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The edge communities of *Asphodelus macrocarpus* subsp. *macrocarpus*: the different ecological aspects and a new case study in the central Apennines

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Abstract

This article begins with an extended presentation of the logical process that led to the definition of the order *Asphodeletalia macrocarpi* Biondi & Allegrezza 2014, highlighting the various aspects that justified this. The new analysis conducted in other areas of the central Apennines that were analysed with the present study allows the more precise description of the syntaxonomy of the lower hierarchical levels. This describes the new alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi* that groups the communities with *Asphodelus macrocarpus* in the lower supratemperate thermotype of the central Apennines, a vicariant of the alliance *Cyano triumfettii-Asphodelion macrocarpi* that is typical of the upper supratemperate thermotype. Three new associations of the new alliance are recognized, according to the geomorphological characteristics and the dynamic context and landscape: *Leontodo cichoracei-Asphodeletum macrocarpi*, *Trifolio ochroleuci-Asphodeletum macrocarpi* and *Senecio apennini-Asphodeletum macrocarpi*. The statistical comparison between the associations published, at European level in which *A. macrocarpus* or *Asphodelus albus* have been used in the epithet of the association, has provided a biogeographical overview at the European level and a critical syntaxonomic revision of the Apennine phytocoenoses, for some of which the correction of the nomenclature was necessary according to the most recent taxonomic acquisitions. Based on the analysis performed, the syntaxonomic scheme of the order *Asphodeletalia macrocarpi* for the central-southern Apennines is proposed, which is currently recognized in three alliances: *Cyano triumfettii-Asphodelion macrocarpi*, *Thalictro aquilegiifolii-Asphodelion macrocarpi* and *Hyperico calabricae-Asphodelion macrocarpi*. The indications of the environmental characteristics and preferential dynamic relationships of each of the syntaxa considered contribute to the present state of knowledge, with both the definition and clarification of the ecological range and landscape of the order *Asphodeletalia macrocarpi*, to complete the main landscape units described for the central-southern Apennines.

Key words: *Asphodelus macrocarpus* subsp. *macrocarpus*, ecology, ecotonal area, heliophilous edge, landscape ecology, phytosociology, syndynamism, syntaxonomy.

Introduction

The phytosociological study of the vegetation in the ecotonal areas between the forest formations and the herbaceous formations was particularly important in the early knowledge of the processes that underlie the dynamics of the vegetation and that have allowed us to understand the development of the dynamic processes of the vegetation. The recognition of the shrub (class *Rhamno-Prunetea*) and herbaceous (class *Trifolio-Geraniea*) formations that surround woods and that open towards the more heliophilous forest edges have made it possible to understand and model the natural dynamic processes that follow the abandonment of agricultural activities, and the successions which lead to the reconstitution of the vegetation (synphytosociology).

When reconstructed in terms of its summary aspects in Biondi (2011), the history of the knowledge of the dynamic processes of the vegetation has provided one of the most important chapters in the path of phytosociology over the last 100 years or more since its foundation. In recent years, the additional knowledge

of the dynamics of the vegetation have allowed further methodological and conceptual studies (Carni, 2005; Dengler *et al.*, 2003; Mucina *et al.* 2009; Bouzille & de Foucault, 1988; Biondi *et al.*, 2014, 2014b). These studies have enabled phytosociology to be used to express important roles also for the planning and management of the plant landscape and for the evaluation of interventions that can be implemented on these (applied phytosociology)

The purpose this article is to further deepen our knowledge on the zone ecotonal transition that affects the edge of the forest formations where there has been a change in the gradient of brightness that occurs within a few meters. This thus creates the ecological conditions for the development of the herbaceous vegetation communities that are typical of this transition.

The class of grassy edges, such as *Trifolio-Geraniea* Müller 1962, traditionally groups this vegetation into two main orders: *Origanetalia vulgaris* Müller 1962, which brings together the mesophilous communities of the forest edges, on mature soils and with deep humus, and that are diffuse in the supratemperate and upper mesotemperate thermotype, and *Antherico-*

Geranietalia sanguinei Julve ex Dengler in Dengler et al. 2003, which is made up of the more calcicole thermoxerophilous forest-edge communities that are widespread mainly in the mesotemperate thermotype, and also in the sub-Mediterranean variant of the temperate macroclimate. Recently, a new alliance was inserted in this order (Mucina et al., 2009) that joins with that indicated as the *typus* of the order, *Geranion sanguinei* Tüxen in Müller 1962, and which was formalized with the name of *Dictamno albi-Ferulagion galbaniferae* (Van Gils, Keysers & Launsdachs 1975) de Foucault et al. 2009. This alliance unequivocally adds in an important new concept in the study of herbaceous communities of the edges, in terms that it brings together the heliophilous and xerophilous communities of the edges that following the increasing light gradient are in contrast to the sciaphilous communities of the forest edges, despite the same xerophilous conditions. More recently, in taking this concept further, the order *Asphodelietalia macrocarpi* Biondi & Allegrezza (Biondi et al., 2014) was established that identifies heliophilous plant communities that are dominated by geophytes and tall hemicryptophytes, and that form a heliophilous edge that is in continuity with the sciaphilous forest edges (order *Origanetalia vulgaris*). Through dynamic invasion, these communities colonise abandoned secondary grasslands in the mesotemperate to supratemperate thermotype. In Apennines, among the species of heliophilous edge more active, is *Asphodelus macrocarpus* that with its showy blooms in the late spring characterizes the physiognomy of secondary grasslands affected by colonisation. A taxonomic revision on the genus *Asphodelus* in the western Mediterranean (Díaz-Lifante & Valdés, 1996) showed that the most common species within the temperate macroclimate are *Asphodelus albus*, with a European distribution and an Atlantic spread, and *A. macrocarpus*, which is distributed on the mountain ranges of the Mediterranean Basin of the Iberian Peninsula, southern France, Italy and northwestern Morocco. In Italy there is only one subspecies of *A. albus* recognized, as subsp. *delphiniensis*, which is limited to northern Italy, while in central-southern Italy, *A. albus* is the vicariant of *A. macrocarpus* subsp. *macrocarpus*.

