*Limodorum abortivum* (L.) Swartz	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	2	*Limodorum abortivum* (L.) Swartz
8	5	5	3	7	3	H scap	EURASIAT.	ARVU	3	*Linaria vulgaris* Miller subsp. *vulgaris*	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Linaria vulgaris* Miller subsp. *vulgaris*
7		5			1	T scap	EURIMEDIT.	FEBR	5	*Linum catharticum* L.	2	2	2	2	2	2	2	2	2	2	2	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	0	0	0	0	0	2	2	2	2	0	0	0	15	*Linum catharticum* L.
7		5	4	8	3	H scap	OROF. S-EUROP.	FEBR	5	*Linum viscosum* L.	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Linum viscosum* L.
4	4	5	6	7	5	G rhiz	EURASIAT.	MOAR	4	*Listera ovata* (L.) R.Br.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	2	2	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	*Listera ovata* (L.) R.Br.
5	5	4	5	7		P caesp	EUROP.-CAUC.	QUFA	9	*Lonicera xylosteum* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	2	2	2	27	*Lonicera xylosteum* L.
7		5	4	7	2	H scap	PALEOTEMP.	MOAR	4	*Lotus corniculatus* L. subsp. *curniculatus*	0	0	0	0	2	0	2	2	2	2	2	2	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	0	0	2	0	0	0	0	0	0	0	0	8	*Lotus corniculatus* L. subsp. *curniculatus*
4	7	5	4	4	5	H caesp	EURIMEDIT.	QUFA	9	*Luzula forsteri* (Sm.) DC.	2	2	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	2	2	48	*Luzula forsteri* (Sm.) DC.
7	5		4	8	7	T scap	PALEOTEMP.	FEBR	5	*Medicago lupulina* L.	2	2	2	2	2	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0	0	0	15	*Medicago lupulina* L.
3	5	5	5	6		H caesp	PALEOTEMP.	QUFA	9	*Melica uniflora* Retz.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	*Melica uniflora* Retz.
5	6	5	4	7	3	H scap	C-EUROP.	QUFA	9	*Melittis melissophyllum* L.	0	0	0	0	0	0	2	0	0	2	0	2	2	2	2	2	2	2	2	2	0	0	2	0	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	2	2	2	27	*Melittis melissophyllum* L.
2	5	4		7	7	G rhiz	EUROP.-CAUC.	QUFA	9	*Mercurialis perennis* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	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	6	*Mercurialis perennis* L.
4	7	5	6	4	8	T scap	EURIMEDIT.	QUIL	9	*Moehringia pentandra* Gay	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	2	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	0	0	2	2	0	5	*Moehringia pentandra* Gay
4	5	5	5	6	7	T scap	EURASIAT.	QUFA	9	*Moehringia trinervia subsp trinervia* (L.) Clairv.	0	0	0	0	0	0	0	2	0	2	0	2	0	0	2	2	0	2	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	0	0	2	2	2	9	*Moehringia trinervia subsp trinervia* (L.) Clairv.

						G bulb	Medit.Atl.	FEBR	5	*Orchis anthropophora* (L.) All.	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Orchis anthropophora* (L.) All.
8	8	4	3	7	5	T scap	STENOMEDIT.	0		*Orlaya daucoides* (L.) Greuter	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	2	*Orlaya daucoides* (L.) Greuter
						G bulb	Endem.	ARVU	3	*Ornithogalum etruscum* Parl. subsp. *etruscum*	0	0	0	0	0	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	6	*Ornithogalum etruscum* Parl. subsp. *etruscum*
5	5	5	6	5	5	G bulb	EURIMEDIT.	QUFA	9	*Ornithogalum pyrenaicum* L. subsp. *pirenaicum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	0	0	0	0	0	2	0	0	2	0	0	0	0	0	2	0	0	0	2	0	0	0	0	0	2	0	0	7	*Ornithogalum pyrenaicum* L. subsp. p*irenaicum*
8		4	4		4	T par	EUROP.-CAUC.	FEBR	5	*Orobanche gracilis* Sm.	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Orobanche gracilis* Sm.
4	8	4	4			P caesp	CIRCUMBOR.	QUFA	9	*Ostrya carpinifolia* Scop.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	50	*Ostrya carpinifolia* Scop.
						H bienn	EUROSIB.	ARVU	3	*Pastinaca sativa* L. ssp. *urens* (Req.) Celak	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Pastinaca sativa* L. ssp. *urens* (Req.) Celak
8		5	4	8	4	H scap	EUROSIB.	ARVU	3	*Picris hieracioides* L. subsp *hieracioides*	0	0	0	0	0	0	2	2	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	0	2	2	2	2	2	2	0	0	0	0	0	0	2	0	9	*Picris hieracioides* L. subsp *hieracioides*
3	5	5	5	4	6	H caesp	EURIMEDIT.	QUFA	9	*Poa sylvicola* Guss.	0	0	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Poa sylvicola* Guss.
6		5	7		7	H caesp	EURASIAT.	MOAR	4	*Poa trivialis* L.	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Poa trivialis* L.
						H scap	EURIMEDIT.	FEBR	5	*Polygala nicaeensis* Risso ssp. *mediterranea* Chodat	0	0	0	0	0	0	2	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Polygala nicaeensis* Risso ssp. *mediterranea* Chodat
3	7	5	3	3	5	H ros	PALEOTROP.	QUFA	9	*Polypodium interjectum* Shivas	2	2	2	2	2	2	0	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	48	*Polypodium interjectum* Shivas
3	6	4	6	6	5	G rhiz	CIRCUMBOR.	QUFA	9	*Polystichum setiferum* (Forsskal) Woynar	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	0	2	2	2	2	2	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	27	*Polystichum setiferum* (Forsskal) Woynar
5	6	5	4	8	4	H ros	EURIMEDIT.	TRGE	7	*Potentilla micrantha* Ramond	0	0	0	0	0	0	2	0	0	0	2	0	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	2	2	2	17	*Potentilla micrantha* Ramond
6	5	4	5	7	5	H ros	EUROP.-CAUC.	QUFA	9	*Primula vulgaris* Huds. subsp. *vulgaris*	2	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	0	0	2	2	2	2	0	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	39	*Primula vulgaris* Huds. subsp. *vulgaris*
8	8	5	3	7	2	H scap	EURIMEDIT.	FEBR	5	*Prunella laciniata* (L.) L.	0	0	0	0	2	0	2	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Prunella laciniata* (L.) L.
7	6	4	6	4		H scap	CIRCUMBOR.	FEBR	5	*Prunella vulgaris* L.	0	0	0	0	0	0	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	3	*Prunella vulgaris* L.
7	5	5				P caesp	EUROP.-CAUC.	RHPR	8	*Prunus spinosa* L.	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Prunus spinosa* L.
7	8	6	3	7	4	P caesp	SE-EUROP.	QUFA	9	*Quercus pubescens* subsp. *pubescens* Willd.	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	2	2	0	2	2	2	2	0	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	40	*Quercus pubescens* subsp. p*ubescens* Willd.
3		4	6	7	7	H scap	EUROP.-CAUC.	QUFA	9	*Ranunculus lanuginosus* L.	0	0	0	2	0	0	2	2	2	2	2	2	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	2	2	2	2	0	0	0	0	0	0	0	0	11	*Ranunculus lanuginosus* L.
8	7	4	4	7	3	H scap	MEDIT.-MONT.	FEBR	5	*Ranunculus millefoliatus* Vahl	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Ranunculus millefoliatus* Vahl
7	8	4	3	6	2	H scap	STENOMEDIT.	STME	1	*Reichardia picroides* (L.) Roth	0	0	0	0	0	2	2	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	4	*Reichardia picroides* (L.) Roth
5	5	5	5	7	5	NP	S-MEDIT.-SUBATL.	QUFA	9	*Rosa arvensi*s Hudson	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Rosa arvensi*s Hudson
						NP	W-Medit.-Mont.	RHPR	8	*Rosa corymbifera* Borkh.	0	0	0	0	2	0	2	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	5	*Rosa corymbifera* Borkh.
7	5	5	3	5	3	NP	S-EUROP.-SUDSIB.	RHPR	8	*Rosa micrantha* Sm.	0	2	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	0	2	2	2	2	0	0	0	0	0	0	0	2	0	2	0	2	2	2	2	2	2	2	0	0	0	0	0	2	2	2	22	*Rosa micrantha* Sm.
7	6	4	4	5	7	NP	S- E C-EUROP.	RHPR	8	*Rubus hirtus* W. et K.	2	0	0	0	0	0	2	2	2	2	2	2	0	2	2	2	2	2	0	2	2	2	2	2	2	2	2	2	2	2	0	0	0	0	0	0	2	2	2	2	2	2	2	0	2	2	2	2	2	2	36	*Rubus hirtus* W. et K.
8				4	5	H scap	CIRCUMBOR.	MOAR	4	Rumex *acetosa* L. subsp. *acetosa*	0	0	0	2	0	0	0	0	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	3	Rumex *acetosa* L. subsp. *acetosa*
8	7	5	7		8	H scap	EURASIAT.	ARVU	3	*Rumex conglomeratus* Murray	0	2	0	0	0	0	0	0	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	5	*Rumex conglomeratus* Murray
4	8	5	4	5	5	G rhiz	EURIMEDIT.	QUIL	9	*Ruscus aculeatus* L.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	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	0	0	0	1	*Ruscus aculeatus* L.
						H scap	Paleotemp.	FEBR	5	*Sanguisorba minor* subsp. *balearica* (Nyman) Muñoz Garm. & C. Navarro	2	2	2	2	2	2	0	2	2	2	2	2	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	0	0	0	2	0	2	2	2	0	0	0	15	*Sanguisorba minor* subsp. *balearica* (Nyman) Muñoz Garm. & C. Navarro
4	5	5	5	8	6	H scap	PALEOTEMP.	QUFA	9	*Sanicula europaea* L.	2	0	0	0	0	0	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	2	43	*Sanicula europaea* L.
5	4	5	6	8	6	H scap	OROF. S-EUROP.	QUFA	9	*Saxifraga rotundifolia* L.	0	0	0	0	0	0	0	0	0	0	0	0	2	2	2	2	2	2	2	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	0	0	0	0	7	*Saxifraga rotundifolia* L.
8	5	5	4	8	2	H scap	EURASIAT.	FEBR	5	*Scabiosa columbaria* L.	0	0	0	0	2	0	0	0	0	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	3	*Scabiosa columbaria* L.
7	5	4	3	6	2	H scap	ENDEM.	FEBR	5	*Scabiosa uniseta* Savi	0	0	0	0	0	0	2	2	2	0	2	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	2	0	2	0	2	0	0	0	0	0	0	0	0	0	7	*Scabiosa uniseta* Savi
6	8	4	4	3	5	H scap	NE-MEDIT.-MONT.	QUFA	9	*Scutellaria columna*e All. ssp. columnae	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	2	2	2	2	0	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	*Scutellaria columna*e All. ssp. columnae
11		5	2		1	Ch succ	EURIMEDIT.	SESC	5	*Sedum album* L.	0	0	0	0	0	0	0	0	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	2	*Sedum album* L.
7	5	4	2	4	1	Ch succ	W- E C-EUROP.	FEBR	5	*Sedum rupestre* L. ssp. *rupestre*	0	0	2	0	0	0	2	0	2	0	2	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	2	2	2	2	2	2	0	0	0	0	0	0	0	0	10	*Sedum rupestre* L. ssp. *rupestre*
11	5	4	2	6	1	H caesp	ENDEM.	FEBR	5	*Sesleria nitida* Ten.	2	2	2	2	2	2	2	0	2	0	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	46	*Sesleria nitida* Ten.
7	6	X	4	X	7	Tscap	COSMOP.	STME	0	*Setaria italica* (L.) P.Beauv	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	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	0	0	0	0	0	0	0	2	4	*Setaria italica* (L.) P.Beauv
						0	OROF. SE-EUROP.	THRO	5	*Silene vulgaris* (Moench) Garcke ssp. *prostrata* (Gaudin)Sch. et Th.	2	2	2	2	2	2	2	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	0	0	2	2	0	0	2	2	2	2	2	2	2	0	0	0	16	*Silene vulgaris* (Moench) Garcke ssp. *prostrata* (Gaudin)Sch. et Th.
5			5		5	H scap	CIRCUMBOR.	EPAN	7	Solidago *virgaurea* L. ssp. *virgaurea*	0	0	0	2	0	0	0	0	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	0	4	Solidago *virgaurea* L. ssp. *virgaurea*
7	5		4	7	7	T scap	EURASIAT.	STME	1	*Sonchus asper* (L.) Hill ssp. *asper*	2	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	2	2	0	2	2	0	0	0	10	*Sonchus asper* (L.) Hill ssp. *asper*
6	5	5	4	7	3	P caesp	PALEOTEMP.	QUFA	9	*Sorbus aria* (L.) Crantz	2	2	2	2	2	2	2	2	0	2	0	2	2	2	0	0	0	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	43	*Sorbus aria* (L.) Crantz
4	7	5	3	8	3	P scap	EURIMEDIT.	QUFA	9	*Sorbus domestica* L.	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	2	2	2	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	2	2	2	10	*Sorbus domestica* L.
6			4	7	8	T rept	COSMOP.	STME	1	*Stellaria media* (L.) Vill. ssp. *media*	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	0	2	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	0	0	0	0	0	2	2	2	14	*Stellaria media* (L.) Vill. ssp. *media*
4	4	4	7	5	7	H scap	EUROP.-CAUC.	QUFA	9	*Stellaria nemorum* L. subsp. *montana* (Pierrat) Berher	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	2	2	2	2	0	2	0	0	2	0	0	0	0	0	2	2	2	12	*Stellaria nemorum* L. subsp. *montana* (Pierrat) Berher
5	7	5	5	8	6	G rad	EURIMEDIT.	RHPR	8	*Tamus communis* L.	0	0	0	0	0	0	0	0	0	2	0	2	2	2	2	2	2	2	0	0	0	2	2	2	2	2	2	2	2	2	0	2	0	2	0	2	0	0	0	2	0	0	0	0	0	0	0	2	2	2	24	*Tamus communis* L.
7	6	5	3	8	4	H scap	EURIMEDIT.	TRGE	7	*Tanacetum corymbosum* (L.) Sch.-Bip.	0	0	0	0	0	0	2	2	2	2	2	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	2	0	2	0	0	0	0	0	0	0	0	0	7	*Tanacetum corymbosum* (L.) Sch.-Bip.
7	6	5	2	8	1	Ch suffr	EURIMEDIT.	FEBR	5	*Teucrium chamaedrys* L.	0	0	0	0	2	0	2	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	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	4	*Teucrium chamaedrys* L.
7	8	5	4	7	6	T scap	SUBCOSMOP.	STME	1	*Torilis arvensis* (Hudson) Link ssp. *arvensis*	0	0	0	0	0	0	0	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	3	*Torilis arvensis* (Hudson) Link ssp. *arvensis*
8	5	5	4		3	T scap	PALEOTEMP.	SESC	5	*Trifolium campestre* Schreber	0	0	0	0	0	0	0	2	2	2	2	2	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	0	0	0	0	0	0	0	0	0	0	0	5	*Trifolium campestre* Schreber
6	6	4	5	5	4	T scap	EUROP.-CAUC.	MOAR	4	*Trifolium dubium* Sibth.	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Trifolium dubium* Sibth.
7		6	3	8	2	H scap	S-EUROP.-SUDSIB.	FEBR	5	*Trifolium montanum* L.	0	0	0	0	0	0	0	2	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	3	*Trifolium montanum* L.
7	5	6	4	8	2	H caesp	S-EUROP.-SUDSIB.	FEBR	5	*Trifolium ochroleucum* Hudson	0	0	0	0	0	0	2	0	2	2	2	2	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	2	2	2	0	0	0	0	0	0	0	0	0	8	*Trifolium ochroleucum* Hudson
7		4				H scap	EUROSIB.	MOAR	4	*Trifolium pratense* L. ssp. *pratense*	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Trifolium pratense* L. ssp. *pratense*
7	5	5	5	7		T scap	EURIMEDIT.	STME	1	*Valerianella locusta* (L.) Laterrade	0	0	0	0	0	0	0	0	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	0	1	*Valerianella locusta* (L.) Laterrade
7	7	5	4	3	2	T scap	EURIMEDIT.	STME	1	*Veronica cymbalaria* Bodard	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	*Veronica cymbalaria* Bodard
5		5	4	2	3	H rept	EURASIAT.	QUFA	9	*Veronica officinalis* L.	0	0	2	0	0	0	2	0	2	0	2	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	0	0	0	0	0	0	0	0	0	0	0	0	4	*Veronica officinalis* L.
8	7	5	4	7	2	H caesp	EURASIAT.	QUFA	9	*Veronica prostrata* L. subsp. p*rostrata*	0	2	0	0	0	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	2	0	6	*Veronica prostrata* L. subsp. p*rostrata*
5	8	5	5	7	6	H ros	STENOMEDIT.	QUFA	9	*Viola alba* Besser ssp. *dehnhardtii* (Ten.) W. Becker	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	2	2	49	*Viola alba* Besser ssp. *dehnhardtii* (Ten.) W. Becker
4	5	4	5	7	6	H scap	EUROSIB.	QUFA	9	*Viola reichenbachiana* Jordan ex Boreau	2	0	0	0	0	0	2	2	0	2	0	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	0	2	0	2	2	2	2	41	*Viola reichenbachiana* Jordan ex Boreau
5		5	5	3		H scap	EUROP.	QUFA	9	*Viola riviniana* Rchb.	2	0	0	0	0	0	2	2	2	2	2	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	0	0	0	2	2	2	0	2	0	0	0	14	*Viola riviniana* Rchb.

Appendix E2. Soil seed bank dataset. Mt. Nerone, Italy

FMU	Total number of visible seeds (sample 1)	Viable seeds (sample 1)	Total number of visible seeds (sample 2)	Viable seeds (sample 2)	Everage number of visible seeds for sample	Everage number of viable seeds for sample	Everage vitality (%)	Everage number of seeds/m^2	Prevailing depth (cm)
1	385	135	311	96	348	116	33.189	1706.7	0 - 8
2	924	906	1182	1135	1053	1021	96.913	4680	0 - 2
3	774	735	796	756	785	746	94.968	3488.9	1 - 4
4	586	486	560	454	573	470	82.024	2546.7	2 - 6
5	515	407	541	395	528	401	75.946	2346.7	2 - 8
6	428	205	442	230	435	218	50.000	1933.3	3 - 7
7	221	7	153	11	187	9	4.812	831.1	5 - 10

7	2.5	3.0			1.0	2.5	3.0			1.0

	oct, 15					oct, 15				
FMU	A mollic	OH	OFr	Olv	OLn	A mollic	OH	OFr	Olv	OLn
1	1.3	0.8			1.0	0.7	1.0			1.0
2	1.5	1.8	2.0	2.0	2.5	1.5	1.2	2.0	2.0	2.5
3	3.0	1.0	1.0	3.0	4.0	3.0	1.0	1.0	3.0	4.0
4	3.0	3.0	2.5	3.5	3.0	3.0	3.0	2.5	3.5	3.0
5	3	2	1	3	2.0	3.0	2.0	1.0	3.0	2.0
6	2.5	1.8	0.5	1.4	1.3	2.5	1.8	0.9	1.0	1.3
7	3.0	3.0			1.0	2.0	3.0			1.0

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	may, 16					may, 16				
FMU	A mollic	OH	OFr	Olv	OLn	A mollic	OH	OFr	Olv	OLn
1	1.0	0.5		1.5	1.0	1.0	0.5		1.5	1.6
2	1.0	1.0	1.5	2.5	1.5	1.0	1.0	1.5	2.5	1.5
3	3.0	1.0	2.7	3.0	4.0	3.0	1.0	2.3	3.0	4.0
4	2.5	2.5	2.0	2.5	2.5	2.5	2.5	2.0	2.5	2.5
5	3.0	2.5	1.0	3.5	2.5	3.0	2.5	1.0	3.5	1.5
6	2.5	2.0	0.8	0.8	1.0	2.5	2.0	1.2	1.2	1.0
7	3.0	3.0			1.5	3.0	3.0			1.5

	nov, 16					nov, 16				
FMU	A mollic	OH	OFr	Olv	OLn	A mollic	OH	OFr	Olv	OLn
1	1.0	0.5		1.5	2.0	1.0	0.5		1.5	2.0
2	1.5	1.0	2.5	2.5	2.5	1.5	1.0	2.5	2.5	2.5
3	4.0	0.8	3.0	3.0	3.0	4.0	0.8	2.0	3.0	3.0
4	3.0	3.5	2.5	3.0	2.5	3.0	3.5	2.5	3.0	2.5
5	3.0	2.0	1.0	3.5	1.3	3.0	2.0	1.0	3.5	1.3
6	2.5	1.5	0.7	1.2	1.5	2.5	2.1	0.7	1.2	1.1
7	2.5	2.5			1.0	2.5	3.5			1.0

2017

	apr, 17					apr, 17				
FMU	A mollic	OH	OFr	Olv	OLn	A mollic	OH	OFr	Olv	OLn
1	1.0	1.0		2.5	2.5	1.0	1.0		2.0	2.0
2	1.5	1.0	2.5	3.0	3.0	1.5	1.0	2.5	3.0	2.0
3	4.0	1.0	2.0	3.0	2.0	4.0	1.0	1.0	3.0	2.0
4	4.0	3.5	3.0	3.0	3.0	3.0	3.5	3.0	3.0	4.0
5	2.5	2.0	1.0	3.0	1.0	3.5	2.0	1.0	3.0	1.0
6	2.5	2.0	1.0	1.0	1.0	2.5	2.0	1.0	1.0	1.0
7	3.0	4.0			0.5	1.0	2.0			0,5

	0ct, 17					0ct, 17				
FMU	A mollic	OH	OFr	Olv	OLn	A mollic	OH	OFr	Olv	OLn
1	1.0	0.5		1.5	2.5	1.0	0.5		2.0	2.5
2	1.5	1.0	2.5	2.5	2.0	1.5	1.0	2.5	2.5	2.0
3	3.0	1.5	2.5	3.5	4.0	4.0	1.5	2.5	3.5	4.0
4	3.0	2.5	2.0	2.5	3.0	3.5	3.5	2.0	3.5	3.0
5	3.0	1.5	1.0	3.0	2.0	3.0	1.5	1.0	2.0	2.0
6	2.5	1.8	0.7	1.2	1.3	2.5	1.8	0.7	1.2	1.3
7	2.0	3.0			1.0	3.0	3.0			2.0

everage value

	Spring				
FMU	A mollic	OH	OFr	Olv	OLn
1	1.000	0.825		2.000	1.525
2	1.500	1.000	2.125	2.625	2.125
3	3,625	1.000	1.875	3.000	2.750
4	3.125	3.125	2.625	3.000	3.125
5	3.000	1.875	1.000	3.000	1.500
6	2.500	2.000	1.000	1.000	1.000
7	2.375	3.000			0.875

	autumn				
FMU	A mollic	OH	OFr	Olv	OLn
1	1.000	0.600		1.667	2.000
2	1.500	1.125	2.375	2.375	2.250
3	3.500	1.200	2.125	3.250	3.750
4	3.125	3.125	2.250	3.125	2.875
5	3.000	1.750	1.000	2.875	1.825
6	2.500	1.800	0.700	1.200	1.300
7	2.500	3.000			1.250

Appendix E4. Soil Cover dataset. Mt. Nerone, Italy

		Total Soil cover projection (%)	**Tree layer (%)**	**Schrub layer (%)**	**Herb layer (%)**
	plot"a"	16.0	3.0	2.0	11.0
FMU 1	plot "b"	12.0	2.0	2.0	8.0
	EVERAGE	14.0	2.5	2.0	9.5
	plot"a"	100.0	47.0	4.0	80.0
FMU 2	plot "b"	100.0	53.0	3.0	82.0
	EVERAGE	100.0	51.0	3.5	81.0
	plot"a"	100.0	77.0	8.0	33.0
FMU 3	plot "b"	100.0	73.0	8.0	37.0
	EVERAGE	100.0	75.0	8.0	35.0
	plot"a"	100.0	75.0	5.0	30.0
FMU 4	plot "b"	100.0	78.0	5.0	30.0
	EVERAGE	100.0	76.5	5.0	30.0
	plot"a"	100.0	75.0	3.0	23.0
FMU 5	plot "b"	100.0	73.0	2.0	28.0
	EVERAGE	100.0	74.0	2.5	25.5
	plot"a"	97.5	55.0	2.5	40.0
FMU 6	plot "b"	99.5	57.0	2.5	40.0
	EVERAGE	98.5	56.0	2.5	40.0
	plot"a"	77.0	35.0	5.0	37.0
FMU 7	plot "b"	92.0	49.0	4.0	39.0
	EVERAGE	82.0	42.0	4.5	38.5

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Cystopteris dickieana R. Sim (*Cystopteridaceae*), a new species in Croatian flora

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Abstract - During a floristic survey carried out in the surroundings of settlement Sv. Rok (NE slopes of the Southern Velebit Mt, Croatia) as part of the research project on the ecology of the *Ostrya carpinifolia* forests, some samples of *Cystopteris* found in rock crevices and initially attributed to the *C. fragilis* were collected in order to compare them with the specimens stored in the herbarium of the University of Ancona (ANC). Based on spore morphology, the collected plants were subsequently recognized as circum-holarctic taxa *C. dickieana*. In spite it is in general morphology very similar to *C. fragilis* it strongly differs from it by irregularly wrinkled and rugose spores, which are never echinate and spiny. *C. dickieana* grows in rock crevices, humid ravines, walls, forest (mostly beech-forests), and in general in shady and humid areas, usually on calcareous substrates, reaching optimum in the low mountain belt. However, due to its difficult distinction within the *C. fragilis* complex, its distribution at world level and ecology to date are still unsatisfactory known. This is the first report of *C. dickieana* in Croatian flora and in the Balkans.

Key words: *Cystopteris fragilis* complex, *Cystopteris fragilis* subs. *dickieana*, pteridophytes, flora, Velebit, taxonomy, SE Europe

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Introduction

Cystopteris is a genus of the family *Cystopteridaceae* (Peruzzi 2010, Christenhusz *et al.* 2011, Bartolucci *et al.* 2018) which includes 22 species, eight of which are present in Europe (Kato & Kramer 1990, Haufler et al. 1993, Hutchinson & Thomas 1996, Wang & Haufler 2008). It is a genus with species often morphologically very similar to each other. Moreover, within the same species variability can be significant due to ecological conditions of particular lcalities, especially in harsh environments where they are exposed to stress and remain small and stunted. Furthermore, the species hybridize easily with each other what makes identifying more complex and challenging (Haufler & Windham 1991). The species of genus *Cystopteris* are rhizomatous perennials mainly distributed in the temperate and cold-temperate zones of Northern Hemisphere and in tropical mountains, which usually grow in rocky habitats or above shallow soils.

The leaves are multiply pinnate, bearing usually rounded sori covered with an inflated bladder-like indusium. Contrary to other ferns, the taxonomy of *Cystopteris*, at least of the species present in Europe, has been neglected (Marchetti 2003). Even today there are few known and commonly accepted discriminative characters applicable to the *C. fragilis* complex due to morphological similarities on one hand and high polymorphism of characters on the other which led some authors (Blasdell 1963, Jonsell et al. 2000) to the conclusion that it is not possible to recognize discrete taxa. However, Nardi (1974) showed that *C. dickieana* differs from *C. fragilis* not only in morphology, but also in ecological preferences. Based on this, he proposed even to distinguish *C. dickieana* from *C. baenitzii*, which were commonly treated as synonyms. Subsequently, some authors (Haufler et al. in Morin 1993, Jonsell et al. 2000) contrariwise that also at the genetic level it is impossible to distinguish microspecies belonging to the *C. fragilis* complex.

Recently, based on a large dataset containing the morphological data of samples from all over the world, Dyer et al. (2000) have shown that *C. fragilis* and *C. dickeiana* differ quite clearly even morphologically. In delimiting *C. dickieana* from other taxa within the complex the authors emphasized importance of two characters – the architecture of the fronds and the sculpturing of the spore surface. The type specimens of *C. dickieana* have mature spores with rugose surface (Dyer et al., 2000), which are distinctive and unique in the genus *Cystopteris*, since all other taxa have echinate spores (Ferrarini et al. 1986). Haufler & Windham (1991) and Marchetti (2003) showed, that the high variability of the frond morphology is often linked to conditions of environmental stress, making difficult to define descrete morphological characters at the level of individuals, although these are evident at the population level. However, morphology (Ferrarini et al. 1986) and dimensions of the spores (Peroni & Peroni 2003) remain constant characters, confirming Jeremy & Harper (1971), who showed that despite the variability of spore roughness in *C. dickieana*, it remains unmistakable character. Different spore morphology of *C. fragilis* and *C. dickieana* are not just different developmental stages of the spores of the same species, as claimed by some authors, but the real structural differentiation between these species (Marchetti 2003). Moreover, populations or individuals with intermediate spore structure were not found (Marchetti 2003). Based on this, in the recent floras (Wang & Haufler 2008, Tison & de Foucault 2014, Pignatti et al. 2018) and checklists (Conti et al. 2005, Lorite 2016, Bartolucci et al. 2018) *C. dickieana* is recognized at the rank of species (in synonymy with *C. baenitzii* Dorfler ex Baenitz), while *C. alpina* (Lam.) Desv, *C. diaphana* (Bory) Blasdell and *C. fragilis* var. *huteri* Milde, are reported as subspecies of *C. fragilis*.

Due to the mentioned difficulties in identification, the knowledge concerning geographical distribution, altitudinal range and ecological characteristics of the different taxa belonging to the *C. fragilis* complex are still approximate. In order to fill these gaps, new distributional data appears to be essential.

Materials and methods

The specimens were collected on two occasions, in May and July 2018, on the north-eastern slopes of the southern Velebit Mt, near the settlement Sv. Rok (Fig. 1), at the altitudes between 650 and 800 m a. s. l. Sampling was done as part of the research project on the ecology of the *Ostrya* *carpinifolia* forests in Croatia. Identification of *C. dickieana* regarding spore morphology, shape of leaves and whole habitus was done according to Pignatti (1982), Ferarini et al. (1986), Tutin et al. (1993), Marchetti (2003), Tison & de Foucault (2014) and Pignatti et al. (2018). The morphological description presented here follows Ferrarini et al. (1986), Marchetti (2003), Tison & de Foucault (2014), Pignatti et al. (2018) and original authors' observations. The spores observation was performed with a Leitz Diaplan microscope connected with a Leica camera, using Wetzlar PL Fluotar 10 / 0.30 160 / - 519872 and Leitz Wetzlar EF 40x 0.65 160 / 0.17 519755 lenses. Measurements were made using Leica LAS X image processing software. Measured dimensions were compared with those available in literature (Ferrarini et al. 1986, Peroni & Peroni 2003). Herbarium samples were digitized and deposited in the *Herbarium Croaticum* (ZA) and in the Herbarium of the University of Ancona (ANC) (acronyms according to Thiers 2018). Images are accessible through Virtual Herbarium ZA & ZAHO (Rešetnik & Šegota 2018). The nomenclature fallows Conti et al. (2005).

Fig. 1

Results and discussion

Morphological description of *C. dickeiana*– Rhizome oblique-creeping, short and (tendentially) gracile. Fronds fringed, non-wintering,, long up to 35 cm. Peduncle thin and delicate , straw-colored, normally shorter than the lamina, with paleas (more or less abundant) towards the base, where it becomes typically brownish-black. Lamina delicate, lanceolate and bipinnately divided. Pinnae more or less widely lanceolate, the lower ones slightly shorter and truncate, evenly spaced along rachis. Pinnules ovate, lobulated to subentire, with mostly obtuse apex and indistinctive teeth. Veins of secondary pinnulae rarely ending in the leaf margin. Sori orbicular. Indusium hood-like with acute free border. Spores with a granulated surface with typically rounded (meteorite-like) shape with longer side 45 µm (± 8), and smaller side 35 µm (± 3) long. The sporulation period vary from May to September depending on the micro-environmental conditions.

Over 75 samples of *Cystopteris* were collected in the area of finding. Based on spore morphology only six of them have been identified as *C. dickieana* (Fig. 2), and all others as *C. fragilis* subsp. *fragilis*. The finding sites were situated on E-NE exposition, between 650 and 800 m a. s. l. From the available literature data the species has an altitudinal range of more than 2000 meters (from 400 to 2500 m a. s. l.), with the optimum between 600 and 2000 m. a. s. l. (Marchetti 2003, Wang & Haufler 2008). The specimens were found growing in the shaded rock crevices within the *Ostrya carpinifolia* dominated forest stands, accompanied with other ferns (*Asplenium ruta-muraria* L., *Asplenium trichomanes* L. ssp. *quadrivalens* D. E. Meyer, *Ceterach officinarum* Willd. subsp. *officinarum*, *Cystopteris fragilis* (L.) Bernh., *Polypodium interjectum* Shivas) and spermathophytes (*Brachypodium sylvaticum* (Hudson) P. Beauv., *Calamintha grandiflora* (L.) Moench, *Campanula pyramidalis* L., *Epipactis atropurpurea* Rafin., *Festuca heterophylla* Lam. *Fragaria vesca* L., *Gentiana asclepiadea* L., *Geranium lucidum* L., *Geranium robertianum* L., *Lactuca muralis* (L.) Gaertn., *Lathyrus niger* (L.) Bernh., *Lathyrus vernus* (L.) Bernh. ssp. *vernus*, *Melica uniflora* Retz., *Moehringia muscosa* L., *Origanum vulgare* L., *Peltaria alliacea* Jacq., *Polygonatum multiflorum* (L.) All., *Saxifraga rotundifolia* L., *Sedum maximum* (L.) Suter, *Sesleria autumnalis* (Scop.) Schultz, *Teucrium chamaedrys* L., *Viola alba* Besser ssp. *alba* and some others).