In Europe, *A. macrocarpus* and *A. albus* herbaceous communities that are characteristic of one of these two taxa have been described for Galicia in Spain (Izco, 1986), for the region of Vendée and the Alpine foothills in western France (Bouzille & de Foucault, 1988; Musset, 2014), and for different areas of the central and southern Apennines. The first study on Apennine *A. macrocarpus* communities dates back to Tommaselli (1952), who described the “*Asphodelus albus* association” at the margins of a beech forest of Monte Terminillo in the Lazio-Abruzzo Apennines (central Apennines) without any clear syntaxonomical refer-

ence. Since then, *A. macrocarpus* associations, subsociations and communities have been described for the Apennine grasslands (Bonin, 1972; Francalancia et al., 1981; Corbetta et al., 1984; Fascetti et al., 2013), and referred to the different syntaxa of the classes *Festuco-Brometea* and *Nardetea strictae*. In the southern Apennines, for the Calabrian Apennines, *Pteridium aquilinum* subsp. *aquilinum* communities have also been described with *A. macrocarpus*, indicated as the association *Asphodelo macrocarpi-Pteridetum aquilini*, referred to as the endemic alliance *Violion messanensis* in the class *Cytisetia scopario-striati* (Brullo et al., 2001).

The latest Apennines-based studies for recent methodological and ecological acquisitions (Allegrezza et al., 2014; Biondi et al. 2014, 2014b) have allowed the definition of the position of the ecological communities dominated by *A. macrocarpus* in the order *Asphodelietalia macrocarpi*. For this order, there have been two alliances described, as *Cyano triumfettii-Asphodelion macrocarpi* for the central Apennines, for the upper supratemperate thermotype, and *Hyperico-Asphodelion macrocarpi* for the southern Apennines and Sicily (Biondi et al., 2014b). The present study provides further aspects of the vegetation in the central Apennines, with particular reference to the vegetation of *A. macrocarpus* for the areas of the low supratemperate thermotype, to highlight the floristic-vegetational autonomy. The dynamic and landscape contextualisation of these plant communities are also proposed. Finally, through a comparison with the different typologies referred to the communities with a dominance of asphodel (i.e., *A. macrocarpus*, *A. albus*), a general biogeographic and syntaxonomic overview is reconstructed as far as possible, at the European and Apennines levels.

The case study

The new case study was carried in the Marche and Umbro-Marche Apennines (Central Apennines) in the territories reported in Figure 1. The analyzes were conducted within five SCI (IT5330015, “Monte San Vicino”; IT5320011, “Monte Puro–Rogedano–Valleremita”; IT5330009, “Monte Giuoco del Pallone, Monte Cafaggio”; IT5210009, “Monte Cucco”; IT5340014, “Monte Vettore, valle del Lago di Pilato”) at altitudes between 970 m and 1220 m a.s.l., along relatively steep slopes and in the summit sectors of the peaks. From the geological point of view, with the exception of the “Sentiero dei Mietitori and Pian delle Pecorelle” areas in the Mount Vettore group (where there are outcrops of the arenaceous-pelitic flysch of the “Bacino della Laga”) all of the other areas are part of the calcareous areas of the Umbro-Marche ridges, which are characterised in particular by outcroppings of the Fucoid

Marls and Maiolica Formations. There are often ferrallitic soils in the summit sectors with subplain morphologies or with rolling plains. These are deep and decarbonated soils that are enriched in clay minerals and oxides (through pedological processes of latent ferrallitisation) that developed in the warm interglacial periods. The bioclimatic classification of the study area was carried out using the climatic data collected at the Fabriano (354 m a.s.l.), Camerino (670 m a.s.l.), Montemonaco (987 m a.s.l.) and Scheggia (575 m a.s.l.) thermo-pluvial stations. According to the Rivas-Martínez (2008) bioclimate classification, all of these thermopluviometric stations considered are included in the submediterranean variant of the temperate macroclimate and in the oceanic bioclimate. The bioclimatic belt is the upper mesotemperate thermotype, as upper subhumid for Fabriano and Camerino, while it is the low supratemperate thermotype for Montemonaco and Scheggia, upper and low humid, respectively.

Materials and Methods

The study of the plant communities was carried out following the phytosociological method of the Zurich-Montpellier School, as successively integrated (Tüxen 1978; Géhu & Rivas-Martínez, 1981; Géhu, 1991; Theurillat, 1992; Rivas-Martínez, 2005; Géhu, 2006; Allegrezza *et al.* 2008; Biondi, 2011; Pott, 2011).

The 139 relevés used to define the vegetational dynamic and plant landscape include 18 original phytosociological relevés carried out in the study area during the spring and summer of 2010 and 2014, plus 109 published relevés from different sectors in the Apennines (Tommaselli, 1952; Bonin, 1972; Corbetta *et al.*, 1984;

Brullo *et al.*, 2001; Allegrezza *et al.*, 2014; Biondi *et al.*, 2014, 2014b), France (Bouzeille & de Focault, 1988; Musset 2014), and Spain (Izco *et al.*, 1986), and 22 published relevés from the same study areas (Biondi *et al.*, 2001; Allegrezza, 2003).

Species nomenclature and chorological and biological characterization follow Aeschmann *et al.* (2004); moreover, the following studies were also consulted: Tutin *et al.* (1964-80, 1993), Jalas *et al.* (1972-1994), Pignatti (1982), Conti *et al.* (2005, 2007), Ballelli *et al.* (2005).

The phytosociological relevé values were constructed according to the Van der Maarel (1979) scale, and were then submitted to multivariate analysis using the VEGAN community ecology package for R (Oksanen *et al.*, 2012). The numerical classification according to cluster analysis was carried out by applying the average and complete link algorithm (Orlaci, 1978) to the similarity ratio matrix (Westoff & Van der Maarel, 1978) computed for the phytosociological relevés. Ordering of the non-metric multidimensional scaling (NMDS), which is suitable for the analysis of ordinal data such as those of Van der Maarel (Podani 2007), was used to describe the main trends of the vegetation variations. The results of the cluster analysis were superimposed on the two dimensional plot of the NMDS. The syntaxomic nomenclature at the level of alliance, order and class follow the Prodrome of the Italian Vegetation (Biondi *et al.* 2014a), the subsequent integrations (Biondi *et al.*, 2014, 2014b), and the variations and integrations of syntaxa indicated in the specific interactive site of the Italian Botanical Society, as recently upgraded (<http://www.prodromo-vegetazione-italia.org/>). Publications regarding syntaxonomic reviews were consulted to define the vegetation type and