Fig. 2

Based on the thermo-pluviometric data collected from 1981 to 2017 by the nearby meteorological station in Lovinac, the mean annual air temperature of this area is 10.05°C, with a mean annual precipitation of 1495 mm. These data corresponds with bioclimatic definition of a temperate oceanic bioclimate, humid ombrotype and supratemperate thermotype (Rivas-Martinez et al. 2011). The geology of the area is dominated by calcareous marl, and the soils are mostly represented by mollisols (SSS 2014). Syntaxonomically, the vegetation of the area belongs to the alliance *Ostryo-Carpinion orientalis* (Horvat 1954) 1958. Based on the data provided from the local forest administration we can conclude that the area was historically managed as coppice forest with a rotation period of about 20 years, extended to over 30 years during the last decades.

The first discovery of *C. dickieana* in Croatia is the first report of the species for the Balkans (Christenhusz & von Raab-Straube 2013). Up to date three species were reported from Croatia: *C. alpina*, *C. fragilis* and *C. montana* (Nikolić 2018), distributed on all main mountain massifs (Fig. 3). Difficulties in characterizing the *Cystopteris* taxa from taxonomical, ecological and geographical point of view make the available information on this species very general and unreliable, thus reporting *C. dickieana* for the Balkans appears to be of considerable importance.

Fig. 3

Although the information on the species are general and low detailed, taking into account these and comparing them with the general morpho-climatic characteristics of the finding area, it is possible to assert that the species has been found at the limit of its microclimate range. Thus, we speculate that in this conditions *C. dickieana* might be in direct competition with *C. fragilis* subsp. *fragilis*. This competition could explain the reduced share of *C. dickieana* in comparison to *C. fragilis* in described locality. Much more difficult is to understand the phase of population dynamics of *C. dickieana* on particular site. The environmental alterations are consequence of two processes - of the general climate change (Solomou et al. 2017) and on the effects of forest management (Mei et al. in press). Their interplay could have created suitable conditions for population expansion or could have triggered the population decline. In order to clarify this dynamic aspect, a floristic monitoring is needed, together with further investigations of vegetation dynamics.

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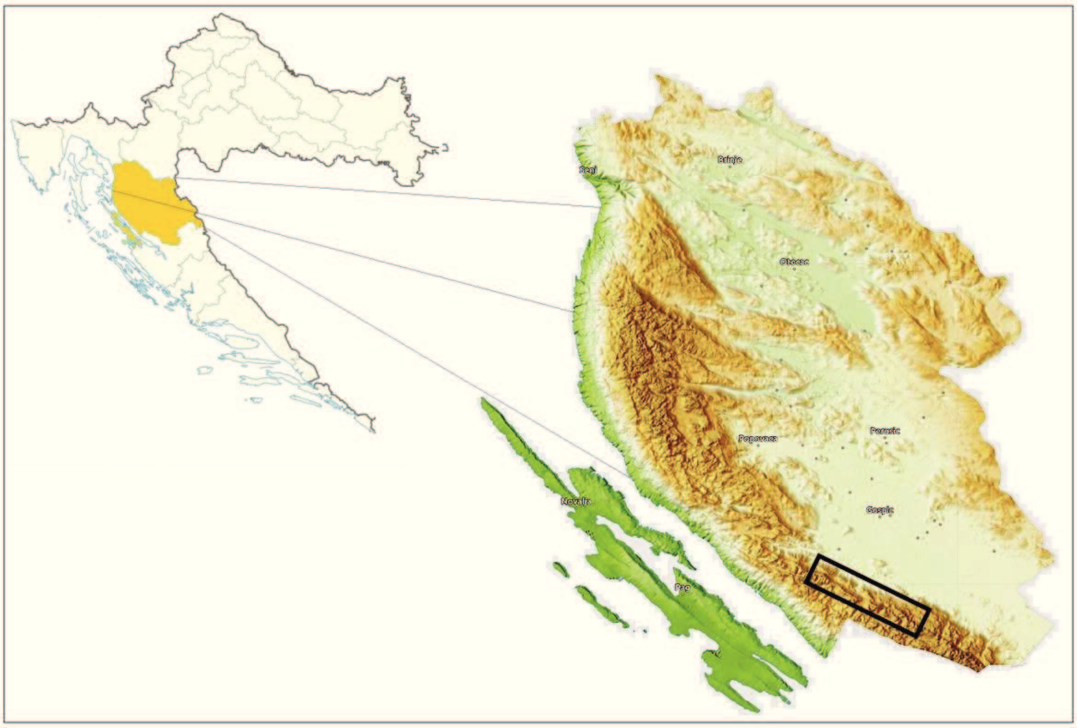


Fig. 1 – Geographic contextualization of the area of discovery of *Cystopteris dickieana* R.Sim

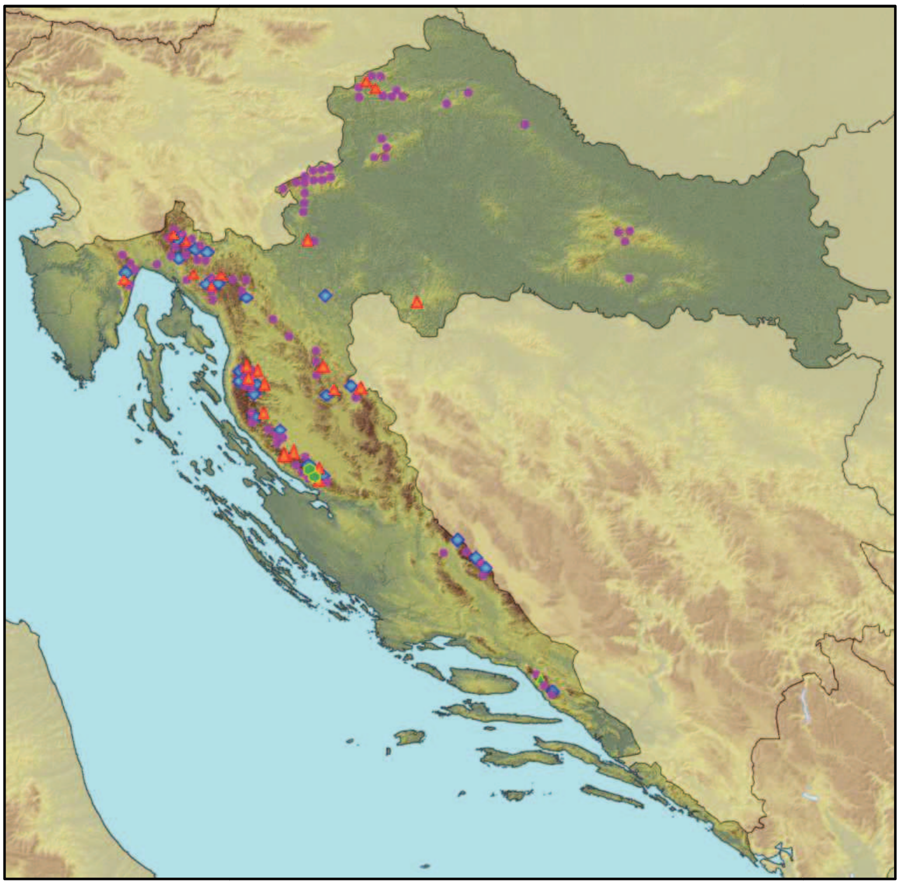


Fig. 2 - Distribution of *Cystopteris* ssp. in Croatia (Nikolić, 2018 – Modified)

▲ *C.*◆*lpinaC. montan*● *fragilis*C. dick⬢na

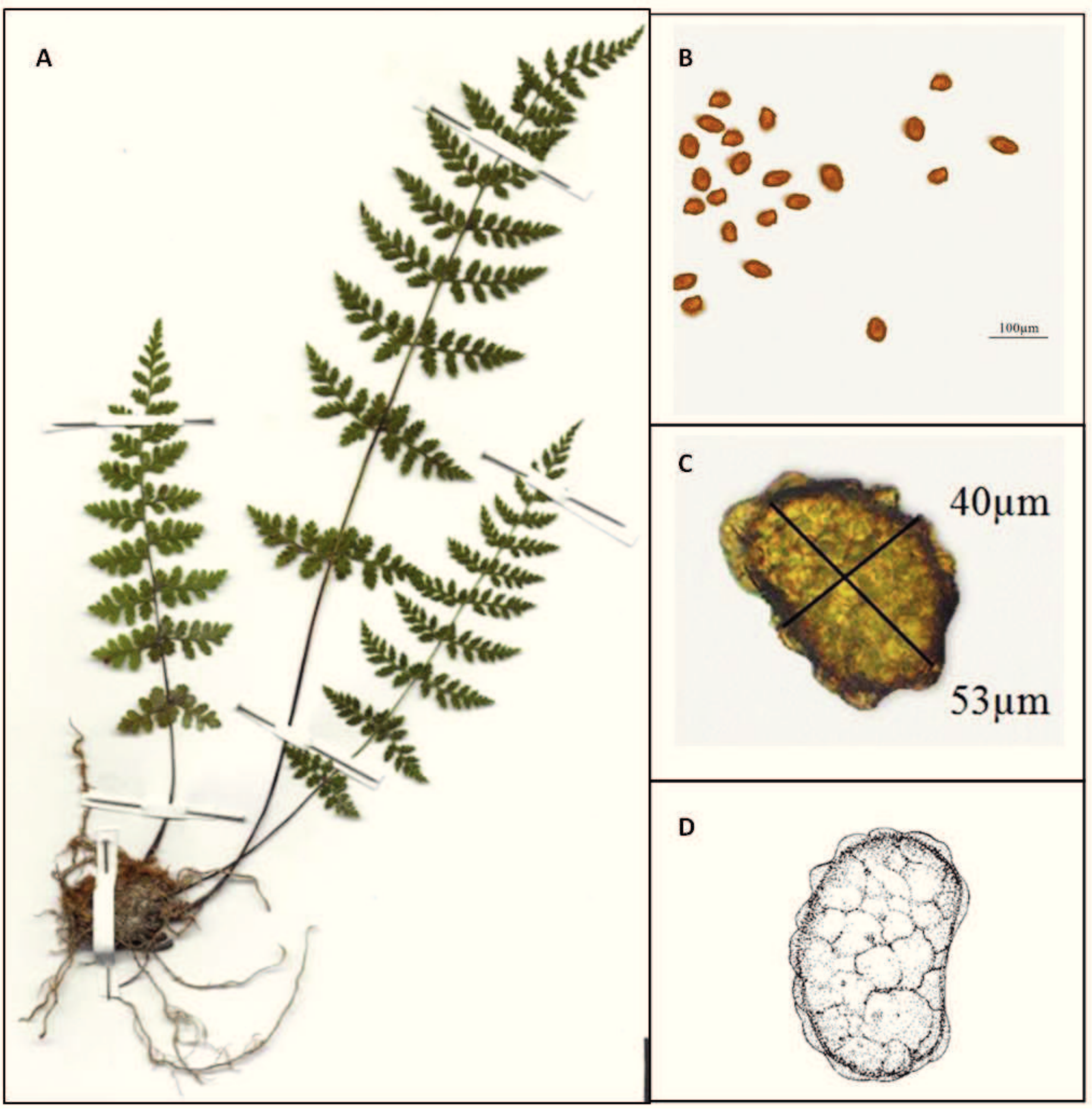
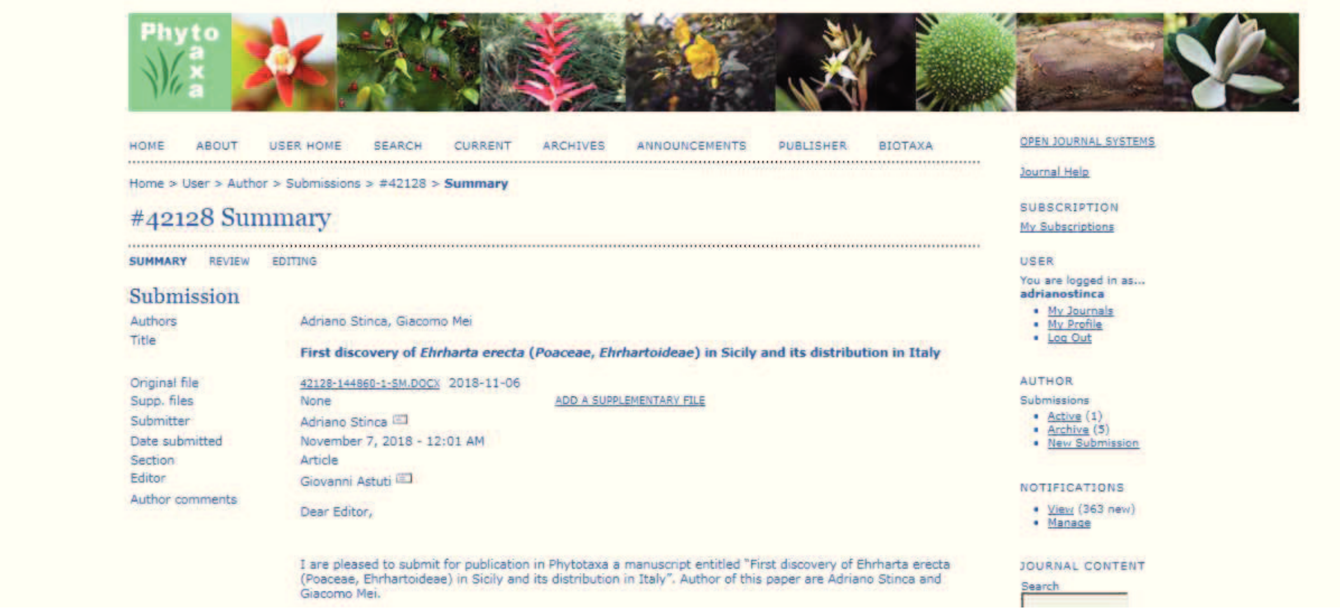


Fig. 3 *Cystopterisdickieana* R.Sim. from SvetiRok: A- Sample stored in the Herbarium of the university of Ancona (ANC) – Italy; B- Picture of the spores (10x); C- Spore in detail (40x) with measures; D- drawing of the typical spores of C. *dickieana*(from Prada, 1986)



Home > User > Author > Submissions > #42128 > **Summary**

#42128 Summary

SUMMARY REVIEW EDITING

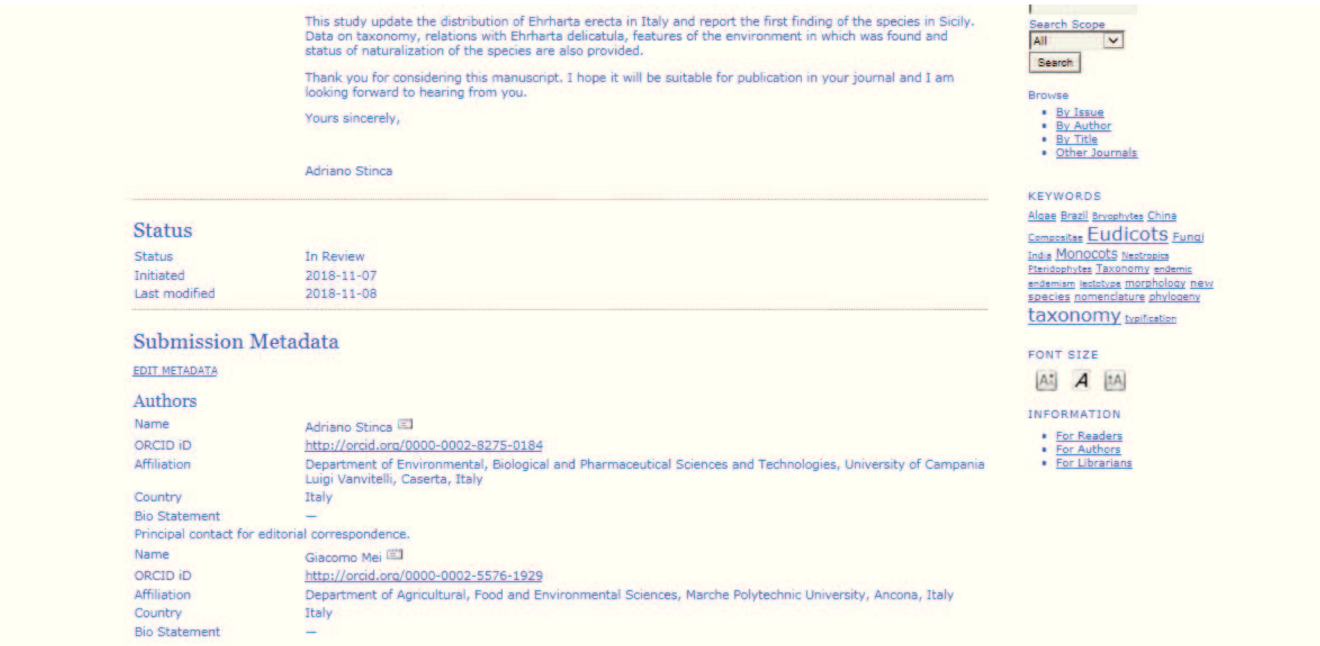
Submission

Authors	Adriano Stinca, Giacomo Mei
Title	**First discovery of *Ehrharta erecta* (*Poaceae, Ehrhartoideae*) in Sicily and its distribution in Italy**
Original file	42128-144860-1-SM.DOCX 2018-11-06
Supp. files	None ADD A SUPPLEMENTARY FILE
Submitter	Adriano Stinca
Date submitted	November 7, 2018 - 12:01 AM
Section	Article
Editor	Giovanni Astuti

Author comments

Dear Editor,

I are pleased to submit for publication in Phytotaxa a manuscript entitled "First discovery of Ehrharta erecta (Poaceae, Ehrhartoideae) in Sicily and its distribution in Italy". Author of this paper are Adriano Stinca and Giacomo Mei.



This study update the distribution of Ehrharta erecta in Italy and report the first finding of the species in Sicily. Data on taxonomy, relations with Ehrharta delicatula, features of the environment in which was found and status of naturalization of the species are also provided.

Thank you for considering this manuscript. I hope it will be suitable for publication in your journal and I am looking forward to hearing from you.

Yours sincerely,

Adriano Stinca

Status

Status	In Review
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EDIT METADATA

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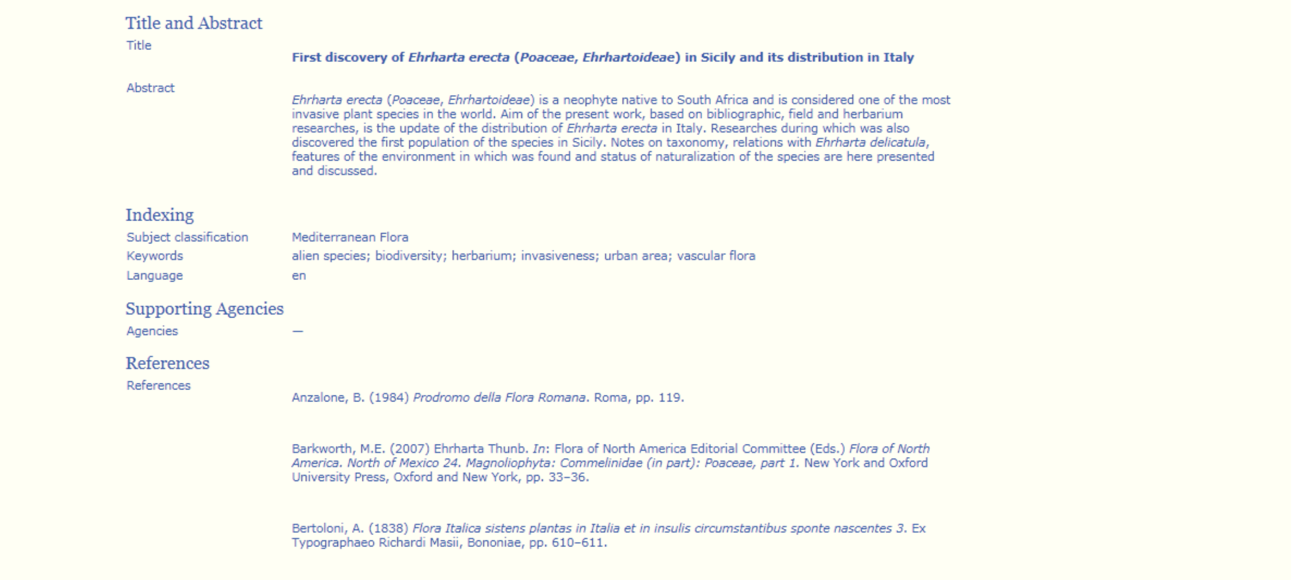

Title and Abstract

Title	**First discovery of *Ehrharta erecta* (*Poaceae, Ehrhartoideae*) in Sicily and its distribution in Italy**
Abstract	*Ehrharta erecta* (*Poaceae, Ehrhartoideae*) is a neophyte native to South Africa and is considered one of the most invasive plant species in the world. Aim of the present work, based on bibliographic, field and herbarium researches, is the update of the distribution of *Ehrharta erecta* in Italy. Researches during which was also discovered the first population of the species in Sicily. Notes on taxonomy, relations with *Ehrharta delicatula*, features of the environment in which was found and status of naturalization of the species are here presented and discussed.

Indexing

Subject classification	Mediterranean Flora
Keywords	alien species; biodiversity; herbarium; invasiveness; urban area; vascular flora
Language	en

Supporting Agencies

Agencies	—

References

References

Anzalone, B. (1984) *Prodromo della Flora Romana*. Roma, pp. 119.

Barkworth, M.E. (2007) Ehrharta Thunb. *In:* Flora of North America Editorial Committee (Eds.) *Flora of North America. North of Mexico 24. Magnoliophyta: Commelinidae (in part): Poaceae, part 1.* New York and Oxford University Press, Oxford and New York, pp. 33–36.

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First discovery of *Ehrharta erecta* (*Poaceae*, *Ehrhartoideae*) in Sicily and its distribution in Italy

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Abstract

Ehrharta erecta (*Poaceae*, *Ehrhartoideae*) is a neophyte native to South Africa and is considered one of the most invasive plant species in the world. Aim of the present work, based on bibliographic, field and herbarium researches, is the update of the distribution of *Ehrharta erecta* in Italy. Researches during which was also discovered the first population of the species in Sicily. Notes on taxonomy, relations with *Ehrharta delicatula*, features of the environment in which was found and status of naturalization of the species are here presented and discussed.

Keywords: alien species, biodiversity, herbarium, invasiveness, urban area, vascular flora.

Introduction

Ehrharta Thunberg (1779: 217) (*Poaceae*, *Ehrhartoideae*) is an African genus ranging from South Africa to Ethiopia and Yemen that includes approximately 35 species (Fish *et al.* 2015). Some species are alien in Australia, China, Indonesia, Mediterranean Basin, New Zealand, North and South America (e.g. Edgar *et al.* 1991, Barkworth 2007, Weiller 2017, Calvo & Moreira-Muñoz 2018, Valdés & Scholz 2018). It includes annual or perennial plants, with pedicellate solitary or sometimes clustered spikelets generally arranged on racemose or paniculiform inflorescences. Each spikelet has glumes 5-7-nerved and 3 florets, the lower 2 sterile and reduced to lemmas and the upper 1 bisexual.

In Euro-Mediterranean area three species are recorded (Valdés & Scholz 2018): *Ehrharta calycina* Smith (1790: no. 33) (Spain and Tunisia), *Ehrharta erecta* Lamark (1786: 347) (France, Israel, Italian Peninsula, Morocco, Netherlands, Purtugal, Sardinia and Spain) and *Ehrharta longiflora* Smith (1790: no. 32) (Canary Islands and Spain).

Aim of the present work is to clarify the distribution in Italy of *Ehrharta erecta* and report its presence in Sicily for the first time. Its taxonomy, relations with *Ehrharta delicatula* Stapf (1897: 288), features of the environment in which the species was found and status of naturalization are here also examined.

Materials and methods

The study was based on researches of relevant literature, field surveys and analysis of herbarium samples stored in the main Italian herbaria. The identification of the analyzed samples was made on the basis of the key and descriptions by Fish *et al.* (2015). Protologue by Lamarck (1786) as well as data reporting by Ricciardi & Anzalone

(1988), Barkworth (2007) and Stapf (1897, 1900) was also examined. The floristic literature was also examined to detect previous indications of the species in Italy and Sicily (e.g. Tenore 1835, Bertoloni 1838, Parlatore 1848, Fiori 1923, Pignatti 1982, 2017, Ricciardi & Anzalone 1988, Giardina *et al.* 2007, Raimondo & Spadaro 2009, Galasso *et al.* 2018).

Field work was conducted in the period 2001-2018 in the Italian locations where this species has been reported in the past (Caserta, Portici and Naples in Campania, Caffarella Valley in Lazio, Cagliari in Sardinia), as well as in Catania (Sicily).

Herbarium researches has been carried out in the following Italian collections: ANC, APP, BI, CAG, FI, HFLA, LEC, MSNM, NAP, P, PAD, PAV, PI, PORUN, RO, SAF, TO, URT, UTV (see Appendix 1; acronyms according to Thiers 2018).

In order to investigate the difference between *Ehrharta erecta* and *Ehrharta delicatula*, 11 morphological characters (Tab. 1) were examined in 40 herbarium specimens selected (25 of *Ehrharta erecta* and 15 of *Ehrharta delicatula*). For comparative study we analyzed also the African specimens keep in KSAN, MSNM, P, PRU, RO and TO (Appendix 1).

As regard the new Sicilian population, geocoding of the locality was performed with the use of a portable GPS device (GPS map 60CSx, Garmin, USA), calibrated beforehand (geographic system UTM WGS84). The climatic characterization of the area of the discovery was performed by processing the rainfall and temperature data from Fontanarossa meteorological station (17 m a.s.l., about 6.5 km from the analysed site) for the period 1961-2016 (Fick & Hijmans 2017, Ministero della Difesa 2018). Data about the habitat and the population size of *Ehrharta erecta* were based on personal observations in the field. The evaluation of the status of naturalization was defined according to the terminology of Pyšek *et al.* (2004).

Results and discussion

Native range and taxonomic notes

Ehrharta erecta, commonly known as Panic veldtgrass or Erect veldtgrass, is a perennial grass native to South Africa (Fish *et al.* 2015). In its native range the species grows from arid habitats to tropical forests and grasslands, occurring from sea level to 2600 m a.s.l. To date it is considered one of the most invasive plant species in the world (Weber 2017). According to Ray *et al.* (2018), effective management of this alien is possible using either mechanical or chemical removal methods.

Ehrharta erecta Lam., Encycl. 2(1): 347. 1786 [16.X.1786].

− *Ehrharta delicatula* auct. Fl. Ital., non Stapf.

= *Ehrharta panicea* Sm., Pl. Ic. Ined. t. 9. 1789.

= *Ehrharta deflexa* (Guss.) Pignatti, Archiv. Bot. Forlì 34: 5. 1958.

= *Panicum deflexum* Guss., in Ten. Fl. Nap. 5: 320(-321). 1835.

= *Ehrharta erecta* Lam. var. *abyssinica* (Hochst.) Pilg., in R.E.Fries & T.C.E.Fries Notizbl. Bot. Gart. Berlin-Dahlem 9(87): 508. 1926.

= *Ehrharta abyssinica* Hochst., Flora 38(13): 193(-194). 1855.

= *Ehrharta erecta* Lam. var. *natalensis* Stapf., in W.T. Thiselton-Dyer Fl. Cap. 7(4): 671(-672). 1900.

Within the genus *Ehrharta*, this species has been classified in *Erecta* group by Gibbs Russell & Ellis (1987) for the presence of small spikelets, short glumes, lemmas characterized by glabrous sides, lacking appendages and first sterile lemma well developed and typically constricted at base. *Ehrharta erecta* is similar to *Ehrharta delicatula* (belonging to the *Calycina* group according to Gibbs Russell & Ellis 1987) native to South Africa and in the past recorded in Italy by Pignatti (1958), Zangheri (1976), Pignatti (1982) and Anzalone (1984). According to our studies, the two species are easily distinguished because *Ehrharta erecta* is a perennial herb with spikelets 3-4.2 mm long, only one sterile lemmas transversely ribbed (rarely, also the second sterile lemma show 1-5 transversal ribs that are not very evident) and 6 stamens, while *Ehrharta delicatula* is an annual plant with spikelets 1.8-2.8 mm long, both sterile lemmas transversely ribbed and 3 stamens (Figure 1, Table 1). Concerning chromosome numbers, both species presented diploid counts 2n = 2x = 12 (Hoshino & Davidse 1988, Spies *et al.* 1989).

Based on our research, *Ehrharta delicatula* must be excluded from the Italian vascular flora. In fact, all the samples collected in Italy and examined by us are to be referred to *Ehrharta erecta*. This result is fully in accordance with Ricciardi & Anzalone (1988).

Gibbs Russell & Ellis (1987) and Fish *et al.* (2015) recognized two variety within *Ehrharta erecta*: var. *abyssinica* (Hochstetter 1855: 193) Pilger (1926: 508) and var. *natalensis* Stapf (1900: 671). All the examined Italian specimens can be attributed to the var. *erecta*. However, this taxa are poorly distinguished from *Ehrharta erecta* s.s. by some characters concerning the spikelet and treated as synonyms by *Ehrharta erecta* according to The Plant List (2018).

Site location, features of the environment and status of naturalization in Sicily

During field surveys in Sicily, the presence of *Ehrharta erecta* was ascertained in the urban area of Catania. In fact, a small population of the species was found in the historical area of the city, that is placed on the southeastern foothills of Mt. Etna, at 28 m a.s.l. (UTM WGS84: 33 S 507689 E and 4151863 N). The finding of the species in the core of the urban area is perfectly in line with what is highlighted by various authors (e.g. Stinca *et al.* 2017, Scafidi & Raimondo 2018) which show how in Italy the urban environments are continually subjected to new introductions of exotic species, with more or less trumpery and damaging effects on the native flora. The climate of the city can be referred to thermo-mediterranean type, with an average annual air temperature of 17.8°C and rainfall of 567 mm (Figure 2). The bioclimatic definition of the area derived from the bioclimatic map of Italy (Pesaresi *et al.* 2014, 2017) is as a mediterranean macrobioclimate, pluviseassonal oceanic bioclimate, upper thermo-mediterranean thermotypes (Rivas-Martinez *et al.* 2011).

The Sicilian *Ehrharta erecta* population covers an area of approximately 25 m^2 and consists of eight individuals that grow between basaltic stones of the urban area of Catania, a nitrophilous and trampled site. The population was characterized by ruderal native such as *Antirrhinum siculum* Miller (1768: no. 6), *Cymbalaria muralis* G.Gaertner, B.Meyer & Scherbius (1800: 397) subsp. *muralis*, *Oloptum miliaceum* (Linnaeus [1753a: 61] Röser & H.R.Hamasha, *Oxalis corniculata* Linnaeus (1753a: 435), *Parietaria judaica* Linnaeus (1756: 32) and *Parietaria lusitanica* Linneaus (1753b: 1052) subsp. *lusitanica*, as well as alien plant species (*Erigeron sumatrensis* Retzius (1788: 28), *Ficus microcarpa* Linnaeus filius (1782: 442), *Oxalis debilis* Kunth (1822: 236) and *Symphyotrichum squamatum* (Sprengel [1826: 515]) G.L.Nesom (1995:

292). The specific composition of this phytocoenosis highlights the human impact on the area.

The vector of introduction of *Ehrharta erecta* is uncertain. At the current state of knowledge, in Italy and in Sicily it is not utilized in gardens as ornamental plant and ethnobotanical uses are unknow. Our hypothesis is that this neophyte was accidentally introduced as soil contaminant in pots of ornamental exotic plants or in the gardens of Catania. As all the examined plants produced caryopses, the diffusion of this species depends on sexual reproduction. We hypothesize that this exotic plant has been introduced recently on the island. According to Richardson *et al.* (2000), the observation period is too short to understand the real success of propagation and declare a state of naturalized species. Therefore it must be considered a casual alien plant in Sicily.

Occurrence in Italy

According to Tenore (1835, sub *Panicum deflexum* Guss.), the first finding of this species in Italy was done by Gussone in the Royal Park of Portici near Naples. Today in Italy *Ehrharta erecta* is certainly present only in Campania (Royal Parks of Portici [Stinca & Motti 2009 and other references cited therein, Stinca *et al.* 2014] and Caserta [Terracciano 1872 sub *Ehrartha* (sic!) *panicea* Smith, Stinca *et al.* 2013]), Sardinia (Oristano in locality Torre Grande [Scrugli *et al.* 1990]) and Sicily (Catania, as shown above) (Figure 3).

In Sardinia this exotic plant is reported also in the Botanical Garden of Cagliari [Viegi 1993, A. Stinca pers. obs. 2009, L. Podda pers. obs. 2018] and immediately outside of it (E. Banfi pers. obs. 2010). In this place it had been reported for the first time by Viegi

(1993) on the basis of a sample collected in 1978 by Zedda and Mascia. To date, this specimens has not been traced in CAG (L. Podda in verbis 2018).