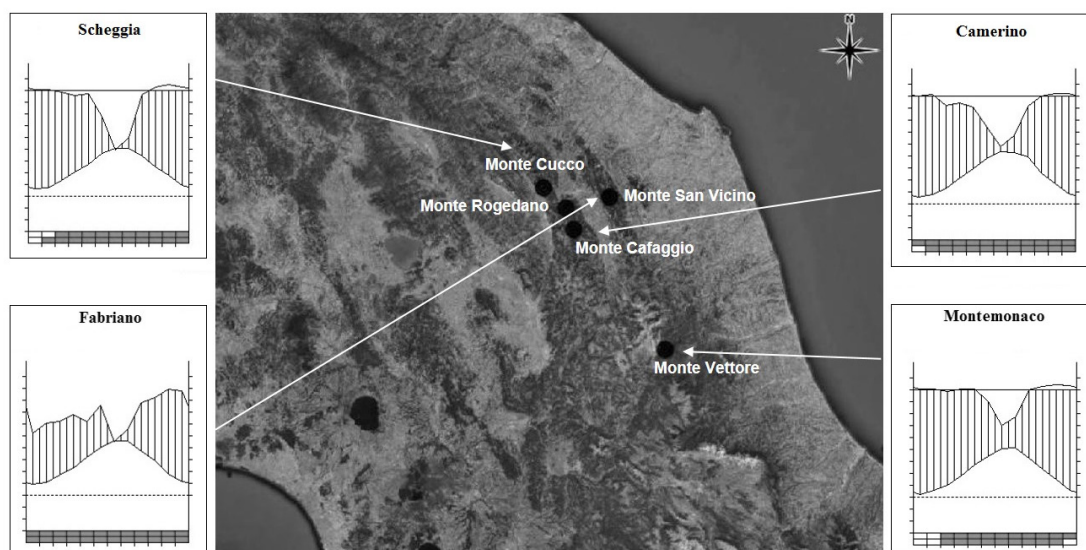


Fig. 1 - Location of the study areas and bioclimatic diagrams from meteorological stations considered.

the vegetational context (Rivas-Martínez *et al.*, 2001; Dengler *et al.*, 2003; Di Pietro *et al.*, 2004; Carni, 2005; Mucina *et al.*, 2009; Terzi, 2011).

Results and discussion

Floristic composition and phytosociology

The dendrogram obtained by the cluster analysis (Fig. 2A) identifies two main clusters that bring together the relevés of the low supratemperate thermotype (Cluster I) and those already published for the upper supratemperate thermotype (Cluster II) of the alliance *Cyano triumfettii-Asphodelion macrocarpi*, with association *Senecio scopolii-Asphodeletum macrocarpi*. Three subclusters were identified at higher similarity levels in the low supratemperate thermotype (Cluster I): the first (subcluster IA) refers to the heliophilous neutral-basic edges of the slopes on limestone substrates; the second (subcluster IB) refers to the mesophi-

lous and subacidophilous edges of the summit lowland sectors of the limestone ridges in the fersiallitic soil; and the third (subcluster IC) refers to the anthropogenic mesophilous and acidophilous communities of the slopes of the flysch substrates. The NMDS (Fig. 2B) confirms the separation of these four groups of relevés that were highlighted by the dendrogram.

The elaboration of the Table 1 allowed to propose the new alliance *Thalictro aquilegifolii-Asphodelion macrocarpi* for the low supratemperate thermotype of the central Apennines that represents the vicariant of the alliance *Cyano triumfettii-Asphodelion macrocarpi* typical of the upper supratemperate thermotype. Three new associations of the new alliance are proposed here and are described below, which correspond to the dendrogram subclusters and the NMDS (Fig. 2): *Leontodo cichoracei-Asphodeletum macrocarpi*, *Trifolio ochroleuci-Asphodeletum macrocarpi*, and *Senecio apennini-Asphodeletum macrocarpi*.