In Puglia *Ehrharta erecta* was indicated as casual alien by Celesti-Grapow *et al.* (2010) and Galasso *et al.* (2018), but we did not find specific bibliographic references and samples in the consulted herbaria. Therefore, it presence in this territory is very doubtful and we suggest to exclude the species from the regional flora.

Furthermore, we confirm the local extinction of the species in the Caffarella Valley (known in the past as Ninfa Egeria Valley) in Lazio (Chiovenda 1898, Buccomino & Stanisci 2000) and in the city centre of Naples (De Natale & La Valva 2000 and other references cited therein, Stinca *et al.* 2013).

As for the stations in the Royal Parks of Portici and Caserta, the species grows mainly inside the Holm oak forests and its edges. However, it is also sporadically present in the more disturbed grassy places. In these two localities *Ehrharta erecta* was recorded, and is still present, respectively from 20 to 95 m a.s.l. and from 70 to 160 m a.s.l.. Instead, the *Ehrharta erecta* populations of Sardinia and Sicily live exclusively in very anthropized environments, such as road edges (Oristano) and between basaltic stones in urban areas (Catania), respectively at an altitude of 5 and 28 m a.s.l..

Based on our field observations, this neophyte in Campania and Sardinia can be considered as naturalized, while in Sicily it must be considered as casual alien plant. Then, correctly Galasso *et al.* (2018) report this weed as naturalized for Italy. According to Frey (2005), in Campania we observed that the species reproduces mostly by seed but also vegetatively by rhizomes rooting at nodes. Similarity in climate with native range of *Ehrharta erecta* may in part explain its rapid establishment in Mediterranean Basin (South Africa is one of five regions in the world with a Mediterranean climate).

Conclusion

Recently Galasso *et al.* (2018) recorded for Italy 1500 non-native species and subspecies (4 undefined status, likely casual aliens; 705 casual; 570 naturalized; 221 invasive). However the number of alien species is steadily increasing, also in Sicily (Guarino *et al.* 2018, Scafidi & Raimondo 2018). Indeed, in throughout the Italian territory the long-lasting human presence has promoted the spread of many alien species whose occurrence may negatively affect the structure and functioning of natural habitats In this context, discovery of new aliens plants as *Ehrharta erecta* in Sicily and evaluation of their distribution and naturalization status in Italy are crucial for their correct management.

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APPENDIX 1. Specimina visa selecta

Ehrharta erecta **Lam.:—ITALY. Campania**. Caserta al Parco Reale (UTM WGS84: 33 T 443627 E, 4548849 N), margine lecceta, 86 m a.s.l., 27 April 2018, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Caserta al Parco Reale (UTM WGS84: 33 T 443753 E, 4547670 N), margine lecceta, 84 m a.s.l., 20 April 2018, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Caserta, via R. Gasparri, parcheggio del Consorzio per la Tutela del Formaggio Mozzarella di Bufala Campana (WGS84: 41.074091°N, 14.329479°E), infestante nei vasi, 65 m a.s.l., 22 March 2018, leg. et det. *Galasso* (MSNM 48374!, 48376!, 48377!, 48378!). Caserta al Parco Reale (UTM WGS84: 33 T 443622 E, 4548848 N), margine lecceta, 86 m a.s.l., 6 March 2016, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Portici al Parco Inferiore (UTM WGS84: 33 T 444258 E, 4517891 N), margine lecceta, 43 m a.s.l., 29 September 2018, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Portici al Parco Gussone (UTM WGS84: 33 T 444717 E, 4518087 N), lecceta, 70 m a.s.l., 10 May 2006, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Portici al Parco Gussone (UTM WGS84: 33 T 444731 E, 4518257 N), lecceta, 72 m a.s.l., 20 October 2001, leg. et det. *Stinca* (PORUN-Herb.Stinca!). Portici. Parco Gussone; tra il cancello dell'Orto Botanico e quello dell'Istituto di Industrie Agrarie, 50 m a.s.l., 28 April 1984, leg. et det. *Ricciardi* (RO-Herb.Anzalone!). Portici. Parco Gussone; tra il cancello dell'Orto Botanico e quello dell'Istituto di Industrie Agrarie, 50 m a.s.l., 28 April 1984, leg. et det. *Ricciardi* (RO-Herb.Generale! [two sheets]). Campania. Bosco inferiore di Portici (inselvatichita), 21 June 1907, *Pellanda* (FI 53986!, 53987! sub *E. panicea* Sm.). Bosco di Portici presso Napoli, da lungo tempo e diffusamente inselvatichita, 10 May 1904, *Guadagno* (FI 53985! sub *E. panicea* Sm.). Neapolis (Napoli), subsponte in herbidis loco dicto Bosco di Portici (Parco Gussone) frequens, 10

May 1904, *Guadagno* (FI 53993! sub *E. panicea* Sm.). Neapolis (Napoli), subsponte in herbidis loco dicto Bosco di Portici (Parco Gussone) frequens, 10 May 1904, *Guadagno* (PAD! sub *E. panicea* Sm. [two sheets]). Neapolis (Napoli), subsponte in herbidis loco dicto Bosco di Portici (Parco Gussone) frequens, 10 May 1904, *Guadagno* (PI-Herb.Guadagno 11486! sub *E. panicea* Sm.; rev. *Mazzitelli*, 15 December 1993, sub *E. delicatula* Stapf). Neapolis (Napoli), subsponte in herbidis loco dicto Bosco di Portici (Parco Gussone) frequens, 10 May 1904, *Guadagno* (RO-Herb.Generale! sub *E. panicea* Sm.). Bosco di Portici, May 1904, *Guadagno* (FI 53988! sub *E. panicea* Sm.). Campania. Bosco inferiore di Portici, 14 June 1898, *Micheletti* (FI 53989!, 53990! sub *E. panicea* Sm.). Bosco inferiore di Portici, 8 August 1897, *Mazza* (TO-Ex Herb.Micheletti! sub *E. panicea* Sm.). Nat. nel bosco sup. a Portici, 1894, *Guadagno* (PI-Herb.Guadagno 11487! sub *E. panicea* Sm.; rev. *Mazzitelli*, 15 December 1993, sub *E. delicatula* Stapf). Bosco di Portici, June 1883, *de Bérenger* (TO! sub *E. panicea* Sm. / *Panicum diffusum* Guss.). Portici, May 74, *s.coll.* (PORUN-Herb.Generale! sub *Erharhta* (sic!) *panicea*; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). Portici, June 73, *s.coll.* (PORUN-Herb.Generale! sub *E. panicea*; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). R. Parco di Portici, December 1868, *Pasquale* (NAP-Herb.Pasquale! sub *E. panicea*). R. Parco di Portici, March 1869, *Pasquale* (NAP-Herb.Pasquale! sub *E. panicea*). Caserta: Parco, 22 April 1870, *Pasquale* (NAP-Herb.Pasquale! sub *E. panicea*). Napoli a Portici, in sylvaticis, October 1842, *Gussone* (FI 53994-Ex Herb.Parlatore!, sub *Erartha* (sic!) *panicea*). Portici, 1850, *Narducci* (FI 53992! sub *E. panicea* W.). Pasconcello, 8 April 1838, s.coll. (NAP-Herb.Pasquale!, ex. Herb.Gussone, sub *E. panicea*). Originaria del Capo di Buona Speranza. Sfuggita forse alla coltura [illeg.] trovasi nella sola Tenuta di Portici, s.d., *s.coll.* (*Pasquale*?)

(PORUN-Herb.Generale! sub *E. panicea* Smith; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). Orto botanico di Napoli, 30 October 1861, *s.coll.* (PORUN-Herb.Generale! sub *Ehrhartha* (sic!) *panicea*). Bosco di Portici, s.d., *s.coll.* (PORUN-Herb.Generale! sub *Ehrartha* (sic!) *panicea*; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). H. B. Neap., s.d., *Cesati* (RO-Herb.Cesati! sub *Panicum prostrato* (sic!) Lam. / *Panicum caespios* (sic!) Swartz; rev. *Chiovenda*, sub. *E. panicea* Sw. (sic!)). Napoli nei giardini., s.d., *s.coll.* (RO-Herb.Generale! sub. *E. panicea*). Napoli a Portici, in sylvaticis, s.d., *Beccari* (FI 53984! sub *Erartha* (sic!) *panicea*). Napoli a Portici, s.d., *s.coll.* (PAV-Herb.Gasparrini! sub *E. panicea*; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). Portici, 11.203 (sic!), *Guadagno* (RO-Herb.Generale! sub. *E. panicea* Sm. / *Panicum deflexum* Guss. ap (sic!) Ten.). Portici, s.d., *Orsini* (PAD! sub *E. panicea* Willd. / *Panicum deflexum* Guss.). Portici, s.d., *Orsini* (PI-Herb.Generale 11493! sub *E. panicea* Willd. / *Panicum deflexum* Guss.). Portici, s.d., *Meneghini* (PI-Herb.Generale 11494! sub *Ehrartha* (sic!) *panicea / Panicum deflexum*). Portici circa Neapoli in arenosis maritimi, s.d., *Orsini* (PI-Herb.Caruel 011485! sub *Panicum deflexum* Guss. / *Ehrartha* (sic!) *panicea* Willd.). Provenit sponte in nemore prope Neapolim a Portici, s.d., *s.coll.* (PAV-Herb.Gasparrini! sub *E. panicea*; rev. *Ricciardi*, 10 September 1986, sub *E. erecta* Lam.). H. R. Neap., s.d., *s.coll.* (NAP-Herb.Tenore! sub *Panicum diffusum*). H. R. Neap., s.d., *s.coll.* (NAP-Herb.Tenore! sub *Panicum prostratum* Lam. var. *caespitosum* Swartz). **Lazio**. Valle della Ninfa Egeria, 13 March 1876, leg. *Cuboni*, det. *Chiovenda*, conf. *Lusina*, conf. *Anzalone* (RO-Herb.Generale!). **Sicily**. Catania lungo Viale XX Settembre (UTM WGS84: 33 S 507689 E, 4151863 N), tra le lastre di basalto, 28 m a.s.l., 7 April 2018, leg. *Stinca* et *Mei*, det. *Stinca* (PORUN-Herb.Stinca!). Catania lungo Viale XX Settembre (UTM WGS84: 33 S 507689 E, 4151863 N), tra le lastre di basalto, 28 m a.s.l., 7 April 2018, leg. *Stinca* et *Mei*, det. *Stinca* (ANC!). **Sardinia**. Torregrande in territorio di Oristano, su terreni alluvionali, a circa 5 m s.l.m., 22 July 1988, leg. et det. *Mulas* (CAG! [two sheets]). Torregrande in territorio di Oristano, su terreni alluvionali, a circa 5 m s.l.m., 22 July 1988, leg. et det. *Mulas* (FI 53995!). **AFRICA. Morocco.** Rabat vicino alla stazione di Rabat-Agdal, in un piccolo giardino pubblico regolarmente annaffiato, 20 m a.s.l., 8 June 1998, *Lambinon* (MSNM 38474! sub *E. erecta* Lam. var. *erecta*). **South Africa**. Pr. Muizenbg., in dunis litoralibus, 6 m a.s.l., 31 July 1891, *Schlechter* (TO!). Pr. Muizenbg., in dunis litoralibus, 6 m a.s.l., 31 July 1891, *Schlechter* (RO-Herb.Generale! [two sheets]). Pr. Riversdale, in fruticetis, 133 m a.s.l., 2 February 1893, *Schlechter* (RO-Herb.Generale!).

Ehrharta delicatula **Stapf:—AFRICA. South Africa**. Tankwa Karoo National Park. Gannaga Pass between viewpoint and foot of pass, mountain slope, 6 August 2006, *Steyn* (KSAN! sub *E. delicatula* (Nees) Stapf). Tankwa Karoo National Park. Elandsberg, mountain slope, 6 August 2007, *Mudau* (KSAN! sub *E. delicatula* (Nees) Stapf). Richtersveld National Park, Numees, 14 September 2002, *Niebel-Lohmann* (KSAN! sub *E. delicatula*). Cape Province. Namaqualand. Kamieskroon, namaqualand broken veld. Well drained sandy soil. Granite. Shade, 13 July 1993, *van Rooyen* (PRU! sub *E. delicatula* (Nees) Stapf [two sheets]). Plags Eselsfantein op Spektakelpas, in skadu in dreineringslyn, 600 m a.s.l., 17 September 1985, *Tietsman* (?) (PRU! sub *E. delicatula* (Nees) Stapf). Hester Malan Veldblomres, rivierwal, 16 October 1974, *Rösch* et *Le Roux* (PRU!). Namakwaland, tussen Kammiesckroon en Garies, enjarige gras, op klam grond, 20 July 1967, *Schijff* (PRU! sub *E. delicatula* (Nees) Stapf). Eastern Cape, Steytlerville, Klipplaat, lawn at station, 23 October 1960, *Grunow* (PRU! sub *E.*

delicatula (Nees) Stapf). Eastern Cape, Steytlerville, Klipplaat, lawn at station. Disturbed area, 23 October 1960, *Rabie* (PRU! sub *E. delicatula* (Nees) Stapf). Kamieskroon, Namaqualand, river/stream, 762 m a.s.l., December 1952, *Liebenberg* (PRU! sub *E. delicatula* (Nees) Stapf). Kaap province: [illeg.] Kamieskroon, Namaqualand, July 1951, *coll. illeg.* (PRU! sub *E. delicatula* (Nees) Stapf). Pr. Piqueenerskloof, in arenosis, 283.3 m a.s.l., 21 August 1894, *Schlechter* (RO! [two sheets]). Pr. Piqueenerskloof, in arenosis, 283.3 m a.s.l., 21 August 1894, *Schlechter* (TO!). Pr. Malmesbury, in calle lapidoso, 300 m a.s.l., 1 October 1892, *Schlechter* (RO-Herb.Generale!). Mierenkasteel, 1000 m a.s.l., 6 August 1830, *Drège* (P 00434603!). Slangenheuvel, 800 m a.s.l., 1 September 1826, *Drège* (P 00434604!). Richtersveld National Park, Numees, s.d., *Jungens* (KSAN! sub *E. delicatula*).

Bloemfontein, sand bedding, 29 August 1980, *Venter* (BLFU 2696! sub *E. delicatula* (Nees) Stapf).

Bloemfontein, environment illeg., 27 August 1983, *Venter* (BLFU 2695! sub *E. delicatula* (Nees) Stapf).

Bloemfontein, strand, 30 January 1987, *Venter* (BLFU 2694! sub *E. delicatula* (Nees) Stapf).

FIGURE 1. Comparison between (**A**) *Ehrharta erecta* (Campania. Bosco inferiore di Portici [inselvatichita], 21 June 1907, *Pellanda*, FI 53987 sub *E. panicea* Sm.) and (**B**) *Ehrharta delicatula* (Pr. Piqueenerskloof, in arenosis, 283.3 m a.s.l., 21 August 1894, *Schlechter*, TO) with detail of the respective spikelets (**a**, **b**, scale bars 5 mm).

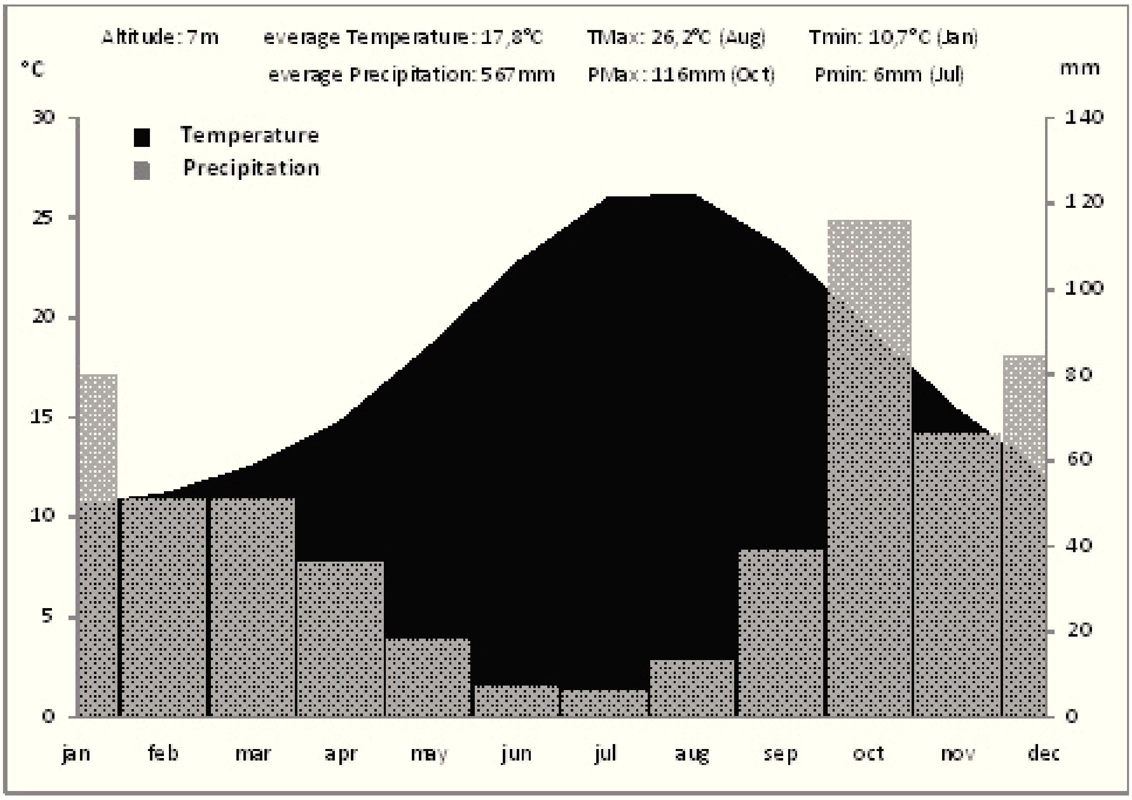

FIGURE 2. Thermo-pluviometric climogram of Fontanarossa (period 1961-2016).

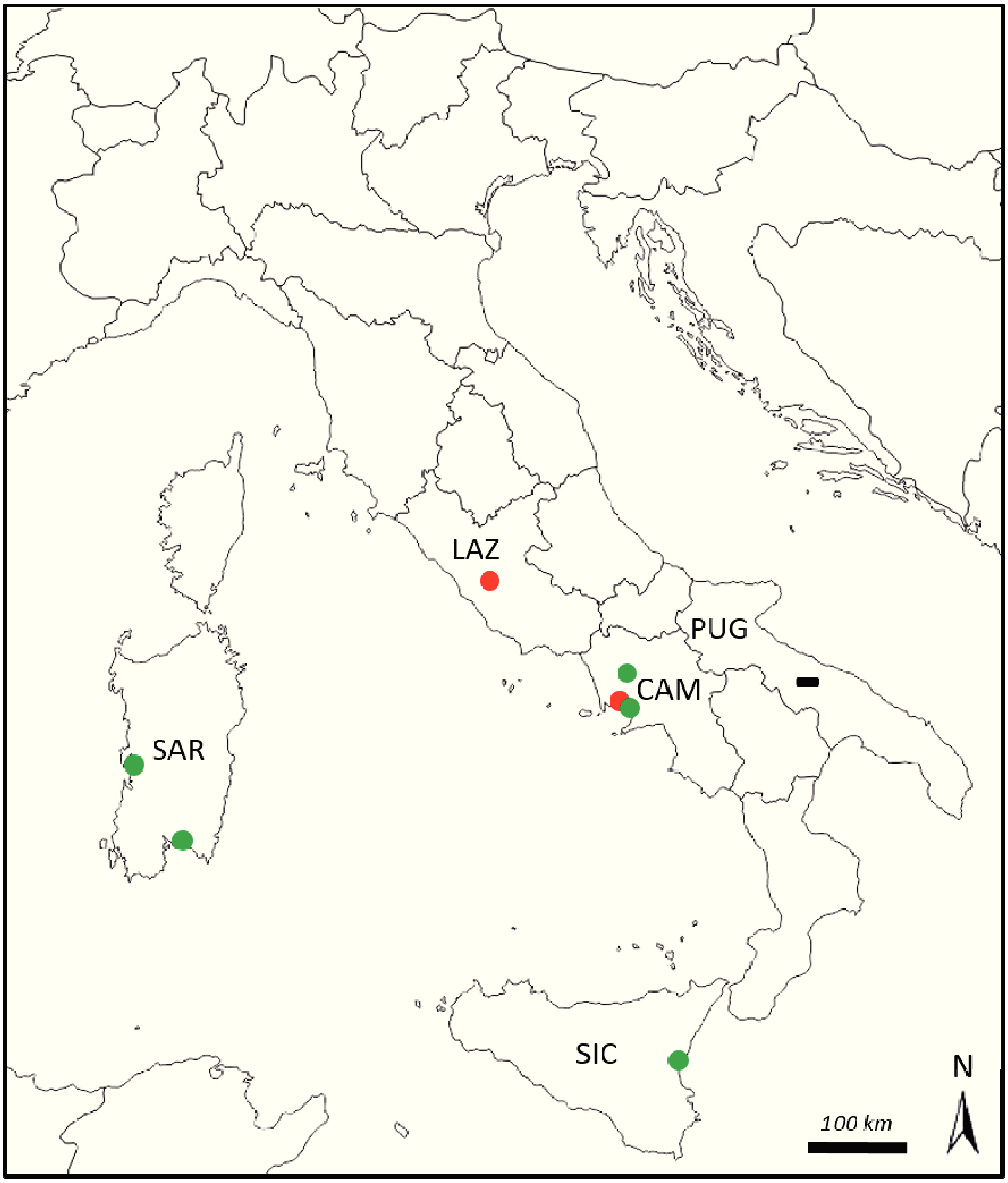

FIGURE 3. Current distribution map of *Ehrharta erecta* in Italy (green circles) with indication of the of recently unconfirmed (red circles) and excluded (-) localities, based on the studied herbarium specimens and field surveys (LAZ: Lazio; CAM: Campania; PUG: Puglia; SIC: Sicily; SAR: Sardinia).

TABLE 1. Morphological characters analyzed to compare *Ehrharta erecta* and *Ehrharta delicatula* (asterisk indicates the diagnostic characters).

	Ehrharta erecta	***Ehrharta delicatula***
***Biological form**	Hemicryptophyta caespitosa	Terophyta scaposa
Plant height (cm)	(30-)36.5-86(-88)	(7-)7.8-40(-60)
Leaf lamina length (in the center of the stem, cm)	(6.5-)7.9-16.5(-19.5)	(1.9-)2-12(-12.5)
Leaf lamina width (in the center of the stem, cm)	(0.6-)0.7-1.4(-1.5)	(0.1-)0.18-0.8(-0.85)
Panicle length (cm)	(7.5-)8.2-19.3(-22)	(2.1-)2.2-16.5(-17)
***Spikelet length (mm)**	(3-)3.1-4.1(-4.2)	(1.8-)1.9-2.7(-2.8)
Lower gluma length (mm)	(1.7-)1.8-2.6(-2.8)	(1.1-)1.2-2.1(-2.2)
Upper gluma length (mm)	(2.0-)2.1-3.0(-3.1)	(1.6-)1.7-2.4(-2.5)
***Number of sterile lemmas transversely ribbed**	1 (rarely, also the second sterile lemma show 1-5 transversal ribs that are not very evident)	2
Number of ribbed on first sterile lemma	(7-)10-14(-15)	(6-)7-8(-9)
***Number of stamens**	6	3

New records for Europaean countries

Viscum album L. subsp. austriacum (Wiesb.) Vollm. (Santalaceae)

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Distribution and habitat

Viscum album subsp. *austriacum* presents an Eurasian type of range; however, the precise distribution is still not fully known (Zuber 2004). In Europe it is widely distributed in all central and southern countries (Uotila 2011). However, the presence of this subspecies in Sicily was recorded only one centuries ago on Etna Mt. (Fiori 1923, as *V. album* L. γ *laxum* Boiss. et Reut.), but after then considered doubtful in the flora of island (Giardina, Raimondo, and Spadaro 2007), and no longer recorded in the Italian check-lists (Conti et al. 2005; Bartolucci et al. 2018).

This taxon is a hemi-parasitic dioecious shrub growing predominantly in mountain areas on the branches of some coniferous (*Pinus* spp., rarely *Picea* spp. and *Larix* spp.). On the Etna Mt. it was found in pioneer Corsican pine forest (Camerano, Cullotta, and Varese 2011) characterized by *Junipero hemisphaericae-Pinetum calabricae* Brullo & Siracusa in transitions among other pioneer associations on lavic materials.

Taxonomy

The cosmopolitan genus *Viscum* L. includes approximately 100 species (Zuber 2004) two of which are recorded in Europe: *V. album* L. and *V. cruciatum* Boiss. *Viscum album* is divided into several commonly accepted subspecies, which are most easily differentiated according to their hosts, as they are morphologically very similar. In Europe, four subspecies are recognized (Böhling et al. 2003; Zuber 2004; Uotila 2011): *V. album* subsp. *album* that lives on eudicots; *V. album* subsp. *abietis* (Wiesb.) Abrom. that occurs solely on *Abies* spp.; *V. album* subsp. *austriacum* that, as mentioned before, is found on *Pinus* spp. or rarely *Picea* spp. and Larix spp.; *V. album* subsp. *creticum* N.Böhling, Greuter, Raus, B.Snogerup, Snogerup & Zuber, which grows on *Pinus halepensis* Mill. subsp. *brutia* (Ten.) Holmboe exclusively in Crete.

Examined specimens (new record)

ITALY: Sicily, Mt. Etna, province of Catania, Linguaglossa in locality Mt. Conca, UTM WGS84: 33N 503670 E – 4182484 N, alt. 1805 m a.s.l., ENE exp., epiphyte on *Pinus nigra* J.F.Arnold subsp. *laricio* Palib. ex Maire, 7 April 2018, *G. Mei & A. Stinca* (ANC, PORUN).

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V1/oct. 2018

Premierre **Observation de *Salix* ×*aurigerana* Lapeyr. en Andorre**

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Résumé : *Salix* ×*aurigerana* Lapeyr., observé pour la première fois en Andorre en juillet 2018, est à ajouter à la flore de la principauté.

Mots-clés : Canillo. Montaup, *Salix caprea* × *Salix pyrenaica.*

Abstract: *Salix* ×*aurigerana* Lapeyr., observed for the first time in Andorra in July 2018, is to be added to the flora of the principality.

Key-words: Canillo. Montaup, *Salix caprea* × *Salix pyrenaica.*

Historique

Le protologue de *Salix aurigerana*, décrit de l'Ariège (France), notamment de la vallée de Vicdessos, par Philippe Picot de Lapeyrouse, fut publié dans *Histoire Abrégée des Plantes des Pyrénées,*1813 : 598-599 ; le *Supplément* (1818) présentant p. 148 & 149 des commentaires sur ce saule.

Réutilisé au siècle suivant, le binôme *Salix* ×*aurigerana* Coste & Soulié correspond à un *nomen nudum.* Le Saule de l'Ariège est considéré par Coste & Soulié (*in* Coste, s.d.) comme hybride de *Salix caprea* L. et de *Salix pyrenaica* Gouan, dont il possède des caractères morphologiques intermédiaires.

Alors que certains auteurs comme Camus & Camus (1904), Vicioso (1951), considèrent *Salix aurigerana* Lapeyr. comme synonyme de *Salix caprea* L., d'autres, plus récemment, reconnaissent le Saule de l'Ariège comme hybride [(Blanco (1993) ; Kerguélen (1999)].

Répartition connue

Comme l'un de ses parents présumés *Salix pyrenaica*, *Salix* ×*aurigerana* est limité à la chaine pyrénéenne où il fut ne fut que très rarement observé.

France

Département de l'Ariège :

- indiqué par Lapeyrouse (1813) en vallée de Vicdessos ;
- Salau, bois vers 1500 m / 26 juillet 1913 / Arbrisseau dressé d'environ 1 mètre / H. Coste [P-P05497669] ;
- Ariège Salau bois, près ruisseaux / 29 juillet 1913 L. Bec et Coste (*in* Herbier J. Arènes n° 21505) [P-P05500177 ; *dupl.* G, K] ;
- Ariège – Salau, ravins au nord-ouest / 29 juillet 1913 L. Bec (*in* Herbier J. Arènes n° 21506) [P-P05500178 ; *dupl.* MPU, MA] [MA-01-00846507]
- cité par Coste (s.d.) : Salau, bois exposé au nord à 1 500 m, sur la rive gauche ;
- cité par Gaussen (1966) en Haute-Ariège (Ai 4) dans le *Catalogue-Flore des Pyrénées* ;
- cité par Guerby (1991) dans le *Catalogue des Plantes vasculaires de l'Ariège*.

Département des Pyrénées-Atlantiques :

cité par C. Bernard (1982) en vallée d'Ossau (Commune de Laruns), montée au lac d'Isabe, *interparentes* vers 1 680 m d'altitude, le 5 août 1980 à l'occasion de la 111^{e} Session extraordinaire de la Société botanique de France.

Espagne

Cité sans localisation par Blanco (1993) dans *Flora iberica* (T. III : 516).

Découverte en Andorre

Saule jusqu'à présent non indiqué en Andorre, nous avons rencontré deux individus de *Salix* ×*aurigerana* dans la principauté le 17 juillet 2018 à l'occasion de l'une des excursions organisées dans le cadre du XII^{e} Séminaire international Gestion et conservation de la biodiversité d'Ordino (Lazare & Riba, 2018).

Ces deux saules se situent sur les rochers escarpés dénudés du tronçon en gorges de la partie amont du Riu de Montaup, situé juste à l'ouest de Costa de Roca Negra et à l'est–nord-est des Pics de Casamanya (Parroquia de Canillo). Le substrat rocheux est constitué de lutites du Silurien avec intercalations de calcschistes et de phyllites plus ou moins métamorphisées (?). Les deux individus de saule sont distants d'une trentaine de mètres. L'individu inférieur, dont des échantillons furent collectés, est situé à 2 247 m d'altitude, en exposition ouest-sud-ouest, sur les rochers de la rive gauche du torrent, entre le sentier est de la vallée de Montaup et le lit du torrent.

Les parents présumés de ce saule hybride sont observables non loin : *Salix pyrenaica* dans des landines subalpines distantes de 150 m environ vers le sud-ouest, et *Salix caprea* en aval dans la vallée de Montaup.

Formant des arbustes de taille comprise entre 1,5 et 1;8 m de hauteur, ils présentent de nombreux rameaux feuillés dont certains portent des chatons femelles (Fig. 1). L'étude des échantillons collectés révèle qu'ils associent des caractères propres aux deux parents et des caractères intermédiaires :

- caractères de *S. caprea* : port arbustif dressé ; bractées florales femelles noirâtres à l'extrémité (Fig. 2) ; chatons à pédoncule court ; bois dénudé lisse avec quelques rares stries peu distinctes (Fig. 3).
- caractères de *Salix pyrenaica* : feuilles adultes < 4 cm, assez mates, à face inférieure glauque, entières, parfois plus ou moins crénelées, à marge du limbe plus ou moins ciliée, à pétiole court, sans stipule apparente (Fig. 2 & 4) ; feuilles des rameaux portant des chatons semblables à celles des rameaux végétatifs ; floraison assez tardive ; bractée foliaire du pédoncule des chatons à bord cilié.
- caractères intermédiaires : taille arbustive moyenne ; face inférieure des feuilles pubescente (surtout sur les nervures) à l'état jeune, devenant plus ou moins glabre à maturité ou conservant des poils sur la nervure principale (Fig. 4) ; apex foliaire plus ou moins aigu, non apiculé, parfois tordu ; chatons femelles

subcontemporains, de 3,5 x 1 cm, à fleurs moyennement serrées ; rameaux florifères généralement en partie poilus, à poils plus ou moins courbés ou crépus.

Conclusion

Cette station andorrane du rare *Salix ×aurigerana* en constitue la première localité précise du versant méridional des Pyrénées. Comme les parents présumés *Salix caprea* et *Salix pyrenaica* ont une large répartition commune dans la chaîne pyrénéenne, il est probable que le Saule de l'Ariège soit moins rarissime dans la chaîne que la connaissance actuelle de sa distribution le laisserait supposer.

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Légende des illustrations

Figure 1 – Rameau ♀ de *Salix ×aurigerana* Lapeyr. *in* GABAS ; Rive gauche du Riu de Montaup (Canillo, Andorre), juste à l'ouest de Costa de Roca Negra, alt. 2 247 m, 17 juillet 2018, leg. J.-J. Lazare *et al.*

Figure 2 – Détail du rameau précédent montrant notamment les bractées florales à extrémité noirâtre et la marge ciliée du limbe foliaire.

Figure 3 – Détail du rameau précédent montrant le bois dénudé lisse présentant quelques stries longitudinales peu distinctes.

Figure 4 – Détail des feuilles du rameau précédent.

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RESEARCH ARTICLE

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Notulae to the Italian alien vascular flora: 3

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Abstract

In this contribution, new data concerning the Italian distribution of alien vascular flora are presented. It includes new records, exclusions, confirmations, and status changes for Italy or for Italian administrative regions for taxa in the genera *Acer*, *Amaranthus*, *Araujia*, *Aubrieta*, *Avena*, *Bidens*, *Calycanthus*, *Celtis*, *Elaeagnus*, *Eragrostis*, *Euonymus*, *Fallopia*, *Ficus*, *Hedera*, *Lantana*, *Ligustrum*, *Ludwigia*, *Morus*, *Oenothera*, *Opuntia*, *Oxalis*, *Parkinsonia*, *Paspalum*, *Paulownia*, *Platycladus*, *Pleuropterus*, *Rumex*, *Salvia*, *Senecio*, *Setaria*, *Syagrus*, *Tradescantia*, *Trifolium* and *Yucca*. Furthermore, a new combination in the genus *Vicia* is proposed.

Keywords

Floristic data, Italy, new combination

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimen along with its scan or photograph has to be sent to FI Herbarium: Sezione di Botanica Filippo Parlatore del Museo di Storia Naturale, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Gabriele Galasso (gabriele.galasso@comune.milano.it). Each text should be within 2,000 characters (spaces included).

Floristic records

Acer negundo L. (Sapindaceae)

+ (CAS) **PUG**: Maglie (Lecce), margine del parco pubblico “Villa Achille Tamborino” (WGS84: 40.117286°N; 18.299727°E), siepi e radure, ca. 82 m, 20 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

Several young individuals of the species, some higher than 2 m, grow at the margins of an urban park, inside hedges of *Laurus nobilis* L. and in clearings of *Quercus ilex* L. subsp. *ilex*. The specimens have developed in a partially shaded position, on dry, brown, calcareous luvisol covered by evergreen oak litter. They derive from wind-dispersed samaras produced by trees cultivated in the park.

N. Olivieri

Amaranthus ×*ozanonii* Thell. (Amaranthaceae)

+ (CAS) **CAL**: Oriolo (Cosenza), C.da Scalapitta nei pressi del Torrente Scalapitto (WGS84: 40.040365°N; 16.451603°E), incolto al margine di una strada sterrata, 325 m, 24 August 2016, *F. Roma-Marzio* (FI). – Casual alien nothospecies new for the flora of Calabria.

This hybrid between *Amaranthus hybridus* L. and *A. retroflexus* L. is probably native to Europe (Iamonico 2015). In Oriolo it is represented by many plants occupying uncultivated land at the margin of a dirt road.

F. Roma-Marzio, D. Iamonico

Araujia sericifera Brot. (Apocynaceae)

+ (CAS) **MOL**: Termoli (Campobasso), versante collinare S del Vallone del Riovivo (WGS84: 41.994961°N; 14.995788°E), pineta artificiale, ca. 27 m, 3 September 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

The species is represented by a small number of individuals in the undergrowth of an artificial pine forest composed mostly of *Pinus halepensis* Mill. subsp. *halepensis* and *P. pinaster* Aiton subsp. *escarena* (Risso) K.Richt., in the urban park of Termoli near the Adriatic coast. Plants grow in partial shade, on sandstone soil covered by a herbaceous vegetation typical of disturbed areas.

N. Olivieri

Aubrieta deltoidea (L.) DC. (Brassicaceae)

= *Aubrieta* ×*cultorum* Bergmans

+ (CAS) **TAA**: Pieve Tesino (Trento), walls of the town centre (WGS84: 46.069459°N; 11.609140°E), stone and cement walls, 850 m, S, 27 June 2016, *G. Mei* (FI, ANC, *Herb. G. Mei*). – Casual alien species new for the flora of Trentino-Alto Adige.

The species is widely cultivated as ornamental and is naturalized in southern and western Europe, widespread in Spain, France, Switzerland, England, Greece and the Balkans. The population of Pieve Tesino is interesting for its abundant fructification, for the presence of individuals of different ages and for the presence of seedlings. These features can be interpreted as the possible start of a future naturalization of the species.

G. Mei

Avena atherantha C.Presl (Poaceae)

+ (NAT) **MAR**: Potenza Picena (Macerata), Autostrada "Adriatica" A14, a S di C.da Terranova (WGS84: 43.384741°N; 13.680887°E), scarpata stradale, con *Sambucus ebulus*, *Arundo donax*, *Urtica dioica*, 8 m, 30 May 2016, *N. Ardenghi*, *P. Cauzzi*, *F. Guzzon* (FI). – Naturalized cryptogenic species confirmed for the flora of Marche.

A large population was detected growing on the motorway embankment; further stands (impossible to sample due to their unsafe location) were observed along Autostrada A14 in the same area. The species was first reported for this region by Ballelli (2002), but the record was not taken into account by Gubellini (2005, 2009).

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Avena sativa L. subsp. *byzantina* (K.Koch) Romero Zarco (Poaceae)

+ (CAS) **BAS**: Matera (Matera), tra Masseria di Pietrapenta e Strada Provinciale Papalione (WGS84: 40.631968°N; 16.545906°E), margine di sterrata, con *Avena barbata* e *Dasypyrum villosum*, 150 m, 9 June 2016, *N. Ardenghi*, *P. Cauzzi* (FI). – Casual alien species new for the flora of Basilicata.

About 100 individuals were observed on the edges of an unsurfaced road.

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Bidens aurea (Aiton) Sherff (Asteraceae)

+ (NAT) **PUG**: San Nicandro Garganico (Foggia), presso San Giuseppe (Km 20 della Strada Provinciale) (WGS84: 41.823250°N; 15.549489°E), cunette stradali, 250 m, 6 December 1987, *F. Pantaleo* (RO–Anzalone–3688); *ibidem*, presso "San Giuseppe" (WGS84: 41.823250°N; 15.549489°E), cunette stradali, 250 m, 23 November 1988, *F. Pantaleo* (RO–Anzalone–3689 sub *Bidens* sp.); *ibidem*, a W del paese, all'inizio della strada per San Marco in Lamis (WGS84: 41.823250°N; 15.549489°E), cunetta stradale, 250 m, 27 October 2016, *R.P. Wagensommer* (FI, *Herb. R.P. Wagensommer*). – Naturalized alien species new for the flora of Puglia.

In Italy, *Bidens aurea* is already known in Veneto, Toscana, Sicilia (Conti et al. 2005, 2007), Calabria (Bernardo et al. 2009), Lazio (Ceschin et al. 2010), Campania (Rosati et al. 2012), and Sardegna (Podda et al. 2012). During the digitization of the *B. Anzalone herbarium* in RO (Iberite et al. 2010), we found sheets collected almost 30 years ago in Puglia, on the Gargano Promontory, near San Nicandro Garganico. A field trip allowed us to confirm that the species is still present in the same locality, covering a small area of about 5 m^2, with no evidence of invasiveness.

G. Nicolella, M. Latini, R.P. Wagensommer, M. Iberite

Calycanthus floridus L. (Calycanthaceae)

+ (CAS) **ITALIA** (**TOS**): Seravezza (Lucca), valle del Torrente Serra, lungo la strada per Azzano, poco dopo la loc. Desiata (WGS84: 44.025840°N; 10.221460°E), casuale lungo la scarpata stradale, 216 m, 8 June 2016, *G. Ferretti*, *M. Gennai*, det. *G. Ferretti* (FI). – Casual alien species new for the flora of Italy (Toscana).

Calycanthus floridus is native to North America and cultivated in Italy as ornamental. A spontaneous population on an area of approximately 50 m^2 was found on the way to Azzano on the Apuan Alps, on a slope at the road edge. The population is probably originated from a plant once cultivated nearby. The specimens were identified according to Johnson (1997).

G. Ferretti, M. Gennai

Celtis occidentalis L. (Cannabaceae)

+ (CAS) **ABR**: Teramo (Teramo), loc. Coste di Sant'Agostino, lungo Via A. De Gasperi (WGS84: 42.663697°N; 13.703552°E), margine stradale, ca. 270 m, SW, 27 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

A young individual, about 2 m high, grows at the road edge, along the northern side of the Vezzola River valley covered by disturbed shrub vegetation. The location is outside the urban area and is characterized by pelitic-arenaceous sedimentary substrate. The vegetation consists of *Robinia pseudoacacia* L., *Rubus ulmifolius* Schott, *Ailanthus altissima* (Mill.) Swingle, *Hedera helix* L. *Ulmus minor* Mill., *Artemisia verlotiorum* Lamotte and *Inula conyzae* (Griess.) DC. There are no trees of *C. occidentalis* nearby, so the plant could be derived from a seed dispersed by endozoochory, since its fleshy drupes are eaten by birds. Until now the species has been reported in Italy from Piemonte, Lombardia, Veneto, Trentino-Alto Adige (Celesti-Grapow et al. 2009), and Emilia-Romagna (Bracchi and Romani 2010).

N. Olivieri

Elaeagnus ×*ebbingei* Door. (Elaeagnaceae)

+ (CAS) **ITALIA** (**ABR**): Pescara (Pescara), "Pineta Dannunziana" (WGS84: 42.455813°N; 14.234277°E), radure, ca. 2 m, 11 August 2016, *N. Olivieri* (FI). – Casual alien nothospecies new for the flora of Italy (Abruzzo).

Elaeagnus ×*ebbingei* (*E. macrophylla* Thunb. × *E. pungens* Thunb.) is a hybrid used as an ornamental plant, especially in coastal areas. Some individuals grow on dry sandy substrates in peripheral clearings of the "Pineta Dannunziana", near the Adriatic Sea not far from private and public gardens where the plant might be cultivated. They are partially shaded by foliage of *Pinus halepensis* Mill. subsp. *halepensis*. The presence of *E.* ×*ebbingei* in Italy has also been reported in Emilia-Romagna, but only as cultivated hybrid in pinewoods and dunes of the Parco Delta del Po (Lazzari et al. 2010, 2012). The species was identified according to Barnes and Whiteley (2011).

N. Olivieri

Eragrostis curvula (Schrad.) Nees (Poaceae)

– **LOM**. – Alien species to be excluded from the flora of Lombardia.

The only record of *Eragrostis curvula* for Lombardia (Mauri et al. 2012), based on a herbarium specimen stored at MSNM (duplicate in FI), is actually a misidentification with *E. pectinacea* (Michx.).

F. Verloove, G. Galasso

Eragrostis mexicana (Hornem.) Link subsp. *virescens* (J.Presl) S.D.Koch & Sánchez Vega (Poaceae)

+ (CAS) **PUG**: Casamassima (Bari) (WGS84: 40.951816°N; 16.888951°E), campo di olivi e altri fruttiferi, periodicamente arato, 230 m, 27 September 2016, *F.S. D'Amico*, *M. Terzi* (FI, BI). – Casual alien species new for the flora of Puglia.

Eragrostis mexicana subsp. *virescens* is an alien plant from South America (Argentina and Chile) whose European distribution area ranges from Portugal to Poland, and from Great Britain to Italy (Martini and Scholz 1998, Valdés and Scholz 2009). In Italy, it was recorded in northern regions and Calabria (Martini and Scholz 1998, Celesti-Grapow et al. 2009, Galasso et al. 2016a). A few individuals were found in an olive grove in a typical weed vegetation, thus confirming the occurrence of this taxon in southern Italy, where it has probably been confused with *E. pilosa* (L.) P.Beauv. subsp. *pilosa*, from which it can be distinguished for the lower isolated branch of the inflorescence (*versus* verticillate) and a pit on the ventral face of seeds (Martini and Scholz 1998).

F.S. D'Amico, M. Terzi

Euonymus japonicus Thunb. (Celastraceae)

+ (CAS) **PUG**: Otranto (Lecce), ruderi di un edificio situato in Via M. Corti (WGS84: 40.152152°N; 18.473799°E), ruderi, ca. 7 m, 21 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

An individual of the species, reaching 3 m in height, was found growing among limestone blocks within the ruins of a building collapsed some time ago. The plant grows in a rather shady position, protected from the wind, set against an inner wall of the building. The substrate is limestone rock debris and calcarenite, on which a layer of soil has developed. The site is characterized by a humid microclimate, a few meters away from the Adriatic Sea.

N. Olivieri

Fallopia baldschuanica (Regel) Holub (Polygonaceae)

+ (NAT) **BAS**: Matera (Matera), Tre Ponti, Strada Statale 7 "Appia", all'altezza dell'ex "Bar Ristorante delle Murge" (WGS84: 40.679654°N; 16.625529°E), scarpata stradale, con *Elymus* cfr. *repens*, 351 m, N, 8 June 2016, *N. Ardenghi, P. Cauzzi*, *F. Guzzon* (FI). – Naturalized alien species new for the flora of Basilicata.

Dense mats of this species have been observed also in Matera, about 350 m west from the locality of the reported herbarium specimen, along Strada Statale 7 (WGS84:

40.679810°N; 16.621462°E), and in Via V. Cappelluti, growing on an old wall (WGS84: 40.663492°N; 16.599205°E).

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Ficus microcarpa L.f. (Moraceae)

+ (CAS) **PUG**: Brindisi (Brindisi), Via Duca degli Abruzzi, giardini pubblici presso il monumento al Marinaio d'Italia (WGS84: 40.645208°N; 17.946816°E), epifita su *Phoenix canariensis*, ca. 10 m, 22 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

Ficus microcarpa is a halophytic species native to India, Sri Lanka, Nepal, China, Taiwan, Japan, Ryukyu Islands, Indochinese Peninsula, Indo-Malay Archipelago, Philippines, north-eastern Australia, New Caledonia, Solomon Islands, and part of Micronesia, widespread for ornamental purposes in Central and South America, Florida, southern California, Puerto Rico, Hawaiian Islands, Bermuda, New Zealand, and some Mediterranean countries. In many of these countries it is naturalized as lithophyte and hemi-epiphyte, often as invasive. In the Mediterranean region, it is considered invasive in Israel (Dufour-Dror 2013). In Brindisi, some young individuals have developed on the top of the trunk of a medium sized *Phoenix canariensis* H.Wildpret, between the rachis residues of cut leaves. They originated from seeds produced by a tree growing in a neighbouring garden. The syconia of this species are eaten by birds and the plant spreads by zoochory. In Italy, *F. microcarpa* has, until now, been reported in Sicilia (Schicchi 1999, Domina and Mazzola 2002) and Sardegna (Lazzeri et al. 2015) as naturalized and casual alien species, respectively.

N. Olivieri

Hedera algeriensis Hibberd (Araliaceae)

+ (CAS) **MAR**: Grottammare (Ascoli Piceno), Via Beata L. Sernardi (WGS84: 42.996095°N; 13.866046°E), crepa nell'asfalto tra muro e strada, 91 m, 30 May 2016, *N. Ardenghi, P. Cauzzi*, *F. Guzzon* (FI). – Casual alien species new for the flora of Marche.

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Hedera canariensis Willd. (Araliaceae)

+ (CAS) **PUG**: Bisceglie (Barletta-Andria-Trani), loc. Matinella, SP85 (WGS84: 41.186373°N; 16.472764°E), incolto con *Lolium perenne* e *Vitis* ×*koberi*, 120 m, 2 June 2016, *N. Ardenghi, P. Cauzzi, F. Guzzon* (FI). – Casual alien species new for the flora of Puglia.

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Lantana camara L. subsp. *aculeata* (L.) R.W.Sanders (Verbenaceae)

+ (NAT) **SIC**: Palermo (Palermo), Inserra (WGS84: 38.151857°N; 13.305263°E), pascolo, ca. 150 m, 9 November 2001, *P. Mazzola*, *G. Domina* (PAL); Vittoria (Ragusa), Scoglitti, incolti a E di Via Cocalo (WGS84: 36.889971°N; 14.436246°E), incolto con *Mirabilis jalapa*, *Saccharum biflorum* e *Solanum linnaeanum*, 31 m, no exp., 10 June 2014, *E. Banfi* (FI, MSNM); Santa Flavia (Palermo), Capo Zafferano, sulle pareti delle rupi sopra la strada (Stradella Vicinale Torre Zafferano) che porta al faro (WGS84: 38.110155°N; 13.538511°E), rupi, ca. 30 m, NE, 16 June 2016, *G. Domina* (PAL). – Naturalized alien subspecies new for the flora of Sicilia.

This taxon has already been reported in Abruzzo (Galasso et al. 2016a) and Molise (Galasso et al. 2016b). The previous report for Sicilia by Domina and Mazzola (2002) of *Lantana camara* has to be referred to this subspecies. According to Sanders (2012), it is easily distinguished due to the stout, recurved, often abundant prickles that cover stems. The plant appears as a robust shrub sometimes up to 3 m in height; corollas, basically yellow, aging red-orange, are typically infused with purple, sometimes pink at opening, aging to deep reddish-purple. Cultivated worldwide in the tropics and subtropics (horticultural origin) and largely escaped, especially in Africa and Australia (Sanders 2012); within the genus *Lantana*, this taxon seems to show a great autonomy in temperate climates.

E. Banfi, G. Galasso, G. Domina

Lantana depressa Small (Verbenaceae)

+ (CAS) **ITALIA** (**SIC**): Vittoria (Ragusa), Scoglitti, prolungamento sterrato di Via Pescara verso la spiaggia (WGS84: 36.892863°N; 14.427918°E), residui di duna, 9 m, no exp., 10 June 2014, *E. Banfi* (FI, MSNM). – Casual alien species new for the flora of Italy (Sicilia).

According to Sanders (2012), the collected plants have to be attributed to the type variety of the species (var. *depressa*) because of its low-mounded shape, the height not reaching 1 m, the lack of a main stem, stems numerous, condensed, prominent, prostrate or decumbent and leaf blade not longer than 3 cm, strigilloso-strigose on the adaxial surface. It comes from peninsular Florida (Miami Ridge), where it typically grows in limestone pinelands; extensively cultivated and escaped in tropics and subtropics worldwide (Sanders 2012).

E. Banfi, G. Galasso, G. Domina

Ligustrum sinense Lour. (Oleaceae)

+ (CAS) **MOL**: Termoli (Campobasso), versante settentrionale del Vallone del Riovivo (WGS84: 41.996544°N; 14.994824°E), su lettiera di leccio, ca. 25 m, 3 September 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

Some young individuals grow on sandy soil, rich in litter, in the urban park of Termoli, under some *Quercus ilex* L. subsp. *ilex* trees and together with young plants of *Rhamnus alaternus* L. subsp. *alaternus* and *Q. ilex*. They have originated from seeds produced by some plants cultivated in the park.

N. Olivieri

Ludwigia peploides (Kunth) P.H.Raven subsp. *montevidensis* (Spreng.) P.H.Raven (Onagraceae)

+ (INV) **TOS**: Carmignano (Prato), fraz. Comeana, sponda del Torrente Ombrone Pistoiese (WGS84: 43.790174°N; 11.058680°E), sponda, popolazione di alcuni metri quadrati, distribuita sia in destra che in sinistra idrografica, 32 m, 26 August 2016, *J. Vannini*, *D. Dinelli*, det. *J. Vannini*, *D. Dinelli*, *V. Bigagli* (FI). – Invasive alien subspecies new for the flora of Toscana.

Ludwigia peploides subsp. *montevidensis* is an aquatic subspecies of South American origin, established in many European countries. It was introduced in Italy in the 20th century as ornamental plant for aquaria (Banfi and Galasso 2010). It quickly spread in many regions of northern Italy, as well as in Lazio (Azzella and Iberite 2010). It is a harmful invasive plant due to its rapid vegetative growth and high spread potential. The plant is subject to control and eradication projects in many European and South American countries. It was recently included in the list of Invasive Alien Species of Union Concern (Commission Implementing Regulation EU 2016/1141). The plant was identified according to Galasso (2007) and it was also observed in other locations along the Torrente Ombrone (il Castellare –Pistoia municipality, Pistoia–, Caserana and Ferruccia –Quarrata municipality, Pistoia–) and along the Arno River (Camaioni –Montelupo Fiorentino municipality, Firenze–). During the summer of 2016, rapid expansion of the taxon and a considerable increase of its coverage was observed.

J. Vannini, D. Dinelli, V. Bigagli, G. Ferretti

Morus indica L. (Moraceae)

+ (CAS) **ABR**: Francavilla al Mare (Chieti), recinzione in cemento posta tra un parcheggio e la linea ferroviaria, presso Via C. de Titta (WGS84: 42.421338°N; 14.287327°E), bordo di recinzione, ca. 3 m, 28 October 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

A young specimen, about 2 m tall, grows within the town, on sandy soil near the Adriatic coast. The species is present with some adult trees grown as ornamental in neighboring private gardens. *Morus indica* is an East Asian species, originally distributed in China, Japan, Korea, Bhutan, India, Myanmar and Nepal (Zhou and Gilbert 2003), which has recently spread in Mediterranean countries as ornamental and shade-tree species, especially in coastal areas, for its resistance to salty winds. In Italy, *M. indica* had been found, so far, only in Lazio (Galasso et al. 2016b).

N. Olivieri

+ (CAS) **PUG**: Gallipoli (Lecce), lungo Via Messina, in un'area parzialmente ombreggiata (WGS84: 40.060313°N; 17.998421°E), bordo di marciapiede, ca. 27 m, 19 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

A young individual was found growing along the sidewalk in an area, partially shaded by the foliage of *Grevillea robusta* A.Cunn. ex R.Br., near a public garden where there is an arboreal individual of the species. The place is located in a suburban area, not far from the Ionian Sea.

N. Olivieri

Oenothera laciniata Hill. (Onagraceae)

+ (CAS) **LOM**: Vigevano (Pavia), Bosco Ronchi (WGS84: 45.285492°N; 8.937638°E), in a dry grassland, 75 m, 7 June 2016, *G. Gheza*, det. *S. Assini* (FI). – Casual alien species new for the flora of Lombardia.

Oenothera laciniata, which is native to North America, is known in Italy for Piemonte (Bouvet et al. 2005), Toscana (Foggi et al. 2005, Pierini and Peruzzi 2014) and Campania (Ricciardi et al. 1988). In the locality reported here, the species was recorded in a dry grassland of the *Thero-Airion* Tx. ex Oberd. 1957 in the valley of the Ticino River.

G. Gheza, S. Assini

Opuntia polyacantha Haw. (Cactaceae)

+ (CAS) **ITALIA** (**TAA**): Merano (Bolzano), Passeggiata Tappeiner (WGS84: 46.682944 N; 11.154278°E), prateria arida (*Festucetalia valesiacae*) su gneiss, 390 m, 2 January 2016, *T. Wilhalm* (BOZ); *ibidem*, 30 June 2016, *T. Wilhalm*, *A. Guiggi*, *M. Fink* (FI, BOZ, HMGBH). – Casual alien species new for the flora of Italy (Trentino-Alto Adige).

Thise species, of North American origin, is characterized by a prostrate habit and brown-yellowish fruit, dry when ripe (Benson 1982). Rarely cultivated, it has a remarkable hardiness for low temperatures and showy blooms. The group of individuals observed in an area of ca. 1–2 m^2, excluding the ornithochory for the characteristics of the fruit, is probably of anthropic origin due to the ornamental value of the species. The plant produces flowers and fruits in this habitat.

A. Guiggi, T. Wilhalm

Oxalis latifolia Kunth (Oxalidaceae)

+ (CAS) **PUG**: Foggia (Foggia), Villa Comunale – Parco Karol Wojtyla (WGS84: 41.462011°N; 15.560057°E), vegetazione erbacea al di sotto di esemplari di *Pinus halepensis* ed *Eucalyptus camaldulensis*, ca. 64 m, 18 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

The species occurs in several areas of the park, mostly partially shaded by trees and in flowerbeds. Specimens have settled in groups on calcareous, alluvial, vertisol, in a dry area of herbaceous vegetation subjected to partial desiccation in the summer.

N. Olivieri

Parkinsonia aculeata L. (Fabaceae)

+ (CAS) **LIG**: Genova (Genova), Quinto al Mare, Via A. Gianelli (44.383852°N; 9.022160°E), fra la strada asfaltata e il marciapiede, 16 m, 22 September 2016, *S. Peccenini* (FI). – Casual alien species new for the flora of Liguria.

Parkinsonia aculeata, native to the northern and central American deserts, is reported in Italy as naturalized in Sicilia and Puglia, casual in Lazio, Calabria and Sardegna (Celesti-Grapow et al. 2009, Celesti-Grapow et al. 2013, Buono et al. 2017).

S. Peccenini

Paspalum dilatatum Poir. (Poaceae)

+ (NAT) **PIE**: Ronco Biellese (Biella), fraz. San Carlo-Caucino, lungo i margini di Via Camillo Benso Conte di Cavour e nei prati immediatamente a ridosso della strada (WGS84: 45.5835°N; 8.0852°E), margine stradale e prati, 540 m, 25 August 2015, *G. Peraldo*, *E. Bonivento*, conf. *M. Lonati*, *A. Selvaggi*, *F. Verloove* (FI). – Naturalized alien species new for the flora of Piemonte.

The genus *Paspalum* L. includes nearly 350 species distributed in tropical and subtropical regions, among which ten species are naturalized in Europe (Banfi and Galasso 2015, Verloove et al. 2016, Galasso et al. 2016a). In Italy, *P. dilatatum* was first observed in Liguria, where it probably started spreading after 1909 from the neighbouring Nice in France (Ariello 1952). Until recently, the species was known from most of the Italian administrative regions (Conti et al. 2005), but not yet from Piemonte. The vector of introduction in the San Carlo-Caucino locality is not clear. However, the species was probably introduced as a weed seed contained in chicken feed, as confirmed by the first plants being observed within a small family-run henhouse (year 2014). The species has been slowly spreading and now it occupies a scattered area close to the road, ranging between 520 to 550 m a.s.l.

G. Peraldo, E. Bonivento, M. Lonati, F. Verloove, A. Selvaggi

Paulownia tomentosa (Thunb.) Steud. (Paulowniaceae)

+ (CAS) **PUG**: Gallipoli (Lecce), bordo di giardino pubblico presso Via Pavia (WGS84: 40.059127°N; 17.997769°E), margine, ca. 27 m, 19 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

The species is present with few, young individuals, some higher than 2 m, growing on the edge of a public garden in a dry and fairly sunny area, on residual red soil of calcareous origin. The specimens probably originated from seeds produced by a tree cultivated in the neighboring garden.

N. Olivieri

Platycladus orientalis (L.) Franco (Cupressaceae)

+ (CAS) **PUG**: Castrignano del Capo (Lecce), loc. Santa Maria di Leuca, parete rocciosa lungo la Strada Provinciale 358 "Delle Terme Salentine" nei pressi dello svincolo per Via Foresta Forte (WGS84: 39.798055°N; 18.368838°E), parete rocciosa, ca. 60 m, S, 21 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Puglia.

Some young individuals of the species have developed towards the top of the subvertical limestone rockface along the trench roadway, with *Thymbra capitata* (L.) Cav., *Dittrichia viscosa* (L.) Greuter subsp. *viscosa* and young individuals of *Pistacia lentiscus* L. They originated from seeds produced by some plants cultivated for ornamental purposes at the edges of a neighbouring private garden.

N. Olivieri

Pleuropterus multiflorus (Thunb.) Nakai (Polygonaceae)

≡ *Fallopia multiflora* (Thunb.) Haraldson ≡ *Reynoutria multiflora* (Thunb.) Moldenke

+ (CAS) **ABR**: Teramo (Teramo), lungo l'alveo del Torrente Vezzola (WGS84: 42.664161°N; 13.699792°E), vegetazione ripariale, ca. 240 m, 16 October 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Some individuals of the species grow along a path near the Vezzola Stream riverbed. They climb up to 3 m on *Robinia pseudoacacia* L. and *Prunus cerasifera* Ehrh. Below they are intertwined with branches of *Rubus ulmifolius* Schott. *Pleuropterus multiflorus* is a rhizomatous perennial climbing species, native to central and southern China (Li et al. 2003), introduced in Europe probably in the late 19th century as ornamental and recently spreading as alien in several administrative regions of northern Italy: Lombardia, Veneto, Trentino-Alto Adige, Piemonte (Galasso et al. 2006, Galasso and Ceffali 2008, Celesti-Grapow et al. 2009, Soldano and Galasso 2011), and Emilia-Romagna (http://www.actaplantarum.org/floraitaliae/viewtopic.php?f=40&t=69727, http://www.actaplantarum.org/floraitaliae/viewtopic.php?f=40&t=67829).

N. Olivieri

Rumex cristatus DC. (Polygonaceae)

+ (INV) **BAS**: Matera (Matera), Tre Ponti, Strada Provinciale Matera–Gioia del Colle (WGS84: 40.679146°N; 16.627682°E), margine stradale, con *Avena sterilis* subsp. *ludoviciana*, *Dasypyrum villosum*, *Carduus pycnocephalus*, *Ferula communis*, 342 m, 8 June 2016, *N. Ardenghi*, *P. Cauzzi*, *F. Guzzon* (*Herb. N. Ardenghi*); *ibidem*, Masseria di Pietrapenta, cava abbandonata (WGS84: 40.632286°N; 16.543702°E), terreno ruderale, con *Beta maritima*, *Dittrichia viscosa*, *Foeniculum vulgare*, 149 m, 9 June 2016, *N. Ardenghi*, *P. Cauzzi* (FI); *ibidem*, C.da Chiancalata, a lato della stradina per lo Studio legale Cifarelli (WGS84: 40.648249°N; 16.609604°E), fosso a lato della strada, con *Avena sterilis* e *Sorghum halepense*, 306 m, 10 June 2016, *N. Ardenghi, P. Cauzzi, F. Guzzon* (FI). – Invasive cryptogenic species new for the flora of Basilicata.

The choice of the invasive status is justified by the population near locality Tre Ponti in Matera, consisting of about 1,000 individuals distributed along the banks of the Fiumicello Stream over a distance of 1.15 km, from Tre Ponti eastwards to the point where the streamflow changes its direction northwards (WGS84: 40.679487°N; 16.641782°E).

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Salvia abrotanoides (Kar.) Sytsma × *Salvia yangii* B.T.Drew (Lamiaceae)

+ (CAS) **ITALIA** (**LOM**): Milano (Milano), binari a lato di Via Molinetto di Lorenteggio (comune di Corsico), angolo Via F. Gonin (WGS84: 45.441001°N; 9.117402°E), binari del tram, 118 m, no exp., 29 September 2013, *G. Galasso* (FI, MSNM). – Casual alien hybrid new for the flora of Italy (Lombardia).

+ (CAS) **TAA**: Pergine Valsugana (Trento), Pergine, sull'argine destro del Torrente Fersina poco a valle del ponte per Brazzaniga (CFCE: 9933/1) (WGS84: 46.071290°N; 11.236011°E), argine-margine della strada, tre cespi in un punto dove certamente non è stata piantata, presenza casuale, 488 m, 30 September 2014, *A. Bertolli*, *F. Prosser*, *G. Tomasi* (FI, ROV–67688). – Casual alien hybrid new for the flora of Trentino-Alto Adige.
+ (CAS) **TOS**: Siena (Siena), Strada di Marciano, su un muro esterno del Park Hotel Villa Gori Golf Club (WGS84: 43.331675°N; 11.305386°E), muro, 357 m, SE, 22 July 2016, *G. Bonari* (FI). – Casual alien hybrid new for the flora of Toscana.

Salvia subg. *Perovskia* (Kar.) J.B.Walker, B.T.Drew & J.G.González (Drew et al. 2017) includes about 8 species widely distributed over arid regions of Asia (Krüssmann et al. 1986, Hedge 1990, Li and Hedge 1994, Grant 2000, Hedge 2011). We considered several sources to identify our plants. Several cultivars are selected by gardeners (Grant 2007) thereby complicating nomenclature and identification. At first glance, we were inclined to attribute the taxon to *S. yangii* (≡ *Perovskia atriplicifolia* Benth.), but leaves were not "simple, margins crenate, serrate or subentire" as reported by Hedge (2011, see also Rechinger 1982). In fact, several varieties can be identified based on leaf shape and indumentum characters, but a comprehensive review is lacking (Hedge and Lamond 1968). Thus, "leaves bipinnatisect" guided us towards *S. abrotanoides* (≡ *P. abrotanoides* Kar.), also considering the figures (plates 369–372, 592) reported by Rechinger et al. (1982). However, this taxon did not perfectly fit our specimens either. Rechinger (1982) reported a hybrid (pl. 373 in Rechinger et al. 1982), which is the plant cultivated in North America according to Darke and Tucker (1989). Our plants seemed to correspond to "*Perovskia* ×'Hybrida' (= *P. abrotanoides* × *atriplicifolia*?)", based on the figure provided by Krüssmann et al. (1986), a plant cultivated by Hillier (England) since 1937 and distributed from the Geisenheim Research Institute since 1955 as *P.* 'Superba'. Because our specimens surely derived from seeds dispersed from cultivated flowerbeds in the cities, "*P.* 'Hybrida'" should be the best name to apply, but "it is not clear whether the majority of cultivars are variants of *P. atriplicifolia* or hybrids between *P. abrotanoides* and *P. atriplicifolia*" (Grant 2007). Considering that they differ from both the genuine putative parental species, we prefer to use the name *S. abrotanoides* × *S. yangii*, a hybrid apparently without nothospecific epithet because the only available one (in *Perovskia*) is *P.* ×*intermedia* Lazkov (*P. abrotanoides* × *P. angustifolia* Kudr.; Sennikov et al. 2011).