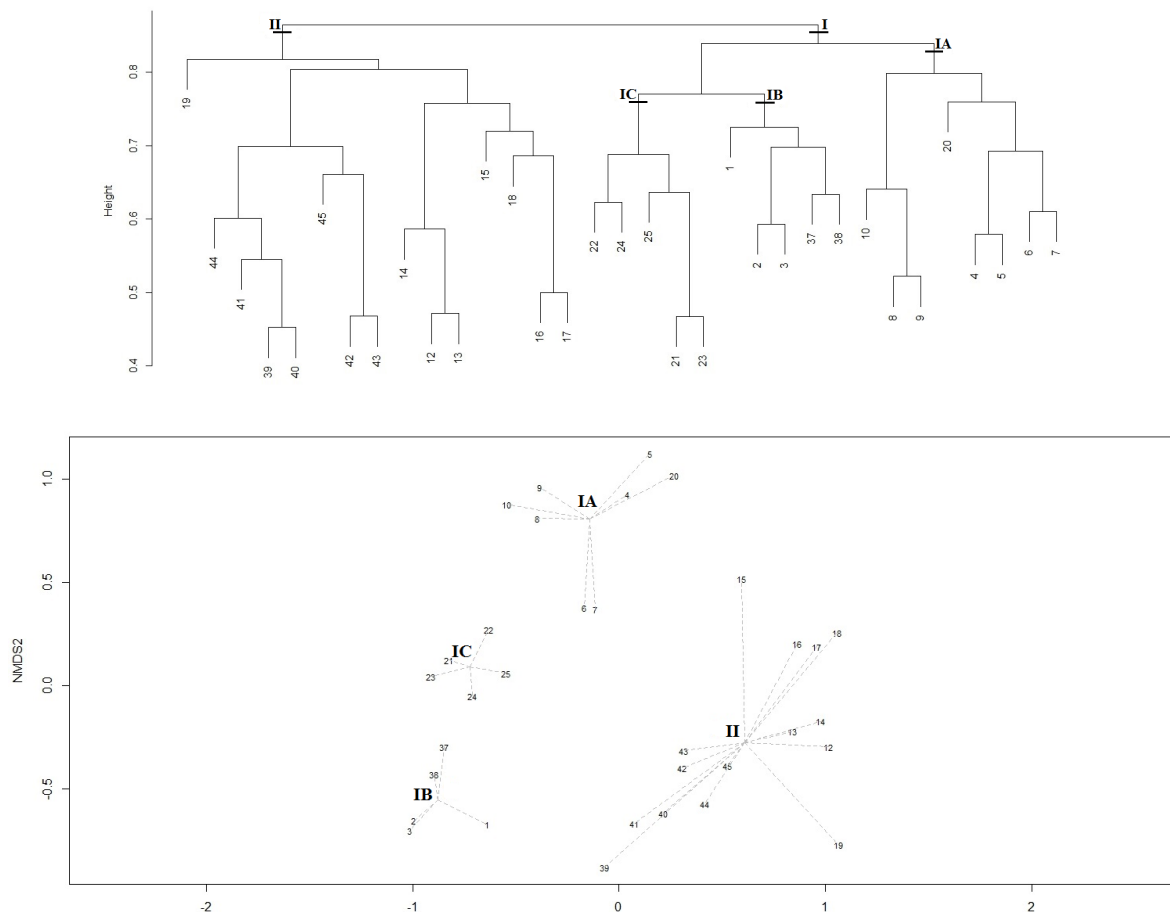


Fig. 2 - Dendrogram (A) and NMDS ordination (B) from the *Asphodelus macrocarpus* communities phytosociological relevés in Central Apennine, and published relevés as comparison. I - *Thalictro aquilegifolii* - *Asphodelion macrocarpi*, IA: *Leontodo cichoracei-Asphodeletum macrocarpi*, IB: *Trifolio ochroleuci-Asphodeletum macrocarpi*, IC: *Senecio apennini-Asphodeletum macrocarpi* (area study); II - *Cyano triumfettii-Asphodelion macrocarpi* [*Senecio scopolii-Asphodeletum macrocarpi* subass. *senecionetosum scopolii* (Tab. II in Biondi *et al.* 2014a) and *Senecio scopolii-Asphodeletum macrocarpi* subass. *luzuletosum sieberi* (Tab. 9 in Allegrezza *et al.*, 2014)].

The presence of two alliances for the *A. macrocarpus* communities in the central Apennines is justified not only by the different floristic compositions, but also through the different dynamic environments and landscape references, a summary of which is shown in the scheme of Table 3 for the central-southern Apennines.

THALICTRO AQUILEGIIFOLII-ASPHODELION MACROCARPI all. nova *hoc loco* (rels. 1-18 of Table 1) (*Holotypus*: *Leontodo cichoracei-Asphodeletum macrocarpi* ass. nova *hoc loco*)

This new alliance brings together the heliophilous and mesophilous edges dominated by *A. macrocarpus*. These show penetration with thermophilous species, such as *Thalictrum aquilegiifolium* subsp. *aquilegiifolium* and *Brachypodium rupestre*, of the low supratemperate thermotype in the Apennines in the limestone and flysch lithologies, on less steep morphologies and in small valleys with deep, humid soil. Their dynamic connections are preferentially with the shady forest edges of the suballiance *Digitalidi micranthae-Trifolienion medii* (alliance *Trifolienion medii*) and the mesophilous abandoned or underused grasslands of the alliances *Phleo ambigu-Bromion erecti*, in its more mesophilous aspects, and *Cynosurion cristati*, *Ranunculo neapolitani-Arrhenatherion elatioris* and *Ranunculo pollinensis-Nardion strictae*. Under conditions in which the previous traditional human activities led to the removal of the forest edge vegetation, the heliophilous edges of the alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi* have dynamic relationships with *B. rupestre* communities, which under these conditions in contact with the woods have replaced the communities of the order *Origanetalia vulgaris*. These are part of the *Pulmonario apenninae-Carpinenion betuli* (alliance *Physospermo verticillati-Quercion cerridis*) and the *Lathyro veneti-Fagenion sylvaticae* (alliance *Aremonio agrimonioidis-Fagenion sylvaticae*) plant landscape. The alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi* represents the lower altitudinal limit of the order *Asphodeletalia macrocarpi* for the Apennines, and the catenal connection with the heliophilous thermoxerophilous edges of the order *Anthetico-Geranietalia sanguinei*, with which it sometimes assumes the meaning of ecosynvicariant.

The specific characteristic combinations include: *Asphodelus macrocarpus* subsp. *macrocarpus*; *Brachypodium rupestre*; *Helianthemum nummularium* subsp. *obscurum*; *Leontodon cichoraceus*; *Cerastium arvense* subsp. *suffruticosum*; *Thalictrum aquilegiifolium* subsp. *aquilegiifolium*; *Senecio apenninus*; *Trifolium ochroleucum*; *Lathyrus pratensis* subsp. *pratensis*; *Galium mollugo* subsp. *erectum*; *Centaurea jacea* subsp. *gaudini*; *Loncomelos pyrenaicus* subsp. *sphaerocarpus*; *Salvia pratensis*; *Primula veris* subsp.

suaveolens; *Cirsium lobelii*; *Prunella vulgaris* subsp. *vulgaris*.

LEONTODO CICHORACEI-ASPHODELETUM MACROCARPI ass. nova *hoc loco* (*Holotypus* rel. 1 in Table 1)

ASPHODELETOSUM MACROCARPI subass. nova *hoc loco* subass. *typus*

FERULAGETOSUM CAMPESTRIS subass. nova *hoc loco* (*Holotypus* rel. 6 of Table 1)

This new association brings together the heliophilous neutro-basophilous and edaphomesophilous edges with a dominance of *Asphodelus macrocarpus* that are typical of the low supratemperate thermotype of the central Apennines in the landscape context of the macrothermal basophilous beech forests (*Lathyro-Fago sylvaticae* sigmetum). In relation to the altitude and edaphic moisture, the association *Leontodo cichoracei-Asphodeletum macrocarpi* is recognized with two new subassociations: *asphodeletosum macrocarpi* and *ferulagetosum campestris*.

The subassociation *asphodeletosum macrocarpi* (subass. *typus*) has as its characteristic and differential species: *Asphodelus macrocarpus*; *Brachypodium rupestre*; *Leontodon cichoraceus*; *Geranium sanguineum*; *Helianthemum nummularium* subsp. *obscurum*; *Orchis mascula*, and *Euphorbia amygdaloides*. This refers to the heliophilous edaphomesophilous edges that have established in positions of particularly steep slopes up to heights from 1000 m to 1220 m a.s.l., on brown humidified soils that are deep and wet, and in connection with the sciophilous forest edges of the alliances *Geranium sanguinei* (s.l.) and *Digitalidi australis-Trifolienion medii* (alliance *Trifolienion medii*). Due to dynamic invasion, the heliophilous edaphomesophilous edges colonize the secondary abandoned grasslands of the alliance *Phleo ambigu-Bromion erecti* for its more mesophilous aspects, and locally, those of the alliance *Cynosurion cristati*.

The new subassociation *ferulagetosum campestris* which are differential species: *Ferulago campestris*, *Laserpitium latifolium* and *Lathyrus sylvestris* subsp. *sylvestris* represents the mesoxerophilous aspect of the association *Leontodo cichoracei-Asphodeletum macrocarpi*. These coenoses have developed at average altitudes of 980 m, on lowland morphologies, although they are located in the sunniest and generally the driest positions of the subassociation *typus*. Frequently, these plant communities are dynamically connected with the *B. rupestre* communities that in contact with the wood, replace the communities of the order *Origanetalia vulgaris*. This occurs under conditions in which traditional human activities in the past were pushed forward for the reduction of the forest vegetation, with the consequent elimination of the edges. In positions where the slopes change and in thin soils, the helio-

Tab. 1 - *Aphodeltus macrocarpus* communities belong to the *Asphodeletalia macrocarpi* order in Central Apennine
 1 - *Aphodeltus macrocarpi* all. nova *hoc loco* (rels. 1-18 Tab. 1, *Holotypus* rel. 1); *Leontodo cichoracei-Asphodeletum macrocarpi* ass. nova *hoc loco* (rels. 1-8; ass.
 4 - *Thalictro aquilegifolii-Asphodelentium macrocarpi* all. nova *hoc loco* (rels. 9-13, *Holotypus* rel. 9), *Senecio apennini-Asphodeletum macrocarpi* ass. nova (rels. 14-18, *Holotypus* rel.
typus; *Holotypus* rel. 1), *Trifolio ochroleucti-Asphodeletum macrocarpi* ass. nova (rels. 9-13, *Holotypus* rel. 9), *Senecio scopoli-Asphodeletum macrocarpi* Biondi & Allegranza in Biondi *et al.*
 17); II - *Cyano triumfettii-Aphodelentium macrocarpi* Biondi & Allegranza in Biondi *et al.*, 2014 (rels. 19-32 Tab. 1); *Senecio scopoli-Asphodeletum macrocarpi* Biondi & Allegranza in Biondi *et al.*
 2014 subass., *senecionetosum scopoli* (rels. 19-26 from Tab. II in Biondi *et al.*, 2014a) and *Senecio scopoli-Asphodeletum macrocarpi* Biondi & Allegranza in Biondi *et al.*, 2014 subass.
luzuletosum sieberi Biondi & Allegranza in Allegranza *et al.*, 2014 (rels. 27-32 from Tab. 9 in Allegranza *et al.*, 2014)

N. rel.																															
Groups from dendrogram and NMDS (fig.2)																															
Altitude (m a.s.l.) x 10																															
Aspect																															
Slope (°)																															
Coverage (%)																															
Area (m²)																															
N. species x rel.																															
Leontodon cichoracei-Asphodelum macrocarpi																															
Leontodon cichoraceus (Ten.) Sunguin.																															
Geranium sanguineum L.																															
Orchis mascula (L.) L. subsp. mascula																															
Euphorbia amygdaloides L. subsp. amygdaloides																															
ferulagetosum campestris																															
Ferulago campestris (Besser) Grecescu																															
Lasertipitum latifolium L.																															
Lathyrus sylvestris L. subsp. sylvestris																															
Trifolium ochroleuci-Asphodelum macrocarpi																															
Trifolium ochroleucum Huds.																															
Helleborus bocconei Ten. subsp. bocconei																															
Centauria jacea L. subsp. gaudini (Boiss. & Reut.) Gremli																															
Linum bienne Mill.																															
Prunella vulgaris L. subsp. vulgaris																															
Senecio apennini-Asphodelum macrocarpi																															
Trifolium alpestre L.																															
Campanula rapunculus L.																															
Rumex nebroides Campd.																															
Festuca stricta ssp. trachyphylla (Hack.) Patzke ex Pils																															
Galium mollugo subsp. erectum Syme																															
Senecio apenninus Tausch																															
Centauria nigrescens Willd. (s.l.)																															
Cirsium lobelii Ten.																															
Diff. species of Gentista sagittalis variant																															
Gentista sagittalis L.																															
Potentilla erecta (L.) Raesch.																															
Thalictrum aquilegifolium-Asphodelum macrocarpi																															
Brachypodium raphaete (Host) Roem. & Schult.																															
Helianthemum nummularium (L.) Mill. subsp. obscurum (Čelák.) Holub																															
Salvia pratensis L. subsp. pratensis																															
Lathyrus pratensis L. subsp. pratensis																															
Thalictrum aquilegifolium L. subsp. aquilegifolium																															
Cerastium arvense L. subsp. suffruticosum (L.) Ces.																															
Lonicheles pyrenaicus (L.) Hrouda ex J. Holub subsp. sphaerocarpus (A. Kern.) Holub																															
Primula veris L. subsp. suaveolens (Berol.) Gutermann et Ehrend.																															

Senecio scopoli-Asphodelum macrocarpi e *Cyano triumfettii-Asphodelum macrocarpi*

[illegible]

Asphodeletalia macrocarpi

[illegible]

Trifolio-Geranieta

[illegible]

philous edges of the association *Leontodo cichoracei-Asphodeletum macrocarpi* subass. *ferulagetosum campestri* have catenal relationships with the heliophilous and thermoxerophilous edge communities of the order *Antherico-Geranietalia sanguinei*, taking on the meaning of ecosynvicariant taxon.

TRIFOLIO OCHROLEUCI-ASPHODELETUM MACROCARPI ass. nova *hoc loco* (Holotypus rel. 9 of Table 1)

This new association refers to the herbaceous mesophilous communities dominated by *Asphodelus macrocarpus* that are typical of the summit sectors of the limestone ridges (average altitude, 980 m a.s.l.) on subplain and rolling morphologies, and with humid and deep fersiallitic soils. This coenosis occupies the ecotonal position of the heliophilous edges in contact with forest edges of the suballiance *Digitalidi micranthae-Trifolienion medii* (alliance *Trifolion medii*) and with the mesophilous woods of the *Pulmonario apenninae-Carpinenion betuli* (alliance *Physospermo verticillati-Quercion cerridis*). Through dynamic invasion, the heliophilous edges of the new association *Trifolio ochroleuci-Asphodeletum macrocarpi* colonise the secondary abandoned or underused grasslands (which were used in the past mainly for mowing) that preferentially belong to the alliance *Cynosurion cristati*. The anthropogenic character of these plant communities that is shown by the presence of some therophytes such as *Geranium dissectum*, *Linum bienne* and *Campanula rapunculus*, is mainly linked to the past mowing activities carried out in these areas. The specific combination that is characteristic of the new association is expressed by the following species: *Asphodelus macrocarpus*, *Trifolium ochroleucum*, *Linum bienne*, *Helleborus bocconeii* subsp. *bocconeii*, *Centaurea jacea* subsp. *gaudini* and *Prunella vulgaris* subsp. *vulgaris*.