G. Bonari, G. Galasso, F. Prosser

Senecio inaequidens DC. (Asteraceae)

+ (NAT) **PUG**: San Giovanni Rotondo (Foggia), periferia S del paese (WGS84: 41.699155°N; 15.720507°E), margine stradale, 550 m, 25 October 2016, *R.P. Wagensommer* (*Herb. R.P. Wagensommer*); *ibidem*, periferia SSW del paese (WGS84:

41.699451°N; 15.711909°E), margine stradale e su materiale di riporto (ghiaia), 560 m, 27 October 2016, *R.P. Wagensommer* (FI, *Herb. R.P. Wagensommer*); Lesina (Foggia), alla stazione ferroviaria (WGS84: 41.854374°N; 15.296612°E), margine stradale e del parcheggio asfaltato, 40 m, 27 October 2016, *R.P. Wagensommer* (*Herb. R.P. Wagensommer*). – Naturalized alien species new for the flora of Puglia.

This invasive species occurs in all Italian administrative regions. To date, it was not recorded only in Puglia (Conti et al. 2005, Celesti-Grapow et al. 2009). We found it in two different sites on the Gargano Promontory, Lesina (about 30 mature individuals) and San Giovanni Rotondo (about 50 mature individuals).

R.P. Wagensommer, E.V. Perrino, G. Russo

Setaria parviflora (Poir.) Kerguélen (Poaceae)

+ (NAT) **CAL**: Scalea (Cosenza), Via Ruggiero di Lauria (WGS84: 39.815817°N; 15.787228°E), fessure della pavimentazione, 6 m, 20 August 2014, *A. Stinca* (PORUN). – Status change from casual to naturalized alien for the flora of Calabria.

This species is recorded from Lombardia, Liguria, Toscana, Marche, Lazio, Campania, Puglia, Calabria, Sicilia, and Sardegna (Celesti-Grapow et al. 2009, Cecchi and Arrigoni 2013, Stinca et al. 2013, Gubellini et al. 2014, Stinca et al. 2016). In Calabria, *Setaria parviflora* is reported as a casual alien (Bernardo et al. 2009) where it was known only for the valley of the Crati River (Banfi and Passalacqua 2011). At Scalea, it exhibits a notable vegetative and sexual propagation capacity; it was also observed in August 2016.

A. Stinca

Syagrus romanzoffiana (Cham.) Glassman (Arecaceae)

+ (CAS) **ITALIA** (**PUG**): Brindisi (Brindisi), Via Duca degli Abruzzi, giardini pubblici presso il monumento al Marinaio d'Italia (WGS84: 40.644977°N; 17.946627°E), tappeto erboso umido spesso irrigato, ca. 10 m, S, 22 August 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Italy (Puglia).

Some very young specimens, identified according to Cullen et al. (2011) and Squire (2007), have grown close to adult individuals of the species in a wet meadow frequently watered and located near the Adriatic Sea. In Brindisi *Syagrus romanzoffiana* is very popular as an ornamental plant in gardens and avenues. Fruits are regularly produced and accumulate on the ground below the trees. The species is native to South America (Brazil, part of Argentina, Paraguay, Uruguay and Bolivia). For its ornamental value, it is widespread in many tropical and subtropical areas and, more recently, also in Mediterranean countries. It is naturalized in Florida, Mauritius and eastern

Australia (Queensland and New South Wales), where it is considered an invasive alien (Randall 2001).

N. Olivieri

Tradescantia fluminensis Vell. (Commelinaceae)

+ (CAS) **MOL**: Termoli (Campobasso), versante collinare S del Vallone del Riovivo (WGS84: 41.993833°N; 14.996083°E), margine di sentiero e canneto di *Arundo donax*, ca. 27 m, 3 September 2016, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

The species grows near the Adriatic coast, in the urban park of Termoli, along a path edge and inside a cane thicket of *Arundo donax* L., along with *Rubus ulmifolius* Schott, *Hedera helix* L. and *Parietaria judaica* L. Plants grow in penumbra, on sandstone soil covered by nitrophilous vegetation typical of disturbed shaded areas.

N. Olivieri

Trifolium alexandrinum L. (Fabaceae)

+ (CAS) **BAS**: Matera (Matera), Bosco di Lucignano, ca. 185 m a SE dalla Cisterna di San Francesco (WGS84: 40.606911°N; 16.703098°E), campo di grano duro, con *Avena sterilis* subsp. *ludoviciana*, *Glebionis segetum*, *Anchusa azurea*, *Phalaris brachystachys*, un esemplare, 363 m, 9 June 2016, *N. Ardenghi*, *P. Cauzzi* (FI). – Casual cryptogenic species new for the flora of Basilicata.

A single individual was found in the middle of a durum wheat field.

N.M.G. Ardenghi, P. Cauzzi, F. Guzzon

Vicia lens (L.) Coss. & Germ. subsp. *orientalis* (Boiss.) Galasso, Banfi, Bartolucci & J.-M.Tison, comb. nov. (Fabaceae)

urn:lsid:ipni.org:names:60474540-2

≡ *Ervum orientale* Boiss., Diagn. Pl. Orient., ser. 1 9: 115(–116). 1849 [I–II.1849] ≡ *Lens orientalis* (Boiss.) Schmalh., Fl. Sredn. Yuzhn. Rossii 1: 297. 1895 ≡ *Vicia orientalis* (Boiss.) Bég. & Diratz., Contr. Fl. Armenia: 61. 1912 [XI.1912] (n.v.) ≡ *Lens culinaris* Medik. subsp. *orientalis* (Boiss.) Ponert, Feddes Repert. 83(9–10) (1972): 634. 1973 [25.IV.1973].

According to the molecular phylogenetic research published by Schaefer et al. (2012), the genus *Lens* Mill. is nested within *Vicia* L. For the type species of *Lens*

(*Lens culinaris* Medik.), the binomial *Vicia lens* (L.) Coss. & Germ. was restored by the above cited authors. Since the subspecific rank is considered suitable for representing taxonomic relationships between a domesticated crop and its wild relative, a new combination is proposed here for the wild relative of *Vicia lens*. It is distinct from the crop for a smaller size of the plant, allogamy, ready opening of the mature pod and seed dormancy (Ladizinski 1993, Zohari et al. 2012).

G. Galasso, E. Banfi, F. Bartolucci, J.-M. Tison

Yucca gloriosa L. (Asparagaceae)

+ (INV) **TOS**. – Status change from naturalized to invasive alien for the flora of Toscana.

Yucca gloriosa, native to North America, is currently recognized as naturalized in Toscana (Ciccarelli et al. 2015). During field surveys conducted along the coastal part of the Migliarino-San Rossore-Massaciuccoli Regional Park, we noted a widespread diffusion of the species. Its high frequency along the Tuscan coast can be also deduced from several floristic records (Peruzzi and Bedini 2015 onwards, Roma-Marzio et al. 2016 and literature cited therein). Based on our field observations, the species shows a high clonal propagation capacity, determining modifications in vegetation and ecosystem dynamics. In addition, the *ad hoc* LIFE project DUNETOSCA (http://ec.europa.eu/environment/life/project/Projects/), conducted in 2010–2013, failed to eradicate the species. Based on these considerations, we regard the status of invasive alien to be most appropriate for *Y. gloriosa* in Toscana.

M. D'Antraccoli, F. Roma-Marzio

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RESEARCH ARTICLE

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Abstract

In this contribution, new data concerning the distribution of native vascular flora in Italy are presented. It includes new records and confirmations to the Italian administrative regions for taxa in the genera *Allium*, *Arabis*, *Campanula*, *Centaurea*, *Chaerophyllum*, *Crocus*, *Dactylis*, *Dianthus*, *Festuca*, *Galanthus*, *Helianthemum*, *Lysimachia*, *Milium*, *Pteris*, and *Quercus*. Nomenclature and distribution updates, published elsewhere, and corrections are provided as supplementary material.

Keywords

Floristic data, Italy, nomenclature

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimens along with its scan or photograph have to be sent to FI Herbarium: Sezione di Botanica "Filippo Parlatore" del Museo di Storia Naturale, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Fabrizio Bartolucci (fabrizio.bartolucci@gmail.com). Each text should be within 2,000 characters (spaces included).

Floristic records

Allium schoenoprasum L. subsp. *schoenoprasum* (Amaryllidaceae)

+ **SAR:** Villagrande Strisaili (Ogliastra), Rio Bau Mela, rocce del torrente, sx orografica a monte del ponte. (WGS84: 40.016700°N; 09.251693°E) 870 m s.l.m., 17 June 2016, *G. Calvia, G. Mereu, A. Tatti* (FI). – Species new for the flora of Sardegna.

This species has a boreal distribution and, in Italy, it is known for all the northern administrative regions, Lazio and Abruzzo, but not yet for Sardegna (Bartolucci et al. 2018). The species is widespread in Corsica, according to Jeanmonod and Gamisans (2013). The Sardinian population reported here was first found in June 2013 (herbarium specimen preserved in Berchidda, Herb. Calvia) and was observed again in 2016, in a small area along a stream in the eastern basal sector of the Gennargentu.

G. Calvia, G. Mereu

Arabis planisiliqua (Pers.) Rchb. (Brassicaceae)

\+ **ABR:** Serramonacesca (Pescara), Castel Menardo (WGS84: 42.240007°N; 14.086163°E), pascoli, 400 m, 18 May 2002, *F. Conti, D. Tinti* (APP No. 14786, FI); Capestrano (L'Aquila), Vallone di S. Giacomo (WGS84: 42.266167°N; 13.821541°E), *Quercus ilex* and *Q. pubescens* wood, 550 m, 20 May 2005, *C. Oberprieler et al.* (APP No. 15085); Valle Castellana (Teramo), M.ti Gemelli al M. dei Fiori presso Sant'Angelo in Volturino (WGS84: 42.771212°N; 13.581027°E), pendii rupestri, 1200-1465, 24 April 2000, *F. Conti, D. Tinti, L. Gubellini, A. Alessandrini* (APP No. 18778). – Species new for the flora of Abruzzo.

In Italy, the species is recorded only for Liguria and Sardegna, while it is not been recently confirmed for Toscana (Bartolucci et al. 2018).

F. Conti, F. Bartolucci

Campanula isophylla Moretti (Campanulaceae)

\+ (CAS) **ABR:** Castelli (Teramo), muraglione in blocchi di roccia calcarea situato lungo il margine stradale all'interno dell'abitato (WGS84: 42.488558°N; 13.711749°E), ca. 497 m, 24 September 2017, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

The site in which the species was discovered is an urban area. The individual has probably grown from seeds produced by plants cultivated for ornamental purposes on private balconies. *Campanula isophylla* is an Italian endemic, native to Liguria (Bartolucci et al. 2018), but widely cultivated for ornamental purposes.

N. Olivieri

Centaurea centauroides L. (Asteraceae)

\+ **CAL:** Albidona (Cosenza), Serra del Glaccaro, lungo la strada SP 153, incolti a margine strada (WGS84: 39.906101°N; 16.514156°E), 480 m, 21 June 2017, *L. Bernardo, D. Gargano, N.G. Passalacqua* (FI, CLU). – Species new for the flora of Calabria.

This species is endemic to southern Italy (Peruzzi et al. 2014, 2015); it is known for Molise, Campania, Basilicata, and Puglia (Del Guacchio 2010, Bartolucci et al. 2018). To date, the locality reported here represents the southern limit of the species' range.

L. Bernardo, D. Gargano. N.G. Passalacqua

Chaerophyllum nodosum (L.) Crantz (Apiaceae)

\+ **PUG:** Monti dell'Arena, Cagnano (Foggia), 15 March 1893, *U. Martelli*, (FI 52277, sub *Physocaulis nodosus* Tausch); Murgie di Gravina, nel "Pulicchio", ai "Fronti di Gravina" (Bari), 12 August 1897, *A. Palanza* (BI 45750-45751); San Giovanni Rotondo (Foggia), Valle Masselli (WGS84: 41.67159°N; 15.79295°E), 482 m s.l.m., lecceta, 31 May 2008, Leg. et Det. *F. Mantino* (BI 40527); Castellaneta (Taranto), Monte S.

Trinità (WGS84: 40.627034°N; 16.858954°E), 410 m s.l.m., boscaglia a Leccio, 9 December 2008, Leg. *F. Carruggio*, Det. *F. Carruggio & G. Pazienza* (BI 40528); Gravina in Puglia (Bari), Pulicchio di Gravina (WGS84: 40.90396388°N; 16.42280277°E), 487 m s.l.m., rimboschimento a Pino d'Aleppo, 7 September 2017, Leg. et Det. *G. Pazienza*, (BI 40531-40532). – Species confirmed for the flora of Puglia.

Chaerophyllum nodosum is reported as doubtfully present in Puglia (Bartolucci et al. 2018). An ongoing study on the Alfonso Palanza Herbarium preserved in BI allowed to trace two 19th century specimens collected in Gravina in Puglia (Bari). Another historical collection by U. Martelli from Cagnano Varano (Gargano) can be found in FI (sub *Physocaulis nodosus* Tausch). Furthermore, this species was indicated for Ginosa in the Arco Jonico (Tenore 1831) and for Monte Sacro, in the Gargano promontory again (Rigo 1877, sub *Physocaulus nodosus* Tausch). The new records confirm the presence of this species in all the Apulian areas for which the species was recorded in the past.

G. Pazienza, F. Carruggio, V. Cavallaro, F. Mantino, L. Forte

Crocus neglectus Peruzzi & Carta (Iridaceae)

+ **LAZ:** Configni (Rieti), M. Cosce versante NO-N (WGS84: 42.431248°N, 12.614087°E), pascolo, suolo calcareo, 820 m, 19 February 2017, *F. Falcinelli* (FI); Leonessa (Rieti), M. La Cerasa versante NO (WGS84 42.560348°N; 13.093250°E), pascolo, suolo calcareo, 1520 m, 23 April 2017, *F. Falcinelli* (PI No. 010235). – Species new for the flora of Lazio.

The presence of *Crocus neglectus* was not yet reported for Lazio (Bartolucci et al. 2018). The localities published here are close to the boundary with Umbria, where the species was recently found (Bartolucci et al. 2017).

Falcinelli F., Roma-Marzio F., Peruzzi L.

Dactylis glomerata L. subsp. *hackelii* (Asch. & Graebn.) Cif. & Giacom. (Poaceae)

+ **CAM:** Anacapri (Napoli), Punta Campetiello (WGS84: 40.549047°N; 14.198525°E), rupe calcarea marittima, 10 m, SW, 26 August 2015, *A. Stinca, M. Ravo* (FI, PORUN); Anacapri (Napoli), Punta di Miglio (WGS84: 40.557127°N; 14.198239°E), rupe calcarea marittima, 10 m, N, 26 August 2015, *A. Stinca, M. Ravo* (PORUN); Capri (Napoli), Bagni di Tiberio (WGS84: 40.559380°N; 14.229349°E), rupe calcarea marittima, 2 m, N, 8 August 2015, *A. Stinca, M. Ravo* (PORUN); Capri (Napoli), tra Marina Grande e Punta Vivara (WGS84: 40.556711°N; 14.237138°E), pendio rupestre marittimo, 3 m, NNE, 8 August 2015, *A. Stinca, M. Ravo* (PORUN); Capri (Napoli), Punta Tragara (WGS84: 40.543408°N; 14.251923°E), rupe calcarea marittima, 5 m, SW, 9 August 2015, *A. Stinca, M. Ravo* (PORUN). – Subspecies new for the flora of Campania.

In Italy, *Dactylis glomerata* subsp. *hackelii* was, so far, recorded only for Toscana, Lazio, Puglia, and Sicilia (Bartolucci et al. 2018).

A. Stinca, G. Chianese

Dianthus carthusianorum L. subsp. *tenorei* (Lacaita) Pignatti (Caryophyllaceae)

+ **PUG:** Corato (Bari), Necropoli di San Magno, prateria xerica su substrato calcareo (WGS84: 41.020401°N; 16.212041°E), 478 m, 3 June 2017, *G. Buccomino* (FI). – Subspecies new for the flora of Puglia.

This is an Italian endemic subspecies, reported by Bartolucci et al. (2018) for central and southern Italy excluding Puglia and the islands. The population reported here consists of a small number of individuals. This taxon has also been observed in the "Trullo di Sotto" locality (Poggiorsini, Bari), in the calcareous steppe grasslands related to vegetation of trans-Adriatic and north-Adriatic Carso areas (Forte et al. 2005). Both sites are included in the "Alta Murgia" National Park and the "Murgia Alta" SCIs-SPAs IT9120007 under EU Directive 92/43/CEE.

G. Buccomino

Festuca trichophylla (Ducros ex Gaudin) K.Richt. subsp. *asperifolia* (St.-Yves) Al-Bermani (Poaceae)

+ **LAZ:** Micigliano (Rieti), Monti Reatini, Fonte Campo Marino (WGS84: 42.44698°N; 13.04959°E), brometo a *Bromopsis erecta*, con *Brachypodium rupestre* e *Lotus herbaceus*, argille, 910 m, E, 18 June 2015, Leg. *E. Del Vico*, *L. Facioni*, Det. *N.M.G. Ardenghi* (FI); Rieti (Rieti), Monti Reatini, Monte Lugnano (WGS84: 42.44231°N; 12.96242°E), prateria a *Brachypodium rupestre*, con *Dactylis glomerata* e *Lolium arundinaceum*, 1249 m, WSW, 22 July 2016, Leg. *E. Del Vico*, Det. *N.M.G. Ardenghi* (PAV). – Subspecies new for the flora of Lazio.

This subspecies, typical of mesophilous to mesoxerophilous grasslands (Foggi et al. 2017), is reported from most Italian administrative regions, but not yet from Lazio (Bartolucci et al. 2018).

N.M.G. Ardenghi, E. Del Vico, L. Facioni

Festuca trichophylla (Ducros ex Gaudin) K.Richt. subsp. *trichophylla* (Poaceae)

+ **LAZ:** Poggio Bustone (Rieti), Monti Reatini, Prati S. Giacomo (WGS84: 42.51347°N; 12.90438°E), prateria a *Cynosurus cristatus* con *Lolium perenne*, terra rossa, 1310 m, WSW, 2 July 2015, Leg. *E. Del Vico*, *L. Facioni*, Det. *N.M.G. Ardenghi* (PAV); Micigliano (Rieti), Monti Reatini, Erba pulita (WGS84: 42.46443°N; 12.99754°E), festuceto a *F. trichophylla* subsp. *trichophylla*, con *Poa molinerii*, *Koeleria splendens* e *Thymus praecox* subsp. *polytrichus*, marne, 1702 m, E, 15 July 2017, Leg. *E. Del Vico*, Det. *N.M.G. Ardenghi* (PAV); Rieti (Rieti), Monti Reatini, l'anello-Campoforogna (WGS84: 42.44679°N; 12.99214°E), prateria a *Cynosurus cristatus*, calcare, 1616 m, SE, 21 July 2015, Leg. *E. Del Vico*, Det. *N.M.G. Ardenghi* (PAV); Cantalice (Rieti), Monti Reatini, Colle Mattutino (WGS84: 42.49041°N; 12.91424°E), prateria a *Brachypodium rupestre*, con *Dactylis glomerata* e *Bromopsis erecta*, calcare, 1192 m, SE, 23 June 2016, Leg. *E. Del Vico*, Det. *N.M.G. Ardenghi* (PAV); Poggio Bustone (Rieti), Monti Reatini, Colle Pietrolone (WGS84: 42.49889°N, 12.90310°E), marne, prateria a *Cynosurus cristatus*, con *Lolium perenne*, 1070 m, WSW, 24 June 2016, Leg. *E. Del Vico*, Det. *N.M.G. Ardenghi* (FI, PAV). – Subspecies new for the flora of Lazio.

This subspecies was not yet reported from Lazio (Bartolucci et al. 2018), despite it being quite common in the Monti Reatini area (central Apennines).

N.M.G. Ardenghi, E. Del Vico, L. Facioni

Galanthus reginae-olgae Orph. subsp. *reginae-olgae* (Amaryllidaceae)

\+ **LAZ:** Ischia di Castro (Viterbo), Valle del F. Fiora, nei pressi dell'Eremo di Poggio Conte (WGS84: 42.510893°N; 11.625411°E), 113 m, bosco misto con cerro, carpino bianco e alloro, esp. W-SW, 23 December 2017, *A. Scoppola, C. Nicolini*, Det. *L. Peruzzi*, (FI, UTV No. 35351). – Species new for the flora of Lazio.

According to Davis (1999) and Pignatti (2017) it is a NE-Steno-Mediterranean taxon occurring in Greece, the northwestern and western Balkan Peninsula, Sicilia, and peninsular Italy. The records from the four administrative regions in mainland Italy are all recent: Toscana (Mazzoni et al. 2009), Calabria (Di Marco et al. 2011), Basilicata (Bernardo and Caldararo 2015), and Campania (Bamonte 2016). In Lazio, it was observed and collected in 2007 in Ponte San Pietro, close to the border with Toscana, where several hundred individuals grew in mixed Turkey and downy oak wood (L. Peruzzi pers. comm.). It was then cultivated for some years at the Pisa Botanical Garden, but the discovery in Lazio was never published. The current finding comes from a locality not far from Ponte San Pietro in the Fiora river valley, where the local environment (woodland) is particularly favorable due to water availability during the growing season. Here, this taxon grows abundantly on deep fertile volcanic soil. It flowers from late November; leaves either about 2–4 cm long or absent at the onset of flowering.

A. Scoppola, M. Martino

Helianthemum oleandicum (L.) Dum.Cours. subsp. *italicum* (L.) Ces. (Cistaceae)

\+ **CAM:** Vico Equense (Napoli), loc. Croce della Conocchia (WGS84: 40.646848°N; 14.496707°E), 1297 m, rocky slops, 7 July 2015, *F. Scafidi, E. Di Gristina* (PAL109646, FI). – Subspecies new for the flora of Campania.

This taxon is endemic to the Euro-Mediterranean Region (Raab-Straube 2018). In Italy, it is reported for northern and central administrative regions, and it is recorded as doubtfully present in Puglia (Bartolucci et al. 2018). To date, the locality reported here represents the southern limit of its Italian range.

F. Scafidi, E. Di Gristina

Lysimachia arvensis (L.) U.Manns & Adreb subsp. *arvensis* (Primulaceae)

+ **CAL:** Oriolo (Cosenza), C.da Scalapitta, nell'alveo del torrente Scalapitto (WGS84: 40.04053°N; 16.451051°E), alveo fluviale in secca, 325 m, 17 August 2017, *F. Roma-Marzio* (FI). – Subspecies new for the flora of Calabria.

Three taxonomically doubtful subspecies are recognized in Italy for *Lysimachia arvensis* (Peruzzi and Bartolucci 2016, Bartolucci et al. 2018): *L. arvensis* subsp. *arvensis*, *L. arvensis* subsp. *latifolia* (L.) Peruzzi, and *L. arvensis* subsp. *parviflora* (Hoffmanns. & Link) Peruzzi. In Calabria, only *L. arvensis* subsp. *parviflora* was recorded so far (Bartolucci et al. 2018). The plants reported here are characterized by red-orange petals with three-celled marginal hairs.

F. Roma-Marzio

Milium vernale M.Bieb. subsp. *vernale* (Poaceae)

+ **TOS:** San Rossore (Pisa), coastal pine forest with *Pinus pinea* L. (WGS84: 43.737031°N; 10.334932°E), on sandy soil, 0-5 m, 4 May 2015, leg. *G. Bonari* (FI). – Species new for the flora of Toscana.

To date, this species was known in Italy for the main islands, the south and the center of the Peninsula northwards to Lazio, Umbria, and Marche (Bartolucci et al. 2018). It includes six different variants accepted at subspecific rank, four of which recorded for the Italian flora (Valdés and Scholz 2009). Among these, *M. vernale* subsp. *intermedium* Prob., described from Algeria and putatively reported for Italy but no longer taken into account (Pignatti 2017), remains unresolved. Certainly, systematic and taxonomic boundaries among these taxa are not clear, with the exception of *M. vernale* subsp. *montianum* (Parl.) K.Richt., a morphologically, ecologically and chorologically better circumscribed unit. The Tuscan finding can be attributed to the autonymic subspecies by its culms not sheathed up to the panicle, by the uppermost leaf and the panicle open, with branches not, or scarcely, verticillate.

E. Banfi, G.Bonari

Pteris vittata L. (Pteridaceae)

+ (CAS) **UMB:** Gubbio (Perugia) (WGS84: 43.351888°N; 12.572579°E), mura dell'Anfiteatro Romano, 380 m a.s.l., 2 April 2014, *G. Mei* (FI). – Casual alien species new for the flora of Umbria.

The observed population consists of a very small number of individuals, all characterized by reduced size, likely a symptom of stress.

G. Mei

Quercus suber L. (Fagaceae)

+ (CAS) **ABR:** Pescara (Pescara), aiuola spartitraffico, presso via Antonio Lo Feudo (WGS84: 42.450919°N; 14.218694 E), a ca. 4 m, 9 August 2017, *N.Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Some young individuals of the species have developed near some adult ones introduced for ornamental purposes in some road-flowerbeds located in the southern part of the city of Pescara. *Quercus suber* is a western Mediterranean species, spread in Italy in Liguria, Toscana, Lazio, Campania, Puglia, Basilicata, Calabria, Sicilia, Sardegna, and alien in Umbria (Bartolucci et al. 2018). In Abruzzo, the species was present, in the past, in the province of Chieti, as evidenced by various findings discovered in a byzantine settlement of the 6th-7th century AD at Crecchio (Sciò 1993).There is evidence that the presence of *Q. suber* in the region lasted until at least 1700 AD in some areas located along the Adriatic coast (Romanelli 1790). In these places, some existing toponyms refer to this plant.

N. Olivieri

Nomenclature and distribution updates from other literature sources

Nomenclature and distribution updates according to Meve and Liede (2002), Barbaro and Kreutz (2007), Crespo et al. (2015), Ardenghi and Polani (2016), Wilson (2016), Lazzeri (2017), Banfi (2018), Baum and Johnson (2018), Di Gristina et al. (2018), Gutiérrez-Larruscain et al. (2018), Nardi et al. (2018), Madhani et al. (2018), Selvaggi et al. (2018) and corrections to Bartolucci et al. (2018) are provided in Supplementary material 1.

F. Bartolucci

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Supplementary material 1

Supplementary material

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Data type: species data

Explanation note: 1. Nomenclature updates; 2. Distribution updates; 3. Synonyms, misapplied or included names.

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RESEARCH ARTICLE

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Notulae to the Italian alien vascular flora: 6

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Abstract

In this contribution, new data concerning the distribution of vascular flora alien to Italy are presented. It includes new records, confirmations, exclusions, and status changes for Italy or for Italian administrative regions of taxa in the genera *Acalypha*, *Acer*, *Canna*, *Cardamine*, *Cedrus*, *Chlorophytum*, *Citrus*, *Cyperus*, *Epilobium*, *Eucalyptus*, *Euphorbia*, *Gamochaeta*, *Hesperocyparis*, *Heteranthera*, *Lemna*, *Ligustrum*, *Lycium*, *Nassella*, *Nothoscordum*, *Oenothera*, *Osteospermum*, *Paspalum*, *Pontederia*, *Romulea*, *Rudbeckia*, *Salvia*, *Sesbania*, *Setaria*, *Sicyos*, *Styphnolobium*, *Symphyotrichum*, and *Tradescantia*. Nomenclature and distribution updates, published elsewhere, and corrigenda are provided as supplementary material.

Keywords

Alien species, floristic data, Italy

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimen along with its scan or photograph has to be sent to FI Herbarium: Museo di Storia Naturale (Botanica), Sistema Museale di Ateneo, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Gabriele Galasso (gabriele.galasso@comune.milano.it). Each text should be within 2,000 characters (spaces included).

Floristic records

Acalypha australis L. (Euphorbiaceae)

+ (CAS) **LAZ**: Castrocielo (Frosinone), loc. Capodacqua (WGS84: 41.518520°N; 13.708890°E), prato, 110 m, 23 September 2016, *G. Nicolella, M. Iberite* (FI, RO). – Casual alien species new for the flora of Lazio.

This record is the first one for peninsular Italy, as the taxon was known only for some northern regions (Galasso et al. 2018a). This Asiatic species was observed growing on the left shore of a small lake characterized by disturbed vegetation, along with *Bidens vulgata* Greene (Nicolella et al. 2017), *Lemna minuta* Kunth, *Zantedeschia aethiopica* (L.) Spreng., and other alien species. The introduction of *Acalypha australis* in Italy is probably accidental, and related both to plant nursery activities (Banfi and Galasso 2010) and contamination of agricultural seeds (Kravchenko 2008). It naturally colonizes river banks and other wet habitats, and it is a feared weed in agriculture, with special regard to its ability to spread into maize fields (Zuo et al. 2008). This population was also reported in the Acta Plantarum Forum (http://www.floraitaliae.actaplantarum.org/viewtopic.php?t=102122).

E. Fanfarillo, D. Iamonico, M. Iberite, M. Latini, G. Nicolella

Acer saccharinum L. subsp. *saccharinum* (Sapindaceae)

+ (CAS) **ABR**: Teramo (Teramo), Via A. De Gasperi, presso l'alveo del Torrente Vezzola (WGS84: 42.662558°N; 13.708741°E), margine stradale, ca. 252 m, 20 June 2018, *N. Olivieri* (FI). – Casual alien subspecies new for the flora of Abruzzo.

Some young individuals grow near a street edge in a cool and shady area located at the base of a slope, on arenaceous soil, not far from the Stream Vezzola, together with *Parietaria judaica* L. and young individuals of *Celtis australis* L. subsp. *australis*, *Laurus nobilis* L., *Quercus pubescens* Willd. subsp. *pubescens*, and *Viburnum tinus* L. subsp. *tinus*. The young plants originated from the samaras produced by two trees planted nearby for ornamental purposes. This species is native to the eastern regions of North America and was introduced in Italy in 1760 (Maniero 2015) as an ornamental plant, marked by rapid growth.

N. Olivieri

Canna indica L. (Cannaceae)

+ (CAS) **MAR**: San Benedetto del Tronto (Ascoli Piceno), lungo la ferrovia all'interno dell'abitato presso Via G. Sgambati (WGS84: 42.941111°N; 13.887777°E), margine della massicciata ferroviaria, ca. 6 m, E, 10 July 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Marche.

A group of plants are located on the edge of the railway embankment, close to the Adriatic Sea, on rather damp gravelly substratum, beneath a young individual of *Phoenix canariensis* H.Wildpret. In the area the herbaceous vegetation is mainly constituted by *Equisetum ramosissimum* Desf. and *Parietaria judaica* L.

N. Olivieri

Cardamine occulta Hornem. (Brassicaceae)

+ (CAS) **MAR**: Camerino (Macerata), Viale G. Leopardi 14, at the Botanical Garden (WGS84: 43.136004°N; 13.069947°E), greenhouse soil, synanthropic habitat, 635 m, no exp., 30 March 2018, *S. Ballelli, R. Pennesi* (FI, CAME); Fabriano (Ancona), Piazzale Santa Maria Maddalena (WGS84: 43.331993°N; 12.899302°E), flower vases soil, synanthropic habitat, 340 m, no exp., 5 April 2018, *S. Ballelli* (FI, CAME). – Casual alien species new for the flora of Marche.

+ (CAS) **UMB**: Foligno (Perugia), Via Gran Sasso 23, near Restaurant Winner (WGS84: 42.960197°N; 12.689901°E), flower vases soil, synanthropic habitat, 230 m, no exp., 23 February 2014, *S. Ballelli* (FI, CAME). – Casual alien species new for the flora of Umbria.

Several authors reported this taxon under different names, but Marhold et al. (2016) clarified that the oldest name applicable for the so-called "Asian *Cardamine flexuosa*" is *C. occulta*. In Italy, *C. occulta* was first found in Sardegna (Lazzeri et al. 2013, under the name *C. flexuosa* With. subsp. *debilis* O.E.Schulz), then in other Italian regions (Toscana and Lombardia: Ardenghi and Mossini 2014, under the name *C. flexuosa* subsp. *debilis*; Piemonte: Verloove and Ardenghi 2015, under the name *C. hamiltonii* G.Don; Veneto: Marhold et al. 2016; Trentino-Alto Adige: Galasso et al. 2016a; Campania: Stinca et al. 2017; Lazio: Galasso et al. 2018b). The present findings broaden its distribution in central Italy both in Marche and Umbria. *Cardamine occulta* has been found growing together with the similar *C. hirsuta* L. in urban environments, especially in flower pots. Its presence in these regions could date back to several years ago; additionally its distribution may be much broader than reported, given the possible confusion with *C. hirsuta* (see Šlenker et al. 2018 for differences).

S. Ballelli, R. Pennesi

Cedrus atlantica (Endl.) G.Manetti ex Carrière (Pinaceae)

+ (NAT) **SAR.** – Status change from casual to naturalized alien for the flora of Sardegna.

This species is endemic to the Atlas Mountains, in Morocco and Algeria, but it has been used in reforestations and as an ornamental tree in many countries (Farjon 2017). In Sardegna it was reported as cultivated by Pavari and De Philippis (1941), and recently indicated as a casual alien species (Bacchetta et al. 2009, Puddu et al. 2016, Galasso et al. 2018a). Actually, the species is naturalized in those places where it was abundantly introduced since the 1930s, such as the State Forests of Bono, Bultei, Anela, and Monte Limbara (Pavari and De Philippis 1941), but also in the State Forests of Orgosolo, Arzana, and Villagrande Strisaili (Montes, M. Idolo, Bau Muggeris). In these sites, there is an important renewal and adult trees occur in woodlands, garrigues, heaths, roadsides, and reforestations.