SENECIO APENNINI-ASPHODELETUM MACROCARPI ass. nova *hoc loco* (Holotypus rel. 17 of Table 1)

This new association describes the herbaceous mesophilous and subacidophilous communities dominated by *Asphodelus macrocarpus* that have typically developed on southerly slopes of the ridges that are relatively steep, on flysch lithologies in the low supratemperate thermotype of the central Apennines (altitudes from 1230 to 1250 m a.s.l.). These coenosis colonise by dynamic invasion the abandoned or underused secondary grasslands of the alliances *Ranunculo neapolitani-Arrhenatherion elatioris* and *Ranunculo pollinensis-Nardion strictae*. The differential and characteristic species of the new association *Senecio apennini-Asphodeletum macrocarpi* are: *Asphodelus macrocarpus*, *Senecio apenninus*, *Trifolium alpestre*,

Centaurea nigrescens subsp. *neapolitana*, *Campanula rapunculus*, *Rumex nebroides*, *Festuca stricta* subsp. *trachyphylla*, *Cirsium lobelii*, and *Galium mollugo* subsp. *erectus*. The variant with *Genista sagittalis* is also indicated for the new association (rels. 14, 15 of Table 1) that has developed at relatively higher altitudes under conditions of higher humidity and edaphic acidity. The new association mainly forms part of the low-montane subacidophilous beech forest series of the *Potentillo micranthae-Fago sylvaticae* sigmetum, and it expresses the catenal connection of the low-montane coenoses of the alliance *Thalictrio aquilegiifolii-Asphodelion macrocarpi* with those that are typically of the higher altitudes of the alliance *Cyanotriumfettii-Asphodelion macrocarpi*, for the more acidophilous aspects.

Dynamic contacts and landscape context

To define the floristic and ecologic autonomy of the *Asphodelus macrocarpus* communities investigated with respect to the grassland and forest edge syntaxa for the same altitudinal and landscape ranges, the classification of the relevés was carried out in terms of the similarity matrix for the coverage values, with the construction of a representative transect (Figs. 3, 4). From the NMDS (Fig. 3), the autonomy of the community dominated by *Asphodelus macrocarpus* is clear, with a floristic autonomy determined by the ecological position of these communities, as between the sciaphilous forest edges and the grasslands still under anthropic activities. This floristic autonomy that has coverage values of *A. macrocarpus* greater than 70% has developed only after prolonged absence of anthropic disturbance and under deep and humid soil conditions. This has been mainly in the heliophilous edge positions, in the narrow valleys, and in the long-abandoned grasslands. For the underused conditions and where the traditional anthropic uses were abandoned more recently, *A. macrocarpus* has lower coverage values (<40%). Under these conditions, *A. macrocarpus* has no effect on the grassland floristic composition, and so it can take on the significance of facies or variants with *A. macrocarpus*, or in some cases, of a subassociation within the syntaxon of the reference grassland. These subassociations or variants with *A. macrocarpus* indicate the start of the colonisation by the heliophilous edges, where if this is not resisted, it inevitably leads to the replacement of different grassland syntaxa with communities of the class *Trifolio-Geranetea*.

General considerations on the syntaxonomy of Asphodelus macrocarpus communities

For a syntaxonomic vegetation overview on the scale of the Apennines and Europe for the various herbaceous plant communities with *A. macrocarpus* described, a comparison with the present day literature

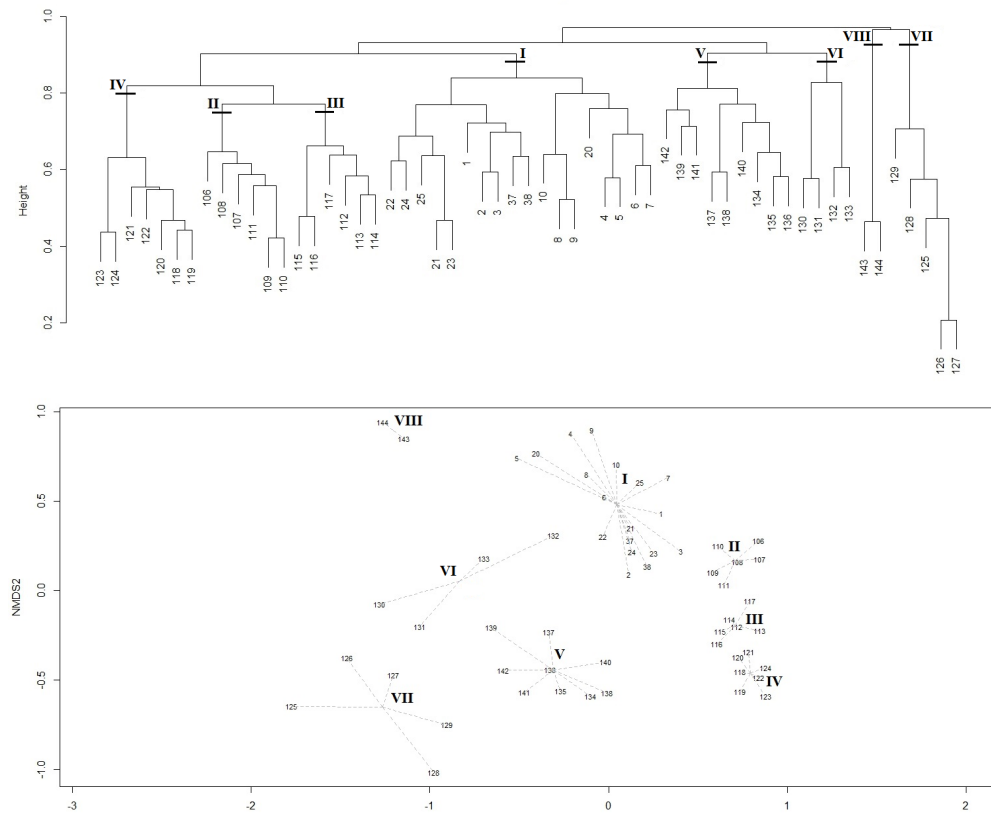


Fig. 3 - Dendrogram (A) and NMDS ordination (B) from the *Asphodelus macrocarpus* communities phytosociological relevés and published relevés referred to several typical forest edge and grasslands communities described in the areas study: I: *Thalictrum aquilegifolium*-*Asphodelion macrocarpi* (Tab. 1: rels. 1-18 in this paper); II: *Ranunculo neapolitani*-*Arrhenatherion elatioris* (*Festuco circummediterraneae*-*Arrhenatheretum elatioris*, Tab. 46 in Allegrezza, 2003); III: *Phleo ambiguus*-*Bromion erecti* (*Brizoa mediae*-*Brometum erecti*, rels. 1-6 Tab. 48 in Allegrezza, 2003); IV: *Cynosurion cristati* (*Colchico lusitanici*-*Cynosuretum cristati*, rels. 1-6 Tab. 47 in Allegrezza, 2003); V, VI, VII: *Digitalidi micranthae*-*Trifolietum medii* [group V – *Digitalidi micranthae*-*Helleboretum bocconeii* (from Tab. 2 in Biondi et al., 2001); group VI -*Trifolietum medii*-*ochroleuci* (from Tab. 3 in Biondi et al., 2001); group VII - *Hieracio virgaureae*-*Luzuletum sylvaticae* (from Tab. 37 in Allegrezza, 2003)], VIII: *Geranium sanguinei* (s.l.) (from Tab. 36 in Allegrezza, 2003).

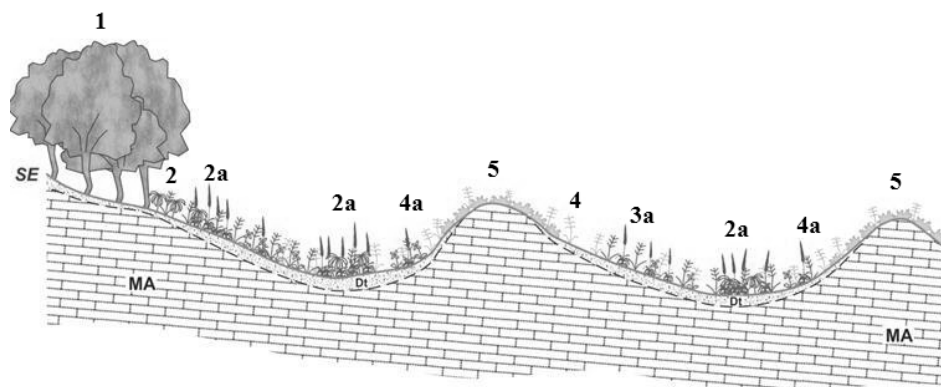


Fig. 4 - Representative vegetation transect in the summit sectors of the Apennine central limestone ridges (lower supratemperate thermotype) on subplain and rolling morphologies with humid and deep fersiallitic soils: 1 - *Carpinus betulus* and *Quercus cerris* forest (*Carici sylvaticae*-*Quercetum cerridis*); 2 - *Helleborus bocconeii* sciaphilous forest edge (*Digitalidi micranthae*-*Helleboretum bocconeii*); 2a - *Asphodelus macrocarpus* heliophilous edge (*Trifolium ochroleuci*-*Asphodelion macrocarpi*); 3a - *Cynosurus cristatus* mesophilous grassland with *Asphodelus macrocarpus* (*Colchico lusitanici*-*Cynosuretum cristati* association *Asphodelus macrocarpus* variant); 4 - *Bromus erectus* semimesophilous grassland (*Briza mediae*-*Brometum erecti*); 4a - *Bromus erectus* semimesophilous grassland with *Asphodelus macrocarpus* (*Briza mediae*-*Brometum erecti* association *Asphodelus macrocarpus* variant); 5 - *Bromus erectus* pioneer xerophilous grassland (*Potentillo cinerariae*-*Brometum erecti*).

data was carried out in which *A. macrocarpus* or *A. albus* were used for the construction of the epithet of the syntaxon at the level of association. The ordering of the 117 relevés on the similarity presence/ absence matrix (Fig. 5) highlights 10 groups of relevés that correspond to the different syntaxa considered. The floristic affinities between the groups of relevés can be detected mainly through biogeographic and bioclimatic factors (Rivas-Martínez *et al.*, 2001, 2001a). Although all of the territories belong to the temperate oceanic macroclimate, it is possible to follow the gradient of the floristic variation from the phytocenoses of *A. albus* described for northwestern France (Group X) that are differentiated by Atlantic and western European species, to those with *Asphodelus macrocarpus* of the south-western pre-Alps (Group VIII) with orophytes of southern Europe, Europe and southern Europe with a western spread, to those of the higher central and southern Apennines (Groups II, III, VII) with orophytes of southern and south-eastern Europe, Mediterranean montane and endemics. The geographical distribution of the plant communities with *A. macrocarpus* considered here provides confirmation of the same distribution area of *A. macrocarpus* (Díaz-Lifante & Valdés, 1996). This is focused on the mountain areas of the Mediterranean Basin with spread into those of south-western Europe with an Atlantic influx, and *A. albus* and typically European species with a western-Atlantic spread. Based on the above-mentioned taxo-

nomie revision, it was necessary to correct the names of the following associations that are indicated for the Apennines: *Asphodeletum macrocarpi* Tommaselli 1952 corr. *hoc loco* (= “association *Asphodelus albus*” Tommaselli 1952); *Filipendulo vulgaris-Asphodeletum macrocarpi* Corbetta *et al.* ex Biondi *et al.* 1995 corr. *hoc loco* (= *Filipendulo vulgaris-Asphodeletum albi* Corbetta *et al.* ex Biondi *et al.* 1995); and *Meo athamantici-Asphodeletum macrocarpi* Bonin 1972 (= *Meo-Asphodeletum* Bonin 1972).

For the different herbaceous plant communities with *A. macrocarpus* described for the central and southern Apennines, the floristic differentiation is justified in the first instance by the contingent of species of the alliances *Phleo ambiguus-Bromion erecti* (order *Phleo ambiguus-Brometalia erecti*), *Cynosurion cristati*, and *Ranunculo neapolitani-Arrhenatherion elatioris* (order *Arrhenatheretalia*) for the central Apennines, suballiance *Viola pseudogracilis-Bromopsenion caprinae* (alliance *Hippocrepido-Stipion austroitalicae*, order *Scorzoneretalia villosae*) and *Ranunculo pollinensis-Nardion strictae* (order *Nardetalia strictae*) for the southern sector. The main problem for the comparison remains the method of sampling with which the relevés have been conducted. Most of those reported in the literature for the Apennines refer to the open grasslands with *A. macrocarpus*, where this species is not clearly dominant, or even if its coverage is high, its role is not recognized as a clear demonstration of