G. Bacchetta, G. Calvia, A. Ruggero

Chlorophytum comosum (Thunb.) Jacques (Asparagaceae)

+ (CAS) **ABR**: Teramo (Teramo), bordo di Via C. Battisti (WGS84: 42.659936°N; 13.703644°E), margine stradale, ca. 268 m, 14 June 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Some individuals of this species can be found near the edge of the road and the base of a building in a shady and humid site, near a rain gutter downspout, in a central area of the town. Probably these individuals were vegetatively generated from plants grown as ornamentals on surrounding buildings. *Chlorophytum comosum* is native to southern Africa and is a popular cultivated plant.

N. Olivieri

Citrus ×aurantium L. (Rutaceae)

+ (CAS) **MAR**: San Benedetto del Tronto (Ascoli Piceno), presso Viale delle Palme (WGS84: 42.950919°N; 13.884188°E), aiuola occupata da arbusti di *Westringia fruticosa*, ca. 8 m, 10 July 2018, *N. Olivieri* (FI). – Casual alien nothospecies new for the flora of Marche.

A young individual has grown within a flowerbed of a public garden, among shrubs of *Westringia fruticosa* (Willd.) Druce and *Melaleuca citrina* (Curtis) Dum.Cours. The place is located at short distance from the Adriatic Sea and is protected from cold easterly winds by the presence of *Pinus halepensis* Mill. subsp. *halepensis* trees and buildings. The young plant probably originated from seeds produced by an adult specimen cultivated in the gardens not far away. Along the southernmost part of the Marche coast, the cultivation of *Citrus ×aurantium* and other *Citrus* fruits has been present since the 12th century D.C. (Zavatti 1966, Manzi and Vitelli 2016).

N. Olivieri

Cyperus microiria Steud. (Cyperaceae)

+ (CAS) **TOS**: Pisa (Pisa), nei pressi dell'aeroporto (WGS84: 43.691115°N; 10.412054°E), campi coltivati, ca. 5 m, 17 October 2017, *R. Guarino* (FI). – Casual alien species new for the flora of Toscana.

This is a late-flowering annual species of eastern Asiatic origin, widely naturalized in Europe and U.S.A. (Verloove 2014). In Italy, it was first collected near Como in 1908

(Camperio and Fiori 1910) and currently it is recorded as invasive alien in Lombardia and Emilia-Romagna, naturalized in Piemonte and Veneto, and casual in Trentino-Alto Adige and Friuli Venezia Giulia (Galasso et al. 2018a). Our finding, in a regularly disturbed field edge next to the airport of Pisa, is the first record south of the Apennines because a previous record from Calabria was found to be erroneus (Galasso et al. 2016b, 2018a).

R. Guarino, L. Peruzzi

Epilobium brachycarpum C.Presl (Onagraceae)

+ (NAT) **ITALIA** (**EMR**): Bologna (Bologna), scalo merci di Bologna San Donato, tratto compreso tra il Posto A e il Posto B (WGS84: 44.506283°N; 11.390399°E), pietrisco fine e compattato di natura calcareo-marnosa tra i binari, 50 m, 26 September 2017, leg. *A. Alessandrini*, det. *N.M.G. Ardenghi* (FI). – Naturalized alien species new for the flora of Italy (Emilia-Romagna).

Epilobium brachycarpum is a therophyte native to western North America. In Europe, it was first recorded in Spain in 1978 and, by the 1990s, in different countries of the central and north-western parts of the continent: France, Germany, Belgium, and United Kingdom. It colonizes disturbed, dry and warm habitats characterized by short-lived ruderal communities, with a distinct preference for railway areas, where many of the European records come from (Izco 1983, Bönsel and Ottich 2005, Verloove and Lambinon 2009, Gregor et al. 2013, Remacle 2014). It is regarded as an invasive species in central Europe (Nierbauer et al. 2016), its rapid expansion being promoted by the high production of seeds, dispersed by wind and probably vehicles, and the strong competition on bare soils with other ruderal plants (Gregor et al. 2013). The population discovered in Bologna is located at the entrance of the almost disused freight yard of Bologna San Donato that has been one of the most important railway yards in Europe. In summer, *E. brachycarpum* forms a dense monospecific stand, covering an area of about 50 ha. Due to the population extent, it is likely that the species was introduced years ago, probably through imported freight or railroad cars from France (via the Torino-Milano-Bologna line) or Germany (via the Verona-Bologna line). Photos of the population are available at: http://www.floraitaliae.actaplantarum.org/viewtopic.php?t=99257.

A. Alessandrini, N.M.G. Ardenghi

Eucalyptus polyanthemos Schauer subsp. *polyanthemos* (Myrtaceae)

+ (CAS) **ITALIA** (**SAR**): Villacidro (Sud Sardegna), Campu s'Isca, Rio Leni (WGS84: 39.39538°N; 8.65812°E), materassi alluvionali granitico-metamorfici, 329 m, 20 July 2018, *G. Bacchetta, G. Brundu, L. Podda* (FI, CAG). – Casual alien subspecies new for the flora of Italy (Sardegna).

This Australian species, identified according to the Centre for Plant Biodiversity Research (2006) and Slee et al. (2015), was introduced in Sardegna for reforestation in the period 1914–1921. It shows a scarce tendency to naturalization, unlike *E. camaldulensis* Dehnh. subsp. *camaldulensis* and *E. globulus* Labill. subsp. *globulus*, occurring only with a dozen young trees near the reforestation site.

G. Bacchetta, G. Brundu, L. Podda

Euphorbia berteroana Balb. ex Spreng. (Euphorbiaceae)

– **ITALIA** (**SIC**). – Alien species to be excluded from the flora of Italy (Sicilia).

On the basis of the following record concerning *E. ophthalmica* Pers., this species should be excluded from Italy.

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Euphorbia hypericifolia L. (Euphorbiaceae)

+ (CAS) **PUG**: Melendugno (Lecce), fraz. Borgagne, nella masseria (WGS84: 40.239834°N; 18.376283°E ± 1 Km), 20 m, unica pianta presente nel sito, 23 June 2014, *E.S. Mauri* (FI sub *Chamaesyce hyssopifolia*). – Casual alien species new for the flora of Puglia.

On the basis of the following record concerning *E. hyssopifolia* L., *E. hypericifolia* should be considered as new for the flora of Puglia. Indeed, the Apulian record of *Euphorbia hyssopifolia* by Buono et al. (2017) should be referred to *E. hypericifolia*.

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Euphorbia hyssopifolia L. (Euphorbiaceae)

– **ITALIA** (**PUG**, **SIC**). – Alien species to be excluded from the flora of Italy (Puglia and Sicilia).

Euphorbia hyssopifolia was recorded as new for the flora of Italy by Banfi and Galasso (2014), based on specimens collected in Sicilia, and it was subsequently reported in Puglia by E.S. Mauri in Buono et al. (2017). We analysed the exsiccata from Sicilia and Puglia conserved in FI. These specimens were compared to scans of type specimen and revised according to Ma and Gilbert (2008) and Steinmann et al. (2016). We also submitted the specimens to Victor Steinmann, an expert of *Euphorbia* sect. *Anisophyllum* Roep. According to our inquiries, both records correspond to *Euphorbia hypericifolia* L., a species reported so far in Italy for Toscana and Sicilia (Galasso et al. 2018a). Accordingly, *E. hyssopifolia* should be excluded from the flora of Italy.

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Euphorbia ophthalmica Pers. (Euphorbiaceae)

+ (CAS) **ITALIA** (**SIC**): Palermo (Palermo), in cultis, in H.B. Panorm copiosa sponte qui crescit (WGS84: ca. 38.112642°N; 13.374495°E), September 1880, *M. Lojacono Pojero* (P sub *E. berteroana*); *ibidem*, in cultis humentibus subsponte in Hortis Palermo (WGS84: ca. 38.112642°N; 13.374495°E), October 1882, *M. Lojacono Pojero* (FI sub *E. berteroana*); *ibidem*, subsponte in Hortis Palermo (WGS84: ca. 38.112642°N; 13.374495°E), September 1883, *M. Lojacono Pojero* (FI sub *E. berteroana*); *ibidem*, subsponte in H.B. Panorm (WGS84: ca. 38.112642°N; 13.374495°E), August 1886, *s.c.* (TO sub *E. berteroana*); *ibidem*, culta in R.H.B.P. (WGS84: ca. 38.112642°N; 13.374495°E), s.d., *s.c.* (PAL No. 51733 sub *E. berteroana*); Catania (Catania), als Unkraut im Botanischen Garten Catania [infestante nel giardino botanico di Catania] (WGS84: ca. 37.515680°N; 15.083732°E), September 1928, leg. *K. Müller* sub *E. nutans*, revidit *G. Hügin* 1995 sub *E. hirta*, revidit *G. Hügin* 1997 sub *E. berteroana* (STU); Ribera (Agrigento), Azienda Pizzuto, infestante degli agrumeti (WGS84: 37.500000°N; 13.267000°E ± 2 Km), agrumeti, sporadica, s.d. [1970s: G. Ferro, in verbis], *G. Ferro* (FI sub *E. berteroana*); *ibidem*, Fondo Cipolla, negli agrumeti (WGS84: 37.500000°N; 13.267000°E ± 2 Km), agrumeti, ca. 100 m, s.d. [1970s: G. Ferro, in verbis], *G. Ferro* (FI sub *E. berteroana*); *ibidem*, infestante degli agrumeti (WGS84: 37.500000°N; 13.267000°E ± 2 Km), agrumeti, 200 m, non molto diffusa, s.d. [1970s: G. Ferro, in verbis], *G. Ferro* (FI sub *E. berteroana*); *ibidem* (WGS84: 37.500000°N; 13.267000°E ± 2 Km), ai margini di un frutteto (quasi ruderale), ca. 180 m, s.d. [1970s: G. Ferro, in verbis], *G. Ferro* (FI sub *E. berteroana*). – Casual alien species new for the flora of Italy (Sicilia).

We revised the herbarium specimens from Italy referred to *E. berteroana* Balb. ex Spreng., concluding that they should be referred to *E. ophthalmica*. Indeed, *E. berteroana* was reported in Sicilia at the turn of the 20th century by Lojacono Pojero (1907) and cited by Fiori (1926, 1928), Giardina et al. (2007), and Pignatti (1982, 2017). Nevertheless, Galasso et al. (2018a) do not mention *E. berteroana* as occurring in Italy. We searched for herbarium specimens that could be linked to such reports, retrieving exsiccata preserved in FI, P, PAL, and TO. In addition, we retrieved more recent specimens of *E. berteroana* in STU, collected in 1928 by K. Müller, and in FI, collected in the 1970s by G. Ferro. Such material was compared to the type material and revised using different identification keys (Burch 1965, Steinmann et al. 2016, Burger and Huft 1995) and the expert opinion of Victor Steinmann. *Euphorbia berteroana* shows affinities with *E. ophthalmica* and *E. hirta* L., but can be clearly distinguished from these species. Indeed, *E. berteroana* shows ovate-elliptic leaf blades with obtuse apex, while *E. hirta* and *E. ophthalmica* leaves show leaf blades generally rhombic, with acute apex. In addition, *E. ophthalmica* differs from *E. hirta* in having capitula strictly terminal or on leafy lateral stalks, and stem branching from base to tips. Our conclusion is that the Italian exsiccata correspond to *Euphorbia ophthalmica*, a species never recorded before for Italy. In addition, based on the revised herbarium specimens, the true *E. berteroana* was never collected in Italy, and the reports by Lojacono Pojero

(1907), Fiori (1926, 1928), Giardina et al. (2007), and Pignatti (1982, 2017) should be considered erroneous.

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Euphorbia prostrata Aiton (Euphorbiaceae)

+ (NAT) **SAR.** – Status change from casual to naturalized alien for the flora of Sardegna.

This is a species native to North America (Pignatti 2017), which behaves as invasive alien in Italy and casual in Sardegna (Galasso et al. 2018a). It was reported from various localities of southern Sardegna by Bocchieri et al. (1982) and Bocchieri (1984), and then confirmed by Arrigoni (2010). Later, Puddu et al. (2016) indicated it as a casual alien in Sardegna, while Camarda et al. (2016) reported it as naturalized. It is widespread in Gallura, Logudoro, Ogliastra, Sulcis-Iglesiente, Sarrabus-Gerrei and Campidano, from sea level to 1,050 m a.s.l., along roadsides and in fallow land, ruderal places, and gardens, mainly on sandy granitic soils.

G. Bacchetta, G. Calvia, L. Podda, A. Ruggero

Euphorbia thymifolia L. (Euphorbiaceae)

– **ITALIA** (**LIG**, **TOS**, **LAZ**). – Alien species to be excluded from the flora of Italy (Liguria, Toscana, and Lazio).

To our knowledge, *Euphorbia thymifolia* was reported (sub *E. thymifolia* Burm.) for the first time for the flora of Italy in Toscana by Arcangeli (1894), and subsequently for Lazio and Toscana by Chiovenda (1895). This species was also tentatively recorded by Sommier (1898) for Valle d'Aosta. However, the same author stated that all his previous reports should be actually referred to *E. maculata* L. instead of *E. thymifolia* (Sommier 1903), as confirmed in Fiori (1901) for all Italian specimens and recently by Bovio (2014) for Valle d'Aosta. Notwithstanding, *E. thymifolia* was subsequently reported as a literature record (Viegi and Cela Renzoni 1981, Del Prete et al. 1991, Arrigoni and Viegi 2011), confirmed for Lazio and Toscana as a naturalized alien species and recorded as historical record for Liguria (Galasso et al. 2018a). We revised the specimens collected by Chiovenda (FI and RO) according to Steinmann et al. (2016) and Hügin (1998), and we attributed them to *E. maculata* (in agreement with Sommier 1903 and Fiori 1901). In addition, we revised herbarium specimens of *E. maculata* and *E. thymifolia* in FI, FIAF, PI, and RO, concluding that all these specimens correspond to *E. maculata*. Accordingly, *E. thymifolia* should be excluded from the Italian alien flora. These two species are similar, but clearly distinguishable by capsules scarcely exserted from the involucre at maturity in *E. thymifolia* vs., well exserted in *E. maculata*.

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Gamochaeta argyrinea G.L.Nesom (Asteraceae)

+ (NAT) **SAR**: Arzachena (Sassari), Nuraghe La Prisgiona (WGS84: 41.025332°N; 9.214608°E), macchie, 130 m, 30 April 2012, *G. Calvia* (*Herb. Calvia, Berchidda*); *ibidem*, Tomba di Giganti Coddu 'Ecchju (WGS84: 41.030579°N; 9.212391°E), prati, incolti, 90 m, 30 April 2012, *G. Calvia* (*Herb. Calvia, Berchidda*); *ibidem*, loc. Capichera, dintorni della Tomba di Giganti Coddu 'Ecchju (WGS84: 41.030027°N; 9.212321°E), prati, incolti, cigli stradali, 85–90 m, 21 July 2018, *G. Calvia* (FI, CAG). – Naturalized alien species new for the flora of Sardegna.

Gamochaeta argyrinea is native to North America (Nesom 2006). According to Galasso et al. (2018a), it is a naturalized alien in Toscana. In Sardegna, it was found in the countryside of Arzachena, and collected in April 2012. It is known from at least five localities, but apparently expanding.

G. Calvia

Hesperocyparis arizonica (Greene) Bartel (Cupressaceae)

+ (CAS) **LAZ**: Alatri (Frosinone) (WGS84: 41.742540°N; 13.327508°E), sotto e nei pressi di rimboschimenti a conifere, 570 m, 9 February 2018, *E. Fanfarillo* (FI, RO). – Casual alien species new for the flora of Lazio.

This northwestern American species, widely used for ornamental purposes and reforestations, is reported as casual for many Italian regions and as naturalized in Toscana (Galasso et al. 2018a). Many small individuals were observed near and under cultivated plants, colonizing the understory of a degraded conifer plantation.

E. Fanfarillo, D. Iamonico, M. Iberite, M. Latini, G. Nicolella

Hesperocyparis macrocarpa (Hartw. ex Gordon) Bartel (Cupressaceae)

+ (NAT) **LAZ**: Alatri (Frosinone) (WGS84: 41.744605°N; 13.327046°E), sotto e nei pressi di rimboschimenti a conifere, 550 m, 9 February 2018, *E. Fanfarillo* (FI, RO). – Naturalized alien species new for the flora of Lazio.

So far, this species was reported as casual in Umbria and Sardegna (Galasso et al. 2018a). Many sexually reproductive individuals originated from cultivated plants, some of which are several metres tall. Although not previously observed, the size of the individuals and the occurrence of several fertile generations suggest that the population is self-sustaining. Thus, the species can be considered as naturalized in Lazio.

E. Fanfarillo, D. Iamonico, M. Iberite, M. Latini, G. Nicolella

+ (CAS) **MOL**: Petacciato (Campobasso), fraz. Marina di Petacciato (WGS84: 42.032463°N; 14.860958°E), margine di impianto di rimboschimento costiero, ca. 3 m, 16 June 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Molise.

Some young individuals of the species grow on the edge of an artificial pine forest composed mainly of *Pinus halepensis* Mill. subsp. *halepensis* and *Pinus pinea* L., along with *Acacia saligna* (Labill.) H.L.Wendl., *Cupressus sempervirens* L., *Eucalyptus camaldulensis* Dehnh. subsp. *camaldulensis*, and *Hesperocyparis macrocarpa*. They are located on a sandy soil, in shady areas not far from the Adriatic coast. *Hesperocyparis macrocarpa* is an American species native to California, where it lives in two small areas southwest of the city of Monterey. The species was introduced in Italy in 1851 (Maniero 2015) and is planted especially in coastal areas as a windbreak.

N. Olivieri

Heteranthera reniformis Ruiz & Pav. (Pontederiaceae)

+ (CAS) **SAR**: Cabras (Oristano), nei pressi dello stagno di Cabras (WGS84: 39.96151°N; 8.51118°E), risaia, 6 m, 9 August 2017, leg. *V. Lozano, P. Capece, G. Brundu*, det. *G. Brundu* (FI, SS). – Casual alien species new for the flora of Sardegna.

Heteranthera reniformis is an annual or pluriannual submerged or floating plant, native to freshwater wetlands of North, Central, and South America (Hussner 2012). This species was introduced accidentally in Europe, probably with seeds of rice, and it is also widely cultivated as ornamental plant.

V. Lozano, P. Capece, G. Brundu

Lemna minuta Kunth (Araceae)

+ (INV) **TOS**. – Status change from casual to invasive alien for the flora of Toscana.

Lemna minuta is native to temperate and subtropical areas of America (Banfi and Galasso 2010), and it is recorded as invasive or naturalized alien in almost all Italian Regions (Galasso et al. 2018a). In Toscana, this species was recorded for the first time in the Migliarino-San Rossore-Massaciuccoli Regional Park by Peruzzi and Savio (2011). Although these authors reported the species as casual alien, they suggested to carefully monitor it, hypothesizing an ongoing naturalization process. During field surveys in the same areas, we observed that this species is widely distributed. Moreover, in the meantime, *L. minuta* was recorded for several other sites in Toscana (Lastrucci et al. 2016, Carta et al. 2018). We noticed that *Lemna minuta* commonly shares the habitat with the native species *L. minor* L. and/or *L. gibba* L., generally behaving as a strong competitor. Considering the quick expansion and the severe competition with native species, we retain most appropriate the status of invasive alien in Toscana for *L. minuta*.

M. D’Antraccoli, F. Roma-Marzio

Ligustrum sinense Lour. (Oleaceae)

+ (CAS) **VDA**: Arnad (Aosta), fraz. Arnad le Vieux (WGS84: 45.645338°N; 7.720963°E), giovani individui naturalizzati nelle zone incolte e muretti a secco presso la sede comunale, 368 m, 15 October 2017, *M. Lonati, S. Ravetto Enri, M. Probo* (FI). – Casual alien species new for the flora of Valle d'Aosta.

Young individuals were observed in fallows and dry stone walls. They originated from seeds from plants cultivated in a neighbouring garden. This species should be monitored in this Region, since it shows a high invasion potential in the plain forests of the neighbouring Piemonte (Lonati et al. 2014, Vacchiano et al. 2016, Regione Piemonte 2018).

M. Lonati, S. Ravetto Enri, M. Probo

Lycium boerhaviifolium L.f. (Solanaceae)

+ (NAT) **ITALIA** (**SAR**): Cagliari (Cagliari), pressi di Viale Buoncammino (WGS84: 39.221681°N; 9.115990°E), calcari miocenici, 91 m, 23 July 2018, *G. Bacchetta, P.L. Nimis, L. Podda* (FI, CAG). – Naturalized alien species new for the flora of Italy (Sardegna).

This species is native to South America (Levin et al. 2011). In the city of Cagliari, it behaves as a ruderal nitrophilous plant, which colonizes urban sites as walls or slopes, mainly on the Miocene sedimentary stones "Pietra Cantone" and "Pietra Forte". To our knowledge, this is the first report as a naturalized alien in Europe.

G. Bacchetta, A. Moro, P.L. Nimis, L. Podda

Nassella tenuissima (Trin.) Barkworth (Poaceae)

+ (CAS) **VEN**: Bassano del Grappa (Vicenza), Via Passalacqua (WGS84: 45.771104°N; 11.742118°), bordo di marciapiede, 130 m, 21 May 2017, leg. *G. Busnardo*, det. *F. Prosser* (FI, ROV). – Casual alien species new for the flora of Veneto.

This species of South American origin is increasingly planted in southern Europe, where it shows a tendency to escape from cultivation (Verloove 2005). In Italy, this species was reported, as casual, only from Bolzano (Wilhalm et al. 2017). In Trentino-Alto Adige, it has recently been collected as escaped from cultivation also in the province of Trento (Villa Lagarina, at least 10 tufts born spontaneously in the area surrounding the roundabout - within which the species is cultivated - at the "Rovereto Sud" entrance of the motorway, 4 July 2018, *F. Prosser*, ROV). In Bassano, a few casual specimens have been noticed on the edge of a sidewalk, certainly deriving from a flowerbed a dozen meters away.

G. Busnardo, F. Prosser

Nothoscordum borbonicum Kunth (Amaryllidaceae)

+ (NAT) **SAR**. – Status change from casual to naturalized alien for the flora of Sardegna.

For this Central American species, Ardenghi et al. (2011) proposed the status of casual alien in Sardegna. However, *N. borbonicum* seems actually naturalized, given its abundance in Cagliari and its suburbs, where it colonizes roadsides, fallow land, gardens, ruderal places, and even walls. It has been also found in Olbia (Sassari).

G. Bacchetta, G. Calvia, L. Podda

Oenothera lindheimeri (Engelm. & A.Gray) W.L.Wagner & Hoch (Onagraceae)

+ (CAS) **TOS**: Capraia Isola (Livorno), Isola di Capraia, spontanea sotto il Castello del paese di Capraia Isola (WGS84: 43.048211°N; 9.844937°E), in una fessura tra le rocce, 52 m, 19 May 2018, *L. Lazzaro, M. Distefano* (FI). – Casual alien species new for the flora of Toscana.

Oenothera lindheimeri is a species native to southern North America (Louisiana and Texas), where it is widely cultivated as ornamental. In Italy, it was already recorded as a casual alien in Lombardia, Veneto, Campania, and Puglia (Galasso et al. 2018a). This species is widely cultivated in other sites in Toscana, mainly in urban flowerbeds. The material was identified according to Raven and Gregory (1972).

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Osteospermum ecklonis (DC.) Norl. (Asteraceae)

+ (CAS) **ABR**: Giulianova (Teramo), prato litoraneo presso giardino privato (WGS84: 42.750277°N; 13.973872°E), prato litoraneo, ca. 8 m, 12 July 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

Some individuals of this species have developed in an arid coastal meadow occupied by psammophilous herbaceous vegetation dominated by *Cenchrus longispinus* (Hack.) Fernald, near a private garden. The site is located south of the harbour of Giulianova, not far from the beach. The plants have developed from seeds produced by individuals grown as ornamentals in a nearby garden.

N. Olivieri

Paspalum distichum L. (Poaceae)

+ (INV) **CAL**: Scalea (Cosenza), centro (WGS84: 39.815757°N; 15.787249°E), fessure della pavimentazione, 6 m, 20 August 2014, *A. Stinca* (PORUN); Roccabernarda (Crotone), Valle Niffi (WGS84: 39.107406°N; 16.873521°E), torrente, 122 m, 26 July 2018, *A. Stinca* (PORUN); *ibidem*, lungo il Fiume Tacina in corrispondenza di loc. Filicetto (WGS84: 39.116179°N; 16.860654°E), argine fluviale, 102 m, 26 July 2018, *A. Stinca* (PORUN); Calopezzati (Cosenza), foce del Torrene Calamitti (WGS84: 39.561422°N; 16.833549°E), argine fluviale, 1 m, 17 August 2018, *A. Stinca* (PORUN); Corigliano-Rossano (Cosenza), fraz. Rossano, tra la foce del Fiume Trionto e la loc. Faro Trionto (WGS84: 39.621369°N; 16.754349°E), terreno fangoso, 4 m, 17 August 2018, *A. Stinca* (PORUN); Cropalati (Cosenza), lungo il Fiume Trionto (WGS84: 39.510398°N; 16.732697°E), argine fluviale, 160 m, 18 August 2018, *A. Stinca* (PORUN); Paludi (Cosenza), loc. V.ne S. Martino (WGS84: 39.539589°N; 16.688078°E), torrente, 220 m, 19 August 2018, *A. Stinca* (PORUN); Strongoli (Crotone), loc. C. Serra Piani (WGS84: 39.264594°N; 17.019728°E), terreno fangoso, 138 m, 22 August 2018, *A. Stinca* (PORUN); Roggiano Gravina (Cosenza), Lago dell'Esaro (WGS84: 39.638220°N; 16.160279°E), sponde, 135 m, 23 August 2018, *L. Peruzzi* (PI No. 011541); Castelsilano (Crotone), Fiume Lese (WGS84: 39.216942°N; 16.865315°E), argine fluviale, 101 m, 8 October 2018, *A. Stinca* (PORUN); Caccuri (Crotone), Fiume Lese (WGS84: 39.231899°N; 16.850924°E), argine fluviale, 125 m, 9 October 2018, *A. Stinca* (PORUN); *ibidem*, Torrente Lepre (WGS84: 39.217925°N; 16.836326°E), argine fluviale, 133 m, 11 October 2018, *A. Stinca* (PORUN); Casabona (Crotone), lungo la Fiumara Vitravo (WGS84: 39.254953°N; 16.905314°E), argine fluviale, 140 m, 12 October 2018, *A. Stinca* (PORUN). – Status change from naturalized to invasive alien for the flora of Calabria.

Paspalum distichum is recorded for all Italian regions, with the exception of Valle d'Aosta and Trentino-Alto Adige (Galasso et al. 2018a). The latter authors reported this species as naturalized in Calabria. However, we found large populations of this neophyte mostly along the banks of several rivers, streams, and lakeshores of the provinces of Crotone, Catanzaro, and Cosenza, forming belts of 1 to 60 m. In addition to the places indicated in the samples, we have observed a large population also along the Crocchio River (Cropani, Catanzaro province, WGS84: 38.916399°N; 16.826309°E). Accordingly, this species should be considered invasive in Calabria.

A. Stinca, F. Bartolucci, L. Peruzzi

Pontederia cordata L. (Pontederiaceae)

+ (NAT) **LAZ**: Sabaudia (Latina), loc. Bella Farnia, Strada Litoranea (WGS84: 41.367494°N; 12.978081°E), fosso, 110 m, 25 June 2013, *M. Iberite* (FI, RO). – Naturalized alien species new for the flora of Lazio.

This is the first record of this taxon for peninsular Italy. Galasso et al. (2018a) report it as a naturalized alien for Lombardia and Veneto, and Montanari et al. (2015) recorded its occurrence in Emilia-Romagna. The population, still present in 2018, covers an extension of about 5 m^2; flowering was observed, but the plants probably reproduce only vegetatively. *Pontederia cordata* is recognized since many years to be a potentially invasive species in Europe, namely because of its clonal growth ability (Weber and Gut 2004). This calls a careful monitoring.

E. Fanfarillo, D. Iamonico, M. Iberite, M. Latini, G. Nicolella

Romulea rosea (L.) Eckl. (Iridaceae)

+ (NAT) **SAR**: Cardedu (Nuoro), Monte Ferru (WGS84: 39.743000°N; 9.624400°E ± 100 m), prato con modesta ritenuta idrica invernale, 540 m, SE, piante concentrate nel prato, con una buona densità; individui sparsi sono presenti fino a un centinaio di metri di distanza, sconfinando nella rada macchia mediterranea, 23 March 2017, *G. Mereu* (MSNM); *ibidem*, propaggine nord-orientale del Monte Ferru, versante E (WGS84: 39.743000°N; 9.624400°E ± 100 m), prato e bordo della macchia mediterranea, 540 m, SE, 15 April 2018, *G. Mereu* (FI). – Naturalized alien species confirmed for the flora of Sardegna.

The presence of this species was considered doubtful for Sardegna and for Italy in Galasso et al. (2018a). It appears to be naturalized since a long time in the indicated area. Evidence suggests that the plants were already present in 1992, when the site was subjected to human intervention following the creation of the "Cantiere forestale di Monte Ferru". Considering that there are no other reports for Italy and that the population reported for France has been identified as *Romulea arnaudii* Moret (Moret at al. 2000), this naturalized population is the only one currently documented in Italy and Europe.

G. Mereu

Rudbeckia triloba L. (Asteraceae)

+ (CAS) **TOS**: San Marcello Piteglio (Pistoia), fraz. Maresca, tra le loc. Case Bizzarri e Case Alte (WGS84: 44.053978°N; 10.857800°E), scarpata erbosa al margine della strada, 866 m, 10 November 2017, *G. Ferretti, F. Ferraro* (FI). – Casual alien species new for the flora of Toscana.

Rudbeckia triloba is an alien species from North America, recorded in Italy for Valle d'Aosta, Piemonte, Lombardia, Trentino-Alto Adige, and Veneto (Galasso et al. 2018a). It is used as ornamental and the recorded plants may have originated from a private garden. The plants were identified according to Ardenghi and Galasso (2013) and Maslo and Šarić (2018).

M. Mugnai, L. Di Nuzzo, L. Lazzaro, G. Ferretti

Salvia hispanica L. (Lamiaceae)

+ (CAS) **LAZ**: Bracciano (Roma), Vigna di Valle, Centro Sportivo dell'Aeronautica Militare presso l'Aeroporto di Vigna di Valle (WGS84: 42.084050°N; 12.222806°E), riva del lago, 157 m, 29 October 2017, leg. *S. Buono*, det. *S. Magrini* (FI). – Casual alien species new for the flora of Lazio.

Salvia hispanica, commonly known as 'chia', is a species native to central and southern Mexico and Guatemala (Cahill 2003). This species is increasingly cultivated in Europe for human food, as its seeds are a rich source of omega-3 and other nutraceuticals (Muñoz et al. 2013). The first record of its occurrence as a casual alien in Italy, from Marche, is very recent (Ballelli 2015). Galasso et al. (2018a) recorded this species also for Lombardia, Trentino-Alto Adige, Emilia-Romagna, and Sicilia. A single individual was observed on sandy soil near Lake Bracciano, together with other alien species, such as *Amorpha fruticosa* L., *Datura stramonium* L., *Pavonia hastata* Cav. (Galasso et al. 2017), and *Physalis peruviana* L. (Galasso et al. 2018b). The plant regularly develops flowers and fruits.

S. Buono, S. Magrini

Sesbania punicea (Cav.) Benth. (Fabaceae)

+ (NAT) **SAR.** – Status change from casual to naturalized alien for the flora of Sardegna.

Sesbania punicea, native to South America (Erb 1980), is now widespread in many countries as an ornamental plant, becoming locally invasive. Its first report from Sardegna was by Camarda (1998). After a few years, Brundu et al. (2003) and Camarda et al. (2004) indicated it as naturalized in the island. Later, several authors confirmed the same status (e.g., Podda et al. 2011, Camarda et al. 2016, Puddu et al. 2016), but finally Bacchetta and Podda in Galasso et al. (2018a) reported it as a casual alien. Recently, a new locality on sandy substrata was observed, near the dam along Rio Leni (Villacidro), where about 100 shrubs colonize a slope.

G. Bacchetta, G. Brundu, L. Podda

Setaria italica (L.) P.Beauv. subsp. *pycnocoma* (Steud.) de Wet (Poaceae)

+ (CAS) **MAR**: Acqualagna (Pesaro e Urbino), fraz. Furlo, loc. Abbazia di San Vincenzo al Furlo (WGS84: 43.636404°N; 12.692410°E), scarpata stradale, 185 m, 28 July 2018, *G. Mei* (FI, ANC, *Herb. G. Mei*). – Casual alien subspecies new for the flora of Marche.

The presence of *Setaria italica* subsp. *pycnocoma* was not yet reported for Marche (Galasso et al. 2018a). This species has been found in an area previously subjected to weeding of the road margins. Most of the population occurs only along road margins, while a few plants have been observed in the nearby abandoned fields. In Italy, this plant colonizes only strongly anthropized areas (Bossard et al. 2000), such as urban suburbs, abandoned railway tracks, road margins, flowerbeds and, less frequently, recently abandoned fields (Banfi and Galasso 2010, Celesti-Grapow et al. 2009).