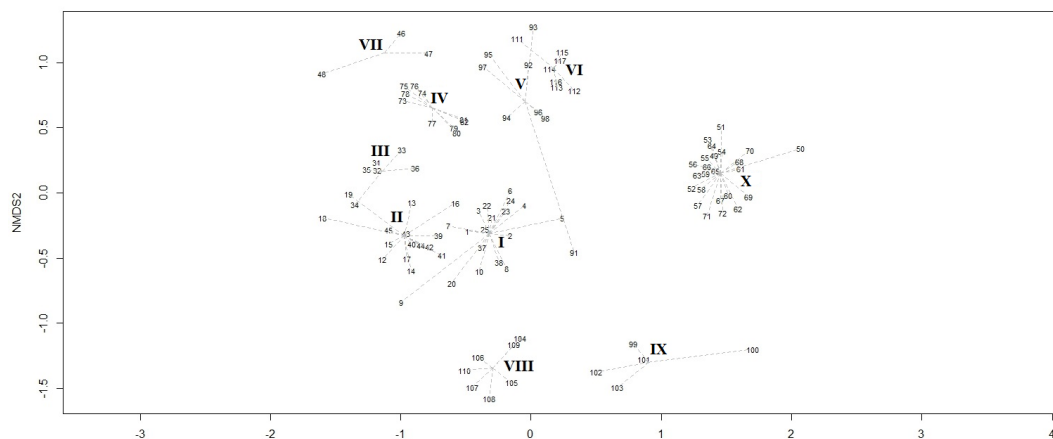


Fig. 5 - NMDS ordination from *Asphodelus albus* and *Asphodelus macrocarpus* communities phytosociological relevés in Europe: I – *Thalictrum aquilegifolium-Asphodelion macrocarpi* alliance (*Leontodo cichoeracei-Asphodeletum macrocarpi*, *Trifolium ochroleucum-Asphodeletum macrocarpi* and *Senecio apennini-Asphodeletum macrocarpi*; rels. 1-18 Tab. 1 in this paper); II – *Cyano triumfettii-Asphodelion macrocarpi* (*Senecio scopoli-Asphodeletum macrocarpi senecionetosum scopoli* and *Senecio scopoli-Asphodeletum macrocarpi luzuletosum sieberi* rels. 19-32 di Tab. 1 in this paper); III – *Filipendulo vulgaris-Asphodeletum macrocarpi* (rels. 1-3, 5-7 di Tab. 8 in Corbetta *et al.*, 1984); IV – *Asphodeletum macrocarpi* (rels. 1-10 di Tab. 4 in Tommaselli, 1952); V – *Hyperico calabricae-Asphodelion macrocarpi* (*Hyperico calabricae-Asphodeletum macrocarpi* rels. 1-8 di Tab. 1 in Biondi *et al.*, 2014b); VI – *Asphodelo macrocarpi-Pteridietum aquilini* (Tab. 43 in Brullo *et al.*, 2001); VII – *Meo athamantici-Asphodeletum macrocarpi* (rels. 7, 14, 16 di Tab. 1 in Bonin, 1972); VIII – *Asphodelo macrocarpi-Laserpietum siler* (rels. 10-15 di Tab. 1 in Musset, 2014); IX – *Asphodelo arrondeaui-Epilobietum angustifolii* (Tab. 4 in Izco *et al.*, 1986); X – *Potentillo montanae-Asphodeletum albi* (Tab. 1 in Bouzillé & De Foucault, 1988).

edge formation for these grasslands. An example in this case is represented by the association *Filipendulo vulgaris-Asphodeletum macrocarpi* (= *Filipendulo vulgaris-Asphodeletum albi*) that was described for the Lucan Apennines (Corbetta et al., 1984) and was recently considered as the association *typus* of the endemic suballiance *Violo pseudogracilis-Bromopsenion caprinae* (Terzi, 2011), alliance *Hippocrepido-Stipion austroitalicae* of the order *Scorzoneretalia villosae*. Another syntaxonomic consideration is the association *Asphodelo macrocarpi-Pteridetum aquilini* of the endemic Calabrian alliance *Violion messenensis* that is included in the class *Cytisetea scopario-striati* (Brullo et al., 2001). The association *Asphodelo macrocarpi-Pteridetum aquilini* described for the southern sector of the Calabrian Apennines, on siliceous substrates, refers to herbaceous vegetation with clear dominance of geophytes and hemicryptophytes that is attributable to a syntaxon of the edges of the class *Trifolio-Geranietea*, where species of the class *Cytisetea scopario-striati* can be considered transgressive. Considering only the phytosociological relevés where *A. macrocarpi* is clearly dominant, the dendrogram for their classification (Fig. 6) highlights the clear separation of the group of relevés from the Calabrian Apennines (Cluster B) from that which includes the Marche, Umbria-Marche, Umbria, Lazio, Abruzzo, and Lucan Apennines (Cluster A).

On the basis of the analysis of the relevé groups that provide the synthetic columns for the classes present in the synoptic Table (Table 2), the association *Asphodeletum macrocarpi* Tommaselli 1952 corr. *hoc loco* (*lectotypus* rel. 8 of Table 4 in Tommaselli, 1952) described for the upper supratemperate thermotype of Monte Terminillo (Lazio-Abruzzo Apennines) in dynamic connection with the microthermal subacido-

philous beech woods of the alliance *Aremonio-Fagion sylvaticae* and for which the author did not provide a clear syntaxonomical reference, is included in the alliance *Cyano triumfettii-Asphodelion macrocarpi*. The specific combination redefined here is characteristic of the association *Asphodeletum macrocarpi*, and is expressed by the following species: *Aristolochia lutea* (sub *A. longa*), *Rumex acetosella*, *Luzula italica* (sub *L. spicata*), *Veronica prostrata* subsp. *prostrata* (sub *V. teucrium* var. *p.*) and *Vicia sepium*. For the Calabrian Apennines association *Meo athamantici-Asphodeletum macrocarpi* corr. *hoc loco* (*lectotypus* rel. 14 of Table 1 in Bonin 1972) described by Bonin (1972), and subsequently confirmed by the same author (Bonin, 1978) and included in the alliance *Ranunculo pol-linensis-Nardion strictae*, this is here included in the alliance *Hyperico calabrici-Asphodelion macrocarpi*. The association is dynamically linked with microthermal beech woods of the suballiance *Lamio flexuosi-Fagenion sylvaticae* (alliance *Geranio versicoloris-Fagenion sylvaticae*).

Based on the original phytosociological Table (Corbetta et al., 1984) and on the comparison of Table 2, also the association *Filipendulo vulgaris-Asphodeletum macrocarpi* described for the upper supratemperate thermotype of the Lucan Apennine limestone (southern Apennines) in connection with the microthermal beech woods of the suballiance *Lamio flexuosi-Fagenion sylvaticae* (alliance *Geranio versicoloris-Fagenion sylvaticae*), is included in the order *Asphodeletalia macrocarpi*. Considering that this syntaxon is currently the association *typus* of the suballiance *Violo pseudogracilis-Bromopsenion caprinae* (