G. Mei

Sicyos angulatus L. (Cucurbitaceae)

+ (INV) **LAZ**: Morolo (Frosinone), argini e sponde del Fiume Sacco in loc. Ponte di Morolo (WGS84: 41.652513°N; 13.218388°E), argini e sponde fluviali, 150 m, 8 September 2018, *E. Fanfarillo* (RO); Supino (Frosinone), argini e sponde del Fiume Sacco in loc. Ponte di Supino (WGS84: 41.638706°N; 13.253182°E), argini e sponde fluviali, 147 m, 8 September 2018, *E. Fanfarillo* (RO); Patrica (Frosinone), sponde del Fiume Sacco in loc. Tomacella (WGS84: 41.608884°N; 13.290797°E), sponde fluviali, 139 m, 8 September 2018, *E. Fanfarillo* (RO). – Status change from casual to invasive alien for the flora of Lazio.

This species was first recorded in Lazio in 2002 along the Sacco River in Morolo (Frosinone), where its presence was defined "quite rare" (Salerno et al. 2006). After resurveying the same locality and adjacent ones in 2018, this taxon appeared widespread along the river, forming dense populations both on the ground and on trees on a surface of about 2 km^2, and sparsely invading the roadsides. Further down the river, two new sites of occurrence were found at a distance of 4 and 10 km.

E. Fanfarillo, G. Nicolella

Styphnolobium japonicum (L.) Schott (Fabaceae)

+ (CAS) **ABR**: Teramo (Teramo), margine di parcheggio presso la Circonvallazione Ragusa (WGS84: 42.660794°N; 13.703624°E), margine, ca. 265 m, 21 June 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Abruzzo.

The species is present with some young individuals in a narrow belt of uncultivated land at the edge of a car park set in an internal courtyard, between the buildings, located behind the church of Sant'Agostino. These young plants, which may exceed the height of 1 m, originated from the seeds produced by a large individual growing on one side of the parking lot. *Styphnolobium japonicum* is a tree native to East Asia, which was introduced in Italy in 1799 (Maniero 2015).

N. Olivieri

Symphyotrichum squamatum (Spreng.) G.L.Nesom (Asteraceae)

+ (INV) **CAL**: Roggiano Gravina (Cosenza), Lago dell'Esaro (WGS84: 39.638220°N; 16.160279°E), sponde, 135 m, 23 August 2018, *L. Peruzzi* (PI No. 011540). – Status change from naturalized to invasive alien for the flora of Calabria.

Symphyotrichum squamatum is recorded for all Italian regions, with the exception of Valle d'Aosta (Galasso et al. 2018a). The latter authors reported this species as naturalized in Calabria but, given the extent of occurrence and density observed at the lakeshore, it is better considered as an invasive alien: a narrow belt of *S. squamatum* surrounded a large *Paspalum distichum* L. population in slightly drier areas, all around the lake.

L. Peruzzi

Tradescantia pallida (Rose) D.R.Hunt (Commelinaceae)

+ (CAS) **SIC**: Misilmeri (Palermo), Via Palmerino (WGS84: 38.035184°N; 13.455890°E), bordi di marciapiedi, 11 June 2018, *F. Scafidi* (FI). – Casual alien species new for the flora of Sicilia.

Some young individuals of this species were found along the edges of a sidewalk; they probably originated from seeds produced by cultivated plants in private flowerbeds. This species was likely introduced in Italy for ornamental purposes, and it was so far known as casual alien for Lazio, Calabria, and Sardegna (Galasso et al. 2018a).

F. Scafidi, G. Domina

Nomenclature and distribution updates from other literature sources

Nomenclature, status, and distribution updates according to Fiori (1902), Leigheb and Cameron-Curry (1999), Zohary and Hopf (2000), Orlandi and Arduini (2010), Levin et al. (2011), Alessandrini et al. (2012), Bona (2015), Montanari et al. (2015), Ardenghi and Polani (2016), Korotkova et al. (2017), Scafidi and Raimondo (2017, 2018), Selvi et al. (2017), Arrigoni (2018), Belyaeva et al. (2018), Brock et al. (2018), Carta et al. (2018), Galasso (2018), Gallo et al. (2018), Gargano (2018), Mayoral et al. (2018), Mosyakin et al. (2018), Motti et al. (2018), Nemati et al. (2018), Nesom (2018), Pellegrini (2018), Pellegrini et al. (2018), Pignatti (2018), Särkinen et al. (2018), Siadati et al. (2018), Sukhorukov et al. (2018), Truzzi (2018), Turland et al. (2018), and corrections to Bartolucci et al. (2018) and Galasso et al. (2018a) are provided in Supplementary material 1.

G. Galasso, F. Bartolucci

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Supplementary material 1

Supplementary data

Authors: Gabriele Galasso, Fabrizio Bartolucci

Data type: species data

Explanation note: 1. Nomenclature updates; 2. Note updates; 3. Distribution updates; 4. Synonyms, misapplied or included names.

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RESEARCH ARTICLE

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Notulae to the Italian native vascular flora: 6

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Abstract

In this contribution, new data concerning the distribution of native vascular flora in Italy are presented. It includes new records, confirmations and status changes to the Italian administrative regions for taxa in the genera *Alchemilla*, *Arundo*, *Bupleurum*, *Clematis*, *Clinopodium*, *Cota*, *Crassula*, *Cytisus*, *Euphorbia*, *Hieracium*, *Isoëtes*, *Lamium*, *Leontodon*, *Linaria*, *Lychnis*, *Middendorfia*, *Ophrys*, *Philadelphus*, *Pinus*, *Sagina*, *Sedum*, *Taeniatherum*, *Tofieldia*, *Triticum*, *Veronica*, and *Vicia*. Nomenclature and distribution updates, published elsewhere, and corrigenda are provided as supplementary material.

Keywords

Floristic data, Italy, nomenclature

How to contribute

The text for the new records should be submitted electronically to Chiara Nepi (chiara.nepi@unifi.it). The corresponding specimens along with its scan or photograph have to be sent to FI Herbarium: Sezione di Botanica "Filippo Parlatore" del Museo di Storia Naturale, Via G. La Pira 4, 50121 Firenze (Italy). Those texts concerning nomenclatural novelties (typifications only for accepted names), status changes, exclusions, and confirmations should be submitted electronically to: Fabrizio Bartolucci (fabrizio.bartolucci@gmail.com). Each text should be within 2,000 characters (spaces included).

Floristic records

Alchemilla filicaulis Buser (Rosaceae)

+ **TOS:** Abetone (Pistoia), Loc. Lago Nero, prateria secondaria su versanti arenacei esposti prevalentemente ad Est (WGS84: 44.065763°N; 10.380465°E), 1774 m, 11 August 2016, Leg. *G. Buccomino*, Det. *G. Tondi*, *F. Festi* (FI). – Species confirmed for the flora of Toscana.

This species was generically quoted for Toscana by Kuurto et al. (2007) and not reported in Bartolucci et al. (2018). The collected plants show very dense hairiness on all parts and belong to *A. filicaulis* var. *vestita* Buser (Festi 2000, Festi et al. 2015). This taxon has been collected at the side of the path also in Val di Luce at 1600 m s.l.m. (WGS84: 44.065763°N; 10.380465°E, Herb. Buccomino).

G. Buccomino, G. Tondi, F. Festi

Alchemilla tenuis Buser (Rosaceae)

+ **EMR:** Parco regionale del Frignano, Pievelago (Modena), Loc. Lago Turchino, area umida ad Est del lago (WGS84: 44.071251°N; 10.355938°E), 1612 m, 13 August 2016, Leg. *G. Buccomino*, Det. *G. Tondi*, *F. Festi* (FI). – Species confirmed for the flora of Emilia-Romagna.

This species was reported for Emilia-Romagna by Festi (2000), but results as "no longer recorded" in Bartolucci et al. (2018). Other samples were collected on 9 August 2011 (WGS84: 44.173226°N; 10.232708°E) between the Passo della Cisa and Monte Cusna (Herb. Buccomino).

G. Buccomino, G. Tondi, F. Festi

Arundo plinii Turra (Poaceae)

+ (CAS) **TAA:** Besenello (Trento), strada per Folgaria 400 m prima (a NW) di Dietrobeseno, lato a valle della strada (WGS84: 45,9299°N; 11,1140°E), scarpata erbosa, 320 m, 18 March 2018, *F. Prosser* (ROV No. 73984, FI). – Casual alien species new for the flora of Trentino-Alto Adige.

This steno-Mediterranean species, typical of clayey slopes and road margins (Pignatti 2017), is reported as native in all regions of Italy from Liguria southwards (Bartolucci et al. 2018). The population found near Dietrobeseno was very probably introduced, perhaps by greening. Currently, the plants form a compact patch of approximately 5 × 10 m. The plants regularly flower but they do not seem to produce viable seeds, and the propagation via stolons is hindered by the surrounding vegetation, so that the presence of this species is evaluated as casual.

F. Prosser

Bupleurum fruticosum L. (Apiaceae)

+ (C) **TOS:** Candeli (Bagno a Ripoli, Firenze), C.da Ulivelli, 500 m a est di Villa La Tana (WGS84: 43.764080°N; 11.348720°E), margine di macchia, 205 m s.l.m., 15 July 2018, *F. Roma-Marzio*, *P. Liguori* (FI, PI No. 011168, Herb. Roma-Marzio). – Cryptogenic species confirmed for the flora of Toscana.

Bupleurum fruticosum L. is a steno-Mediterranean species, occurring as native from Morocco to Greece, and introduced in Great Britain, Germany, Ukraine, and Crimea (Hand 2011). In Italy, this species is native in Sicily, Sardinia, and Liguria, and not confirmed in Puglia (Bartolucci et al. 2018). In the latter region, however, it is considered as doubtfully native by Pignatti (2018). Although *B. fruticosum* is not reported in the recent checklist of woody flora of Toscana (Roma-Marzio et al. 2016), this species was actually mentioned as cultivated by Baroni (1897–1908), and Montelucci (1933) indicated this species for the park of Sammezzano and near Rignano sull'Arno around Florence. Negri (1946) confirmed the presence of cultivated plants at Sammezzano, but the same author also reported a new locality for *B. fruticosum* in Candeli, south-eastern of Florence, Bagno a Ripoli, in the ex hunting lodge of Villa La Tana. Negri (1946) admitted that that presence of *B. fruticosum* could be the result of a naturalization from plants cultivated in the past, but he also hypothesized that this species could be native in Candeli (see also Corti 1959). We confirmed the occurrence of *B. fruticosum* in Candeli: we observed mature plants, several young individuals and some seedling. Although the plants are well integrated in the local maquis shrubland vegetation, considering the historical indications of cultivated plants and that all the known localities are more or less close to old mansions and parks, we opt to consider *B. fruticosum* in Tuscany as a cryptogenic species.

F. Roma-Marzio, L. Peruzzi

EX (C) **PUG:** – Cryptogenic species extinct in Puglia.

Bupleurum fruticosum was reported in Puglia only for Salento (Capo di Leuca), more than 130 years ago (Groves 1887). Two years later, Caruel (1889) indicated this species as cultivated in peninsular Italy, and considered *B. fruticosum* as probably alien at Capo di Leuca. More recently, Mele et al. (2006) considered this species as possibly extinct in Salento, but Bartolucci et al. (2018) indicated it as a native, not confirmed species. No specimen is preserved in FI, and field research carried out by one of us (PM) in the last years allows to exclude the current occurrence of *B. fruticosum* in the Salento area. Furthermore, we consider it as cryptogenic in Puglia, in accordance with Caruel (1889) and Pignatti (2018).

F. Roma-Marzio, P. Medagli, R.P. Wagensommer

Clematis rigoi W.T.Wang (Ranunculaceae)

+ **PUG:** Castellaneta (Taranto), a ovest di Masseria Signora Nunzia (WGS 40.541400°N; 16.906533°E), 12 m s.l.m., bosco igrofilo a Frassino meridionale, 21 May 2018, *F.*

Carruggio, *G. Pazienza*, *D. Saulle*, *L. Forte* (BI Nos. 41955-41956-41957). – Species confirmed for the flora of Puglia.

Clematis rigoi is quite similar to the western Mediterranean species *C. campaniflora* Brot. (Fernández Carvajal 1986, Wang 2000), with which it was confused in the past (Cavara 1907). It is endemic to southern Italy, and it was certainly known so far only for Basilicata and Calabria, while it was no longer recorded in Puglia (Bartolucci et al. 2018). Some authors reported Lesina in the Gargano Promontory as the only one regional site of occurrence for this species (Cavara 1907 under the name *C. campaniflora* Brot., Fiori 1924 under the name *C. viticella* L. var. *scandens* (Huter, Porta & Rigo) Arcang.). This new locality lies in a narrow-leafed ash hygrophilous wood, in the Lato river basin.

F. Carruggio, G. Pazienza, D. Saulle, L. Forte

Clinopodium acinos (L.) Kuntze subsp. *acinos* (Lamiaceae)

+ **BAS:** Parco naturale Gallipoli Cognato Piccole Dolomiti Lucane, Pietrapertosa (Potenza), Monte dell'Impiso (WGS84: 40.285088°N; 16.055150°E), versante boscato a lato del sentiero, 1288 m, 21 June 2013, *G. Buccomino* (FI); Parco nazionale del Pollino, Viggianello (Potenza), Piano Ruggio (WGS84: 39.918879°N; 16.137209°E), pascolo arido su suolo calcareo, 1560 m, 21 June 2014, *F. Caldararo* (FI). – Subspecies new for the flora of Basilicata.

The first notice of this report appeared in the web-forum Acta Plantarum (http://www.floraitaliae.actaplantarum.org/viewtopic.php?t=74633).

G. Buccomino, F. Caldararo

Cota tinctoria (L.) J.Gay subsp. *australis* (R.Fern.) Oberpr. & Greuter (Asteraceae)

+ (NAT) **SAR.** – Status change from casual to naturalized alien for the flora of Sardegna.

This taxon has a European-Pontic distribution (Pignatti 2018), and it is native to the mainland Italy (Bartolucci et al. 2018). Atzei (1996) reported *C. tinctoria* subsp. *australis* for the first time in Sardegna from Mt. Limbara. This species plant is now diffuse in several localities of that mountain, from 1000 to 1350 m, normally growing on roadsides and disturbed places, but also in clearings of reforestations, along paths, and in garrigues.

G. Calvia, A. Ruggero

Crassula tillaea Lest.-Garl. (Crassulaceae)

+ **LOM:** Pavia (Pavia), Via Sant'Epifanio, davanti all'entrata dell'Orto Botanico, interstizi sabbiosi dell'acciottolato; vegetazione: *Ochlopoa annua*, *Polycarpon tetraphyllum*, *Herniaria hirsuta* (*Saginion procumbentis*), 74 m, 11 May 2010, *N. Ardenghi* (Herb.

N. Ardenghi); *ibidem* (WGS84: 45.18531°N; 9.16285°E), acciottolato, 74 m, 29 May 2018, *N. Ardenghi* (FI). – Species confirmed for the flora of Lombardia.

Bartolucci et al. (2018) indicated this species as "extinct" in Lombardia, but it is present in front of the entrance of the Pavia Botanical Garden since at least 2010. About 100 individuals were counted in 2018. The only record for the province of Pavia (consisting of two localities fromthe municipalities of Linarolo and Miradolo Terme) dates back to Nocca and Balbis (1816) and has been repeated by subsequent local and national floras until Pignatti (1982).

N.M.G. Ardenghi

Cytisus scoparius (L.) Link subsp. *scoparius* (Fabaceae)

+ (INV) **SAR.** – Status change from naturalized to invasive alien for the flora of Sardegna.

This is an European species, which is native to Italy but reported as naturalized in Sardegna (Arrigoni 2010, Podda et al. 2012, Camarda et al. 2016, Puddu et al. 2016, Bartolucci et al. 2018). Actually, it became locally invasive, above all on Mt. Limbara, where it was introduced in the 1960's (Veri and Bruno 1974). It is gradually expanding in clearings, roadsides, garrigues and meadows above 950 m, but it is also starting to colonize wilder and isolated areas below, un po 500 m.

G. Bacchetta, G. Calvia, A. Ruggero

Euphorbia cuneifolia Guss. (Euphorbiaceae)

+ **CAL:** Montalto Uffugo (Cosenza), contrada Mavigliano (WGS84: 39.39378°N; 16.22858°E), pratelli terofitici su suolo argilloso umido, 170 m, 18 April 2018, *L. Bernardo, G. Maiorca* (FI, CLU No. 26197). – Species confirmed for the flora of Calabria.

Euphorbia cuneifolia was described by Gussone (1826) on samples coming from Calabria, near Brancaleone, Roseto, and Capo Bruzzano. Later authors confirmed its occurrence for the same localities (Tenore 1831, Parlatore 1867, Fiori 1926) or generically for Calabria (Pignatti 1982, 2018). However, there have been no further reports for this region. At present, this species is known for central and southern Italian regions, excluding Marche, Abruzzo, and Basilicata, doubtfully occurring in Umbria (Bartolucci et al. 2018).

L. Bernardo, G. Maiorca

Euphorbia illirica Lam. (Euphorbiaceae)

+ **VEN:** Negrar (Verona), Monte Tondo in località Case Antolini (WGS84: 45.537681°N; 10.974972°E), 650 m, 24 July 2018, *F. Menini* (VER). – Species confirmed for the flora of Veneto.

According to Bartolucci et al. (2018), this species has been indicated in Veneto by mistake. However, the report published by Goiran (1897–1904) for Contrada Antolini was certainly correct, as evidenced by herbarium vouchers conserved in VER (leg. Goiran, June 1889, under the name *E. pilosa* L.). Prosser in Buffa et al. (2017), indicated this species as extinct in the province of Verona. A search near Case Antolini by the first author led instead to a confirmation of the old record. The population consists of several individuals located mainly at the edge of the meadow (*Arrhenatheretum*) and wood in a radius of about 200 m. It grows in a mesophilous habitat, with *Hypericum hirsutum* L., *Trifolium patens* Schreb., and *Veratrum nigrum* L. In the woods, we can note the presence of *Castanea sativa* Mill. Also in areas bordering Veneto *E. illirica* is very rare, being known in Friuli Venezia Giulia only in four localities in the resurgence belt (F. Martini, pers. comm.), and having been collected in central-eastern Lombardy for the last time in 1985 (Martini et al. 2012).

F. Menini, F. Prosser

Hieracium pellitum Fr. subsp. *pellitum* (Asteraceae)

+ **MOL:** San Massimo (Campobasso), tra Campitello Matese e Monte Miletto (WGS84: 41.449873°N; 14.382191°E), pascolo, 1450-1775 m, 4 July 2016, Leg. *A. Stinca, L. Frate, A. Scolastri*, Det. *G. Gottschlich* (FI, PORUN, Herb. Gottschlich No. 66949). – Species new for the flora of Molise.

In Italy, *Hieracium pellitum* subsp. *pellitum* is recorded only for Piemonte, Liguria, Marche, and Abruzzo (Bartolucci et al. 2018). Therefore, our finding represents the new southern limit of the species range in the Italian Peninsula.

A. Stinca, G. Gottschlich

Isoëtes echinospora Durieu (Isoëtaceae)

+ **TAA:** Mezzana (Trento), Laghi del Malghetto di Mezzana, lago Inferiore (WGS84: 46.2794°N; 10.8102°E), sul fondo del laghetto, soprattutto a 2 m di profondità, 2001 m, 24 August 2017, *D. Miserocchi*, *C. Steffanini* (FI, ROV No. 73577). – Species confirmed for the flora of Trentino-Alto Adige.

The distribution of *I. echinospora* in Italy was previously limited to Piedmont and Lombardy (Troìa and Greuter 2014). This species has also been reported by Huber (1906) for Lago Grande di Monticolo (Bolzano, Südtyrol), but this report not confirmed by recent surveys, is considered doubtful by Beck and Wilhalm (2010). Recently, this species was considered as not confirmed for Trentino-Alto Adige by Bartolucci et al. (2018). After the first findings in the upper and lower lakes of Malghetto di Mezzana (5 August 2017, *Redolfi*, *Miserocchi*, *Pegoretti*), we have looked for *I. echinospora* in further lakes of the eastern Adamello Group (Pinzolo, Trento), also finding it on the following sites: Tre Laghi, Lago Medio (WGS84: 46.2607°N; 10.7978°E), 2271 m and Lago Inferiore (WGS84: 46.2593°N; 10.7976°E), 2257 m, 21 September 2017; Lago delle Malghette (WGS84: 46.2675°N 10.8172°E), 1880 m, 21 September 2017; Lago di Pradalago (WGS84: 46.2491°N; 10.8131°E), 2082 m, 29 September 2017. This species was therefore found in six alpine lakes, approximately in 3.5 km from North to South. In some of these lakes, *I. echinospora* forms submerged prairies. All lakes are located on acid rock (tonalite). We have searched for this species in further 13 lakes in the area, but without success.

D. Miserocchi, A. Cavagna, C. Steffanini, F. Prosser

Lamium bifidum Cirillo subsp. *balcanicum* Velen. (Lamiaceae)

+ **BAS:** Viggianello (Potenza), Piano di Ruggio (WGS84: 39.910604°N; 16.130958°E), prato nitrofilo a bordo nevaio, 1550 m, 30 May 2015, *L. Bernardo, D. Gargano* (FI, CLU No. 26200); *ibidem*, 23 May 2016, *F. Caldararo* (CLU No. 26201). – Subspecies new for the flora of Basilicata.

This report extends southward the distribution of this subspecies, so far reported only for Marche, Lazio, and Abruzzo (Conti et al. 2008, Bartolucci et al. 2018).

L. Bernardo, F. Caldararo, D. Gargano

Leontodon rosanoi (Ten.) DC.

+ **PUG:** Agro di Roseto Valfortore, Foggia (WGS84 41.375674°N; 15.118577°E), pascolo roccioso a *Bromopsis erecta*, 890 m slm, 11 July 2018, *M. Terzi, F.S. D'Amico* (FI). – Species confirmed for the flora of Puglia.

Pittoni (in Pignatti 1982) indicated *Leontodon rosanoi* [under the name *Leontodon villarsii* (Willd.) Loisel.; see Mariotti Lippi and Garbari 2004] for all the regions of the Italian Peninsula. However, in the recent updated checklist of the flora of Italy (Bartolucci et al. 2018), this species is considered as a "no longer recorded" in Puglia.

M. Terzi, F.S. D'Amico

Linaria simplex (Willd.) Desf. (Plantaginaceae)

+ (NAT) **VEN:** Verona, in Lungadige Attiraglio, nei pressi di Ponte Catena (WGS84: 45.44964813°N; 10.98327089°E), sull'argine in pietra, 60 m, 9 April 2018, *M. Trenchi*, *F. Di Carlo* (FI, ROV, VER); Castel Montorio (Verona), di fronte alla chiesetta sconsacrata (WGS84: 45.45900395°N; 11.05028927°E), prato arido, 125 m, 26 Mai 2018, *M. Trenchi* (VER). – Naturalized alien species confirmed for the flora of Veneto.

Although Pignatti (1982, 2018) quotes this euri-Mediterranean species also for Veneto, Bartolucci et al. (2018) report its doubtful occurrence in this region. Indeed, we do not know any precise data for Veneto, neither from bibliography, nor from herbaria (FI, PAD). It has never been found by the botanists who have been active in Verona and it is not listed in the most recent local flora (Di Carlo and Bianchini 2014). *Linaria simplex* is indicated by Bartolucci et al. (2018) as native in all Italian regions, with the exception of Emilia-Romagna (doubtful), Lombardy (extinct; Martini et al., 2012), Trentino-Alto Adige (casual), and Friuli-Venezia Giulia (naturalized). In the latter three regions, this species has been mentioned for the first time, as casual, by Angiolini and Scoppola (1999) based on herbarium specimens in PESA. In Verona, *L. simplex* grows widely in a stretch of approximately 150 m of Lungadige, on the stone embankment. It grows together with mostly annual species, including: *Avena barbata* Pott ex Link, *Erigeron canadensis* L., *Euphorbia cyparissias* L., *E. helioscopia* L. subsp. *helioscopia*, *Medicago rigidula* (L.) All., *Myosotis ramosissima* Rochel subsp. *ramosissima*, and *Saxifraga tridactylites* L.

M. Trenchi, F. Di Carlo, F. Prosser

Lychnis coronaria (L.) Desr. (Caryophyllaceae)

+ **TOS:** Bibbiena (Arezzo), Parco Nazionale delle Foreste Casentinesi, lungo la strada sterrata tra Serravalle e Tramignone, nei pressi di un castagneto e di un impianto di noce (WGS84: 43.780926°N; 11.847683°E), ca. 890 m, 4 July 2018, *D. Viciani, L. Lazzaro* (FI). – Species confirmed for the flora of Toscana.

Lychnis coronaria is reported as a species doubtfully occurring in Toscana by Bartolucci et al. (2018). It is a Mediterranean-Turanian species, occurring in almost all the regions of continental Italy, mostly as alien in Northern Italy, and as native in Central-Southern Italy (Bartolucci et al. 2018). In Toscana, this species was doubtfully reported by Caruel (1866), based on a record by G. Santi for Pitigliano (Grosseto), and later on for Bibbiena (Arezzo) by Baroni (1897–1908), a record neglected by Viciani et al. (2010). Actually, this plant was recently documented also by Selvi (2002) and Viciani et al. (2004) close to San Quirico (Grosseto). We confirm its presence also close to Bibbiena (Arezzo), in the area of the “Parco Nazionale delle Foreste Casentinesi, Monte Falterona e Campigna”. The population reported here is far enough from residential areas to support its native status in Toscana, and the growing conditions are close to those described by Selvi (2002).

D. Viciani, L. Lazzaro

Middendorfia borysthenica (Schrank) Trautv. (Lythraceae)

+ **TOS:** Porcari (Lucca), Padule, loc. Chiuso delle Canne (WGS84: 43.80000°N; 10.63265°E), fanghi umidi di un chiaro di caccia, 6 m, 15 June 2016, *A. Sani* (FI). – Species confirmed for the flora of Toscana.

This annual, submediterranean species (Pignatti 2017) occurs in Italy in Piemonte, Lazio, Puglia, Sicilia, and Sardegna, but it was doubtfully recorded for Toscana (Bartolucci et al. 2018). For the latter region, only six ancient records from Caruel (1860–1864) and Baroni (1897–1908) were available so far. Two of them refer to Maremma (Lago Secco and Doganella in the Capalbio area, Grosseto), where this species was not found again recently (Selvi 2010). The remaining four records (Altopascio, Asciano, Bientina, and Castagnolo) refer to plain areas in the low Arno valley, i.e. the same area in which we were able to find this species again.

A. Sani, L. Peruzzi

Ophrys sphegodes Mill. subsp. *sphegodes* (Orchidaceae)

+ **LAZ:** Barbarano Romano (Viterbo), loc. Chiesaccia (Parco *Marturanum*), boscaglia su terreno argilloso-sassoso (WGS 84: 42.229557°N; 12.050115°E), 327 m, 7 March 2018, *S. Buono* (FI). – Species confirmed for the flora of Lazio.

Within *Ophrys sphegodes* group, two close taxa are considered vicariant in Italy: *O. sphegodes* subsp. *sphegodes*, occurring only in the northern regions, and the taxonomically doubtful species *O. classica* Devillers-Tersch. & Devillers, recorded for central and southern Italy (Bartolucci et al. 2018). The two taxa differ mainly for the presence of bulges in the lip. In particular, *O. sphegodes* subsp. *sphegodes* shows a lip with no bulges or with very small ones, while *O. classica* is always characterized by prominent, rounded bulges in the lip (GIROS 2016). The population reported here was made up of plants with no bulges in the lip.

S. Magrini, S. Buono, M. Rempicci

Philadelphus coronarius L. (Hydrangeaceae)

+ (CAS) **MAR:** San Benedetto del Tronto (Ascoli Piceno), margine della massicciata ferroviaria alla periferia dell'abitato (WGS84 42.9375°N; 13.889444°E), ca. m 6, 10 July 2018, *N. Olivieri* (FI). – Casual alien species new for the flora of Marche.

A single individual of the species grows at the edge of the railway embankment, on the eastern side, in an area characterized by rather humid pebbly substratum. The site is located on the southern outskirts of the town. This species grows with *Equisetum ramosissimum* Desf., and some young individuals of *Chamaerops humilis* L. *Philadelphus coronarius* is considered native in Lombardia, Veneto, Trentino-Alto Adige, and probably also in Toscana (Bartolucci et al. 2018, Pignatti 2018). In the rest of the Italian territory, this species has been introduced for ornamental purposes and is – in case – locally naturalized. It is cultivated in some gardens near the observation area.

N. Olivieri

Pinus nigra J.F.Arnold subsp. *laricio* Palib. ex Maire (Pinaceae)

+ (INV) **SAR.** – Status change from caual to invasive alien for the flora of Sardegna.

This taxon, endemic to Corsica, Calabria, and Sicilia (Jeanmonod and Gamisans 2013), also occurs in Toscana (Bartolucci et al. 2018). In Sardinia it has been introduced in reforestations starting from 1929/1930 (Pavari 1935), being reported as a casual alien by Bartolucci et al. (2018). On the eastern side of the Gennargentu Massif (Arzana, Villagrande Strisaili), subjected to abundant reforestations, it is now naturalized. In the area of Monte Limbara as well, it is spreading rapidly, invading almost all degraded areas over 900 m, up to 1.5 km far from plantation sites. Abundant trees, saplings and seedlings occupy vast areas, especially invading heaths and garrigues with endemic dwarf brooms, as well as rocky places, paths, and roadsides. The density of saplings and seedlings is higher close to reforestation sites. Locally, the trees compete with the native *Pinus pinaster* Ait.

G. Bacchetta, G. Calvia, A. Ruggero

Sagina micropetala Rauschert (Caryophyllaceae)

+ **CAL:** Montalto Uffugo (Cosenza), contrada Mavigliano (WGS84: 39.39378°N; 16.22858°E), pratelli terofitici su suolo argilloso umido, 170 m, 18 April 2018, *L. Bernardo, G. Maiorca* (FI, CLU No. 26196). – Species new for the flora of Calabria.

In southern Italy, this species is recorded only for Campania and Puglia (Bartolucci et al. 2018), probably due to misidentification with *S. apetala*, Ard. which is however distinguished by different morphological and ecological features (Bomble 2015).

L. Bernardo, G. Maiorca

Sedum caespitosum (Cav.) DC. (Crassulaceae)

+ **CAL:** San Lorenzo Bellizzi (Cosenza), strada per Cerchiara di Calabria, sotto Pietra S. Angelo (WGS84: 39.878427°N; 16.337091°E), margine strada, 820 m, 30 April 2005, *L. Bernardo* (FI, CLU No. 19870); Serra Pedace (Cosenza), San Nicola Silano, ca. 250 m NW dalla SP11, a S della ferrovia, lungo la strada per Silvana Mansio (WGS84: 39.312096°N; 16.541050°E), prato arido su sabbie granitiche, 1420 m, 15 May 2013, *L. Bernardo* (CLU No. 25956). – Species new for the flora of Calabria.

Based on this report, *S. caespitosum* occurs in all the southern regions of Italy, but it has not been recently confirmed for Campania (Bartolucci et al. 2018).

L. Bernardo, G. Maiorca

Taeniatherum asperum (Simonk.) Nevski (Poaceae)

+ **CAL:** Cerchiara di Calabria (Cosenza), pendici Nord di Coste Aquafredda (Monte Sellaro), nei pressi di Casa Francomano (WGS84: 39.86135°N; 16.35719°E), prato arido su calcare, 1010 m, 28 June 2018, *L. Bernardo, N.G. Passalacqua* (FI, CLU No 26202). – Species new for the flora of Calabria.

In Italy, *Taeniatherum asperum* was known only for Puglia, Basilicata, Sardegna, and Sicilia (Bartolucci et al. 2018).

L. Bernardo, G. Maiorca, N.G. Passalacqua

Tofieldia calyculata (L.) Wahlenb. (Tofieldiaceae)

\+ **MAR:** Mt. Nerone – loc. Fiamba (Pesaro-Urbino) (WGS84: 43.542063°N; 12.577614°E), moist meadow on limestone substrate at the head of the stream of the Fiamba gorge 780 m, 14 May 2016, *G. Mei* (FI). – Species new for the flora of Marche.

The presence of *Tofieldia calyculata* was not yet reported for Marche (Bartolucci et al. 2018). It is interesting to note that this species, along the Apennines, is limited to the main mountainous massifs, exclusively on the Adriatic side.

G. Mei

Triticum biunciale (Vis.) K.Rich. subsp. *biunciale* (Poaceae)

\+ **CAL:** Amendolara (Cosenza), tra le contrade Monachicchio e Civegna (WGS84: 3993982°N; 16.55893°E), incolto a margine strada, 275 m, 22 May 2018, *L. Bernardo, D. Gargano* (FI, CLU No. 26195); Cerchiara di Calabria (Cosenza), margini strada SS 92 (WGS84: 39.863379°N; 16.35899°E), incolto, 970 m, 17 June 2017, *L. Bernardo, G. Maiorca* (CLU No. 26199); Villapiana (Cosenza), alveo Fiumara Saraceno (WGS84: 39.84204°N; 16.50835°E), prato arido su pietraia, 5 m, 30 May 2018, *L. Bernardo, D. Gargano* (CLU No. 26203); Crosia (Cosenza), contrada Macchia della Bura, incolto retrodunale, 5 m, 27 April 2018, *L. Bernardo, D. Gargano* (CLU No. 26198). – Species new for the flora of Calabria.

According to Perrino et al. (2014) and Pignatti (2017), *T. biunciale* occurs in Veneto, Toscana, Campania, Basilicata, and Puglia. However, Bartolucci et al. (2018) confirm its occurrence only for Campania and Puglia. It is widespread in the Ionian side of northern Calabria, often mixed with the more common *T. neglectum* (Req. ex Bertol.) Greuter.

L. Bernardo, D. Gargano, G. Maiorca

Veronica acinifolia L. (Plantaginaceae)

\+ **SAR:** Gairo (Ogliastra), versante nord-orientale di Perda Liana, bordo di ruscello montano (WGS84: 39.914700°N; 9.418400°E ± 100 m), 950 m, 9 June 2018, *G. Mereu* (FI). – Species confirmed for the flora of Sardegna.

The presence of this species in Sardegna was indicated by Moris (1827), but later no longer confirmed by the same author (Moris 1858–1859).

G. Mereu

Vicia nigricans (M.Bieb.) Coss. & Germ. (Fabaceae)

+ **LIG:** Vobbia (Genova), ai piedi del Castello della Pietra (WGS84: 44.61321°N; 9.01594°E), prateria xerofila su conglomerati, 538 m, S, 18 May 2016, *N. Ardenghi* (FI). – Species confirmed for the flora of Liguria.

This species is indicated as "recorded by mistake" in Liguria by Bartolucci et al. (2018), but it is quite frequent on the rocky cliffs at the base of the castle in Vobbia.

N.M.G. Ardenghi

Nomenclature and distribution updates from other literature sources, and corrigenda

Nomenclature and distribution updates according to Gutermann and Kropf (2009), Marcenò and Gristina (2010), Pezzetta (2011), Al-Shehbaz (2012), Gennai et al. (2012), Martini et al. (2012), Domina and Jaouadi (2013), Marchetti (2015), Mavrodiev et al. (2015), Peruzzi et al. (2015), Ardenghi and Polani (2016), Fraser-Jenkins et al. (2016), Martignoni et al. (2016), Arrigoni (2017, 2018), Benítez-Benítez et al. (2017), Gottschlich (2017), Lasen and Da Pozzo (2017), Minissale et al. (2017), Pignatti (2017), Sáez and Aymerich (2017), Soreng et al. (2017), Astuti and Peruzzi (2018), Bräuchler (2018), Brock et al. 2018, Carta et al. (2018), Dentant et al. (2018), Erben et al. (2018), Esmailbegi et al. (2018), Gargano (2018), Hassemer (2018), Iamonico and Mosyakin (2018), Koopman (2018), Macháčková et al. (2018), Míguez et al. (2018), Mosyakin (2018), Pignatti (2018), Raab-Straube and Raus (2018), Särkinen et al. (2018), Siadati et al. (2018), Španiel et al. (2018), Steffan (2018), Sukhorukov et al. (2018), Troia et al. (2018), Vogt et al. (2018) and corrigenda to Bartolucci et al. (2018) are provided in Supplementary material 1.

F. Bartolucci, G. Galasso

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Supplementary material 1

Supplementary data

Authors: Fabrizio Bartolucci, Gabriele Galasso

Data type: species data

Explanation note: 1. Nomenclature updates; 2. Distribution updates; 3. Synonyms, misapplied or included names.

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Conference proceedings

Vegetazione, Suolo e Dinamiche ecologiche nel corso del turno in un Ostrieto mesofilo dell'Appennino Umbro-Marchigiano

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Nonostante la ceduazione sia una pratica antichissima che nei secoli ha plasmato e caratterizzato, e tutt'oggi caratterizza, gran parte dei paesaggi italiani di bassa montagna e collina, la selvicoltura del ceduo è da sempre stata considerata semplice e poco costosa, suscitando poco interesse dal punto di vista scientifico.

Negli anni tuttavia il modo di considerare "il bosco" ha subito profondi cambiamenti, legati soprattutto alle modifiche socio-economiche e culturali più che all'approfondimento delle conoscenze biologiche e fisiologiche del sistema.

La ceduazione è stata quindi rimproverata di un modesto contributo paesaggistico, dell'impoverimento del suolo e di una sostanziale perdita di biodiversità.

Obiettivo di questo lavoro è stato dunque quello di indagare gli effetti della reiterazione del governo a ceduo sui processi di recupero del "sistema bosco" in un Ostrieto mesofilo, analizzando l'evoluzione dei suoi diversi parametri nel corso del turno, datandone la flora presente, verificando l'origine delle specie erbacee e considerando l'impatto che questo tipo di gestione ha su genesi e conservazione del suolo; il fine è quello di valutare il grado di naturalità che caratterizza queste formazioni e di fornire nuove conoscenze sulle dinamiche che vengono ad instaurarsi a regime e nel mosaico forestale costituito dall'insieme delle particelle forestali.

Si tratta di aspetti sui quali sono ancora poche le informazioni disponibili in letteratura, nonostante gli Ostrieti rappresentino una delle formazioni forestali più diffusa sul territorio nazionale.

La scelta dell'area di studio, sulla base di ricerche cartografiche e informazioni fornite da Enti e Comuni nella fase preliminare del lavoro, è caduta su una formazione presente nell'Appennino Umbro-Marchigiano, individuando anche grazie al coinvolgimento degli *stakeholders,* sul versante Nord-Orientale del Monte Nerone, nel comune di Piobbico (PU), 80 ha di Ostrieto mesofilo gestito ininterrottamente da quasi tre secoli a ceduo matricinato dall'Università Agraria degli "Uomini Originari di Rocca Leonella", in cui sono state selezionate 6 particelle con anzianità dal taglio ripartita in un arco temporale di 36 anni. La scelta è stata dunque quella di interpretare le dinamiche del soprassuolo attraverso un un approccio di tipo sincronico. All'interno di ciascuna particella si è proceduto all'individuazione di zone in posizione elevata rispetto alle vie d'esbosco principali o distanti da queste almeno 600m, distanti meno di 50m da un'aia carbonile e non meno di 50 m da inclusi non boscati, tra loro caratterizzate da pendenza media più simile possibile, differenza d'esposizioni minore di 30° e differenza altitudinale minore di 100m. Sono quindi state tracciateAree di Saggio di 100m^2 entro cui si è proceduto alla raccolta di dati :

Stazionali: pendenza media e reale, coordinate geografiche del punt medio, esposizione prevalente;
Dendrometrici: misura millimetrica dei diametri di tutti i soggetti che raggiungevano i 130cm di altezza,
misura centimetrica dell'altezza di tutti i soggetti (anche inferiori ai 130cm),
caratterizzazione dei soggetti in base a origine, caratteristiche fisiologiche e strutturali
numerazione progressiva delle ceppaie (vive e morte),
stima delle necromasse;
Floristico-Vegetazionali: determinazione delle entità e loro quantificazione, indicazione degli stadi fenologici;
Pedologici: descrizione caratteristiche geomorfologiche, apertura e descrizione di profili pedologici.

Le elaborazioni dendrometriche e lo studio fitosociologico hanno evidenziato l'analogia del soprassuolo studiato con quelli censiti a livello regionale dall'IPLA; l'analisi dei dati floristici ha messo in luce una numerosità e densità floristica in linea con quella indicata in bibliografia (Pignatti, 1998 - Ubaldi, 2012) per questo tipo di formazione, nettamente superiore ai valori registrati per altre formazioni forestali.

Particolarmente interessanti sono poi i dati emersi dall'interpretazione dello spettro biologico, che ha messo in luce una buona percentuale di geofite (16%), che, seppur diffuse un po' in tutti i climi, in percentuali elevate sono un ottimo indicatore di cenosi forestali non eccessivamente disturbate. Per quanto riguarda le terofite, forma biologica molto spesso indice di ambienti antropizzati e/o disturbati, si è registrata una forte differenza tra le percentuali riscontrate entro le A.d.S. (7,5%) e quelle riguardanti l'intera superficie particellare (15%): tale differenza è da imputare alla presenza o al confinamento con la superficie particellare, di chiarìe forestali, affioramenti rocciosi e aree più recentemente interessate dal taglio, in cui la componente delle annuali risulta preponderante. L'interpretazione di questa situazione ha permesso di chiarire l'origine principale delle specie appartenenti a questa forma biologica, che risulta molto probabilmente dovuta alla germinazione dei semi presenti nella *soil seed bank* in seguito alle condizioni favorevoli che si realizzano con la periodica scopertura, propria di questa forma di governo, e non in conseguenza dell'apporto dovuto ad attività antropiche. Questa situazione trova conferma e sostegno nello spettro corologico, che evidenzia una discreta percentuale di specie endemiche (5%), costante durante tutto il periodo indagato, e costantemente superiore a quella delle specie cosmopolite (3%).

Interessante anche l'analisi delle proporzioni tra numero di famiglie, generi e specie (spettro tassonomico) utilizzata per fornire indicazioni di carattere paleobotanico, che permette di far risalire l'origine della flora esaminata al periodo subatlantico (Età del ferro), in linea con l'età di formazione di gran parte della flora forestale italiana (Piussi,1994), evidenziandone tuttavia successive specializzazioni e adattamenti riconducibili in gran parte, ma non soltanto, alla pratica della ceduazione e alle condizioni di disturbo periodico ad essa legate.

Quanto appena affermato trova riscontro con la moderata omotonia evidenziata nell'andamento a "J rovesciata" emerso nello spettro della valenza ecologica e confermato dai valori dell' indice di somiglianza (indice di Jaccard): trend tipico, secondo Ubaldi (2012), di cenosi abbastanza ben assestate nella cui selezione ecologica intervenga la competizione oppure un fattore ambientale di tutto rispetto.

Lo studio delle fenologie, pur non consentendo la creazione di un calendario e di una cartografia fenologica di dettaglio ad hoc per l'area esaminata a causa dell'andamento climatico del periodo di osservazione, non conforme alla media, ha comunque permesso l'elaborazione di un grafico degli andamenti fenologici che mostra la stretta correlazione tra fenologia delle specie erbacee e copertura arborea e il ruolo di quest'ultima nello scandire le varie fasi del ciclo fenologico, confermando quanto descritto in bibliografia (Pignatti,1998).

Il ruolo fondamentale della copertura arborea nella regolazione fenologica della vegetazione erbacea e soprattutto arbustiva è evidenziato dal diverso andamento assunto da tali componenti nelle particelle in cui la copertura risulta assente (A.d.S. 001) o meno influente (A.d.S. 005 e 006): proprio in queste aree infatti si sono registrati maggiori anomalie e sfasamenti del ciclo fenologico, con fioriture protratte e, per alcune specie, addirittura ripetute durante i mesi in cui si sono raccolti i dati.

Si ritiene tuttavia che tale sfasamento fenologico risulti essenziale per la perpetuazione di specie, spesso di grande interesse floristico-vegetazionale, che trovano condizioni ottimali al loro sviluppo proprio nel periodo immediatamente successivo al taglio, ed i cui semi restano latenti per anni nei primi centimetri di suolo fino al nuovo realizzarsi delle condizioni idonee alla germinazione. Questo periodo di latenza, corrispondente ai 18-30 anni del turno, potrebbe compromettere la vitalità dei semi se eccessivamente prolungato o se rimanesse legato esclusivamente a fenomeni di schianto e ribaltamento, che non consentono il realizzarsi di tali condizioni su superfici di estensioni adeguate all'emergenza di una popolazione sufficientemente numerosa.

Interessanti sono anche i risultati emersi dall'applicazione del metodo messo a punto da Taffetani e Rismondo (2009), che consente di misurare l'impatto delle attività gestionali e di osservare i cambiamenti che ne conseguono, evidenziandone la struttura ecologica attraverso la suddivisione in classi di vegetazione. Ne è infatti emerso che, se il contingente floristico più consistente risulta essere quello attribuito alla classe fitosociologica *Querco-Fagetea,* si mantengono comunque ben nutriti i contingenti di specie dei mantelli forestali (classe *Rhamno-Prunetea*) e gli elementi di numerose altre classi di vegetazione erbacea di prateria. Tra queste il gruppo più interessante risulta essere quello della classe *Epilobietea angustifolii* , che rappresenta gli elementi della vegetazione delle radure forestali, accompagnata da alcune specie della classe *Galio-Urticetea*, comprendente le specie di orli forestali nitrofili.

L'analisi ha inoltre consentito di evidenziare come molte entità strettamente forestali che sembrano scomparire nei primi anni subito dopo il taglio, in realtà trovino rifugio nelle aree di contatto con le ceppaie in cui vengono a realizzarsi situazioni microstazionali idonee.

Inoltre il metodo ha permesso di mettere in risalto come le praterie "stabili" poste nelle immediate vicinanze delle aree forestali rappresentino la fonte principale di specie che vanno a colonizzare le aree scoperte dal taglio subito dopo l'apertura, ruolo questo svolto in ambienti disturbati o fortemente antropizzati da specie della classe *Stellarietea mediae,* quando non addirittura da specie esotiche invasive, che risultano invece qui assenti o pochissimo rappresentate.

L'assenza di queste classi è indice di una flora e di un sistema in perfetto equilibrio dinamico con le attività in atto; piena conferma si riscontra negli studi fitosociologici svolti, che nonostante riguardino particelle forestali in diversi stadi del turno, caratterizzate quindi da differenze sia cronologiche che strutturali, attestano l'appartenenza di tutte le aree esaminate non soltanto alla medesima associazione (*Scutellario columnae-Ostryetum carpinifoliae)* ma anche alla stessa sub-associazione *(violetosum reichembachianae)*.

Questo dato mette ancora una volta in evidenza come il taglio non alteri drasticamente gli equilibri e le dinamiche vegetazionali presenti, ma anzi permetta il mantenimento della cenosi e di un elevato grado di biodiversità.

Lo studio pedologico, infine, ha mostrato la presenza in tutte le aree di suolo etichettabile come *Rendzic Leptic Phaeozem (Skeletic)* (IUSS, 2006), appartenenti alla classe dei *Phaeozems* per WRB e riconducibili alla classe dei *Mollisols* per ST. I suoli appartenenti a questa classe sono tra i più fertili al mondo (Ugolini e Certini, 2010) e sono caratterizzati da saturazione in basi superiore al 50%, colore molto scuro e struttura fortemente sviluppata a grumi di diverse dimensioni (Chaney e Swift, 1984): per la loro formazione e conservazione, legate principalmente al processo di melanizzazione, questi necessitano di un clima continentale umido caratterizzato da regimi idrici e termici del suolo che favoriscano l'accumulo e la protezione della sostanza organica incorporata nel suolo (SSS, 2003).

Sulla base dei dati emersi da questo studio e sopra riassunti, è dunque possibile affermare che le cenosi analizzate non soltanto non risultano depresse o in qualche modo danneggiate dalle normali pratiche gestionali, ma anzi sono da queste plasmate e selezionate.

Inoltre il mosaico forestale che l'insieme di queste aree costituisce crea una numerosità di situazioni e nicchie ecologiche capaci di ospitare una flora il cui numero di specie pregiate risulta molto più elevato della media fornita in letteratura (Del Favero et al, 2000 - IPLA, 2001), portando a rivalutare l'importanza di questa formazione rispetto ad altri tipi forestali.

Inoltre questa gestione permette l'aumento delle aree con condizioni ecologiche assimilabili a quelle degli orli forestali, fondamentali per il mantenimento di specie pregiate dal punto di vista floristico, la cui presenza è strettamente legata al perpetuarsi delle ceduazioni, nonché per la conservazione di elevati livelli di biodiversità (Peterken e Francis, 1999; Del Favero, 2001; Riondato et al., 2005), come confermato dalle analisi vegetazionali.

Come sostenuto da diversi autori (Rubio et al., 1999; Bengtsson et al., 2000), la pratica della ceduazione trova il suo punto di forza nel mimare la dinamica naturale dei *gaps*, permettendo così sia lo sfruttamento della foresta che una elevata biodiversità, specialmente dello strato erbaceo.

Sebbene il recupero dei boschi cedui sia stato a lungo inteso come conversione in alto fusto, questa potrebbe addirittura portare ad una perdita sensibile di alcuni degli aspetti positivi sopra esposti, da quello prettamente floristico fino a quello paesaggistico, coinvolgendo in parte anche l'assetto idrogeologico.

Inoltre, come evidenziato da Rubio et al. (1999) e da Logli e Joffre (2001), nelle cenosi in esame non si avrebbe un riscontro economico adeguato alle operazioni eseguite in quanto i prodotti ritraibili da una gestione differente non solo non sarebbero compatibili con l'atomizzazione fondiaria che caratterizza le proprietà appenniniche ma neanche conciliabili con la produzione di carbone e la richiesta di legname da fuoco di piccole dimensioni per uso domestico e artigianale, voce attiva nell'economia della zona. Inoltre tali produzioni legnose non troverebbero nemmeno mercato data la mancanza sul territorio sia di segherie che di una propria filiera.

A quanto detto risulta auspicabile una rivalutazione di questa forma di governo con un accorciamento del turno che, come rilevato dall'analisi dei dati dendrometrici ed in linea con gli studi effettuati negli ultimi anni (Riondato, 2004; Lasen, 2013; Del Favero et al., 1999), rendendo più frequente il disturbo, può contribuire ad elevare la biodiversità del sito aumentandone l'eterogeneità.

Chiaramente nella scelta della gestione selvicolturale si deve avere ben chiaro l'obiettivo di perseguire il miglioramento strutturale del bosco, preservando alcuni processi e alcune nicchie ecologiche e mantenendo comunità stabili e mature.

Parole chiave: Ostrieto mesofilo, Ceduo, Vegetazione, Suolo, Biodiversità, Dinamiche forestali

MESOFAUNA DEL SUOLO COME PROXY PER LA COMPRENSIONE DELLE DINAMICHE ECOLOGICHE LEGATE A ISOLAMENTO E ABBANDONODELLE CENOSI FORESTALI RESIDUE. RISULTATI PRELIMINARI.

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Dall'ultimo dopoguerra a oggi nel paesaggio rurale basso collinare e planiziale italiano si è registrata una semplificazione ambientale seguita daimpoverimentoqualitativo e quantitativodella biodiversità vegetale senza precedenti, soprattutto a caricodelle aree seminaturali non produttive.Le principali cause di questo processo sono riconducibili alla meccanizzazione agricola, all'espansione delle aree urbane e a un'errata visione dell'abbandono come garanzia di mantenimento della biodiversità. In questo contesto, i lembi di vegetazione forestalerappresentano delle isole di vegetazione potenziale e si trovano in una posizione particolarmente delicata:l'ampliamento delle superfici agricole confinantili ha posti in condizione di isolamento ecologico, mentreela perdita di interesse economico nei confronti dei prodotti forestali da essi ritraibili ha fatto si che, a secoli di sfruttamento a volte anche intenso, subentrasse l'abbandono. Tale situazione ha determinato una sempre maggiore semplificazione strutturale, vegetazionale edecosistemica, nonchéuna riduzione della fruibilità paesaggistica di tali ambienti.Sono tuttavia ancora scarsi gli studi e totalmente assenti dati relativi all'impatto di tale fenomeno sul suolo.
Con questo studio si è voluto focalizzare l'attenzione sugli ostrieti, ecosistemi forestali che da soli occupano circa il 30% della superficie forestaleitaliana. Lo studio ha lo scopo di analizzare gli effetti dell'isolamento ecologico e dell'abbandono gestionale sul sistema forestale a tre differenti scale: di paesaggio, di serie e di cenosi. Per quanto riguarda quest'ultimo livello, è stata considerata come unità d'indagine l'associazione vegetazionale e come indicatore la mesofauna del suolo, vista la sua sensibilità ai cambiamenti ambientali. In ogni area appartenente all'associazione forestale di riferimento (*Asparagoacutifolii-Ostryetumcarpinifoliae*) sono stati tracciati due transetti (dall'esterno all'interno dell'area) costituiti da tre siti di campionamento distanti tra loro almeno 10 m; in ognuno di questi siti sono stati prelevati in doppio gli orizzonti O e A presenti entrouna cornice di 30 x 30cm.L'estrazione della mesofauna è stata condotta separatamente per entrambi i tipi di orizzonte mediante estrattori Berlese-Tullgren.
L'analisi dei taxavegetali ha evidenziato per questi boschi isolati una situazione meno stabile rispetto alle formazioni forestali continue,evidentemente dovuta all'isolamento ecologico subito.Anche l'analisi dei trend di mesofauna nei transetti hamesso in evidenzadifferenti intensità di pressione all'interno dell'associazionevegetazionale considerata, con marcate differenze tra la parte interna e quella esterna. Tali risultati hanno evidenziato come l'analisi dellamesofauna si siarilevatanon solo un valido indicatore a scala di cenosi, ma sia anche capace di evidenziare variazioni ambientali al di sotto della sensibilità percepita dalla vegetazione nel breve periodo.

Parole chiave:vegetazione, boschi residui, ostrieto

CRONOSEQUENZA DELLE FORME DI HUMUS COME INDICATORE DEL DINAMISMO AMBIENTALEDEGLI OSTRIETI APPENNINICI

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Caratterizzanti gran parte del paesaggio collinare-basso montano italiano e gestite esclusivamente a ceduo, le formazioni forestali afferenti alla categoria degli ostrieti, hanno rappresentato nei secoli scorsi una grande risorsa per le popolazioni dell'entroterra. Alla luce dei recenti studi ecologici e vegetazionali che evidenziano un maggior livello di biodiversità nelle aree regolarmente ceduate rispetto a quelle invecchiate, convertite o abbandonate, lo studio di queste cenosi appare oggi quanto mai attuale. Particolarmente significativo ai fini della comprensione del sistema, risulta poi l'interazione dei dati relativi agli studi vegetazionali con quelli del suolo di queste cenosi; a tale scopo questo studio hapreso in considerazione lo studio delle forme di humus forestale come indicatore del dinamismo ambientale.L'humus forestale (l'insieme delle proprietà morfologiche e chimiche degli orizzonti O e A) è infatti il risultato di una miriade di interazioni spazio-temporali tra micro- e macro-clima, condizione geochimica, vegetazione, animali (macro- meso- e microfauna), batteri, funghi,etc.; per questo motivo, l'humus forestalerappresenta un fattore di sintesi tra evoluzioni di breve e di lungo periodo della foresta,ed è capace di fornire informazioni sul sistema forestale complementari a quelle desumibilidallo studio vegetazionale.
Individuato nell'ostrieto mesofilo il tipo forestale afferente alla categoria degli ostrieti più diffuso a livello nazionale, e identificato lo *Scutellariocolumnae - Ostrietumcarpinifoliae*comel'associazione vegetazionale maggiormente caratterizzante questa tipologia lungo l'Appennino centro-settentrionale, si è proceduto alla descrizione e allostudio delle forme di humus forestale presenti nei vari momenti del turno di ceduazione: dal primo anno dopo il taglio fino al superamento dello stesso in seguito all'abbandono. Le osservazioni morfologiche sono state effettuate in sette differenti plots ein due momenti dell'anno (primavera e autunno),così da avere informazioni relative sia all'arco temporale sia a quello stagionale. L'evoluzione delle forme di humus durante il turno, parzialmente in linea con i dati vegetazionali ed ecologici reperibili in bibliografia, ha messo in luce un sistema estremamente complesso e dinamico, evidenziando l'importanza che questo tipo di gestione assume nella mantenimento di questa cenosi forestale.L'importanza della gestione del ceduo è anche confermatadall'analisi del plot relativo al periodo successivo al superamento del turno; qui, contrariamente a quanto si poteva presumere,gli orizzonti organici risultano discontinui a causa del dissesto innescato dall'abbandono,e l'organizzazione degli orizzonti O ha subito una notevole semplificazione, con conseguente perdita di pedo-diversità.

Parole chiave*:*humus forestale, ceduo, gestione, abbandono

Ecological dynamics, vegetation and soil in a mesophilic European Hophornbeam stand during coppice rotation in central-northern Apennines (Italy)

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This study analyzes ecological dynamics of six forest management units located on Mt. Nerone (Central-Northern Apennines) that have been managed as coppices for more than three centuries to investigate, by means of a synchronic approach, the effects of coppicing practice on the forest ecosystem recovery process and the evolution of its various components during the rotation.

In particular, the study analyses dendrometric, pedologic and floristic-vegetational data that characterize the increasing ages of the forest management units, delineating trends and dynamics. Our results show that, although from the phytosociological point of view all the stands belong to the same association (*Scutellario columnae-Ostryetum carpinifoliae*), the highest floristic richness and ecological diversification are realized in the early stages after the cut, because of sudden uncovering creates excellent conditions for the germination of the species found in the soil seed bank. Moreover, the conditions of edge are amplified, while maintaining suitable conditions for the nemoral flora in the vicinities of the stumps.

Afterwards, with the closure of the canopy, decreased number of species and ecological homogenization were observed and they reached maximum 20th years after the cut.

Further the situation tends to change due to the decrease in coverage mainly due to the increasing number of gaps.

With the overrun of the rotation, the number of species rises again, but not the quality of vegetation.

We conclude that the analyzed stands appear very important for their ecologic characteristics, they aren't particularly affected by the coppicing practice, but rather dependent on it for their maintenance.

Keywords

European Hophornbeam, Coppice, Stand rotation, Flora, Vegetation, Soil, Biodiversity

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CEDUAZIONE, BIODIVERSITÀ E PAESAGGIO:
RISPOSTE DELL'ECOSISTEMA ALLA SELVICOLTURA DEL CEDUO.
IL CASO DI UN ORNO-OSTRIETO DELL'APPENNINO CENTRALE.

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Keywordss: *gestione forestale, dinamiche ecologiche, Scutellario columnae-Ostryetum carpinifoliae, turno,*

La ceduazione, con cui sono gestite sistematicamente le principali formazioni a latifoglie del nostro paese, è una pratica selvicolturale antichissima e importante in tutta l'area del Mediterraneo (Piussi e Alberti, 2015), che ha plasmato e che caratterizza tutt'oggi gran parte del paesaggio italiano basso-montano e collinare. Tuttavia la selvicoltura del ceduo, caratterizzata da superfici ridotte, generalmente legata a proprietà frammentate e incapace di produrre legname di pregio, principale prodotto perseguito con l'assestamento forestale fino alla metà del secolo scorso, è da sempre stata considerata semplice e poco costosa, suscitando scarso interesse dal punto di vista scientifico. Negli ultimi decenni il modo di considerare "il bosco" ha subito profondi cambiamenti legati soprattutto alle modifiche socio-economiche e culturali, spostando gli interessi della gestione forestale dalla produzione di legname ai servizi eco-sistemici, paesaggistici e alla protezione idrogeologica, aspetti che trovano la massima espressione in popolamenti stabili, caratterizzati da elevata naturalità e complessità ecologica. Il governo a ceduo, contraddistinto da turni brevi e disturbi periodici reiterati, è stato quindi rimproverato di un modesto contributo paesaggistico, dell'impoverimento del suolo e di una sostanziale perdita di biodiversità su basi concettuali spesso carenti di un reale approfondimento delle conoscenze biologiche e fisiologiche del sistema.

Obiettivo di questo lavoro è stato quello di indagare gli effetti del governo ceduo sui processi di recupero dell'ecosistema forestale nel corso del turno e al suo superamento. Identificato l'Orno-Ostrieto come il tipo forestale gestito a ceduo più esteso a livello nazionale, si è proceduto prendendo in analisi il versante a sud dell'abitato di Cardella (PU), la cui secolare gestione a ceduo permettesse di evidenziare gli effetti della reiterata ceduazione mediante l'analisi di dinamiche floristiche, vegetazionali e fenologiche, stato fisiologico e fitosanitario, copertura del suolo, necromasse, aspetti faunistici e pedologici e di effettuarne la classificazione ecologica per valutare naturalità e stabilità della cenosi (Taffetani e Rismondo, 2009).

I risultati mostrano buona copertura del suolo già dopo un anno dal taglio con esponenziale decrescita al superamento del turno, ricchezza e qualità floristica elevata con picco negli anni immediatamente successivi al taglio imputabile tanto alla germinazione della soil seed bank quanto alle nuove condizioni microclimatiche, che tuttavia non portano ad una modifica vegetazionale *(Scutellario columnae-Ostryetum carpinifoliae*). Le fenologie risultano fortemente influenzate dalla copertura arborea con scalarità nel turno e sfasamento nei 2 anni successivi al taglio. Infine l'adattamento di polloni e ceppaie alla competizione aumenta esponenzialmente al superamento del turno con conseguente instabilità, comparsa di fitopatie e diversificazione quali-quantitativa delle necromasse.

Concludendo il sistema appare caratterizzato da naturalità e stabilità magnificate dalla compresenza di tutte le fasi del turno che creano ambienti differenti in spazi ristretti, essenziali alla sopravvivenza di flora e fauna selezionate dalle modalità gestionali e da esse dipendenti per il loro mantenimento.

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Criteri per la valutazione di biodiversità e stabilità in boschi a governo ceduo

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Uno studio multidisciplinare applicato su oltre 85 ha tradizionalmente gestiti a ceduo e appartenenti all’associazione *Scutellario columnae-Ostrietum carpinifoliae*, ha permesso di osservare i parametri caratterizzanti le diverse fasi di sviluppo della cenosi, la cui compresenza caratterizza le aree forestali gestite secondo questa forma di governo. La successione evolutiva della formazione dal momento del taglio fino al primo decennio successivo al suo abbandono gestionale è stata poi ricostruita mediante approccio sincronico. I risultati ottenuti hanno permesso di evidenziare come l’elevato grado di biodiversità e complessità ecologica presente a livello di unità di paesaggio sia legato non soltanto alla compresenza di particelle con condizioni dinamico-strutturali differenti ma soprattutto grazie al continuo rinnovamento di aree di rifugio legata alle azioni di disturbo proprie della forma gestionale. Modifiche al turno tradizionale implicano effetti non soltanto a livello floristico e strutturale ma anche a livello di pedofauna, seed bank, necromasse e andamento fenologico. Questo comporta alterazioni degli effetti feedback e una sostanziale modifica del sistema che perde la sua caratteristica resilienza a favore di una più spiccata resistenza. Al ricrearsi delle condizioni di scopertura la cenosi presenta evidenti alterazioni, tra cui la scomparsa di un cospicuo numero di specie animali e vegetali. Appare quindi ovvio come la valutazione del valore in termini di biodiversità e complessità ecologica non possa essere effettuata senza tener presente l’intero ciclo del turno (compresi i primi anni dopo il taglio) e le fasi successive all’abbandono, ponendo attenzione alle modifiche che interessano contingente floristico, maturità della cenosi, composizione e vitalità della *seed bank*, strutturazione delle forme di humus e auto-ecologia delle specie che rivestono un ruolo chiave nel mantenimento della cenosi.

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Parole chiave: Biodiversità, ceduo, sistema complesso, gestione forestale, seed bank, humus, ~~,~~ bioindicazione, maturità, paesaggio.

Long-term effects of the traditional coppice management, its modification and its abandonment on phenology and seed-bank of a Scutellario-Ostryetum.

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Keywords: *Scutellario columnae - ostryetum carpinifoliae; forest management, ecological dynamics, feedback effects, resilience, resistance, biodiversity.*

Coppicing is an ancient forestry practice diffuse throughout the Mediterranean area that has shaped and still characterizes much of the Italian hilly and mountainous landscape. However, the socioeconomic changes that have characterized the last 50years have led to widespread abandonment of historically coppiced areas, with consequent effects on the ecology and landscape still relatively unknown. European hophornbeam forests are formations with high biodiversity and ecological complexity that characterize much of the Italian and Balkan low mountain and hill landscapes. Here, we applied a synchronic approach to analyze changes in the phenological trend and seed-bank characteristics at different stages during the traditional coppicing rotation, after the lengthening of the rotation and subsequently the abandonment of a typical European hophornbeam forest that had been managed by coppicing for centuries. For this purpose, in each stage phenological trend were collected for three years and a quantification of the soil seed-bank was carried out through seed counting, identification, and evaluation of seed viability, for the seeds recovered from a soil volume of about 3.375 dm^3 collected using a 15 ×15cm frame hammered into the soil to a depth of 15 cm starting from the OLf horizon.

The analysis of the phenological trends showed after an initial phenological phase shift linked to the sudden elimination of the tree layer, a strict synchronization of the phenological phases among the species. Phenological synchronization that remained constant in all the investigated stages, with the exception of the post-abandonment one. In this stage constant phase shift of the phenology phases were highlighted. The seed bank analysis showed a peak of number of seeds and seeds viability around the third year after the coppicing. Subsequently, both the number and the viability of the seeds tend to decrease following constant trend up to the last years of the traditional rotation, while the specific composition remains substantially unchanged. With lengthning of the rotation the viable seeds decrease following an accentuated trend and triggering slight changes to the specific composition. instead, the seed bank of the post-abandonment stage shows strong differences in all aspects, both qualitative and compositional.

Our data show that the dynamism that characterizes this coenose during traditional coppice rotation changes with the lengthening of the rotation period, and alters after cessation of the management practices. On the basis of the results obtained, we suggest to considering carefully the consequences that could derive from management decisions that today seems to be increasingly oriented towards a lengthening of the rotation period up to conversion for abandonment, with the aim of protecting biodiversity.

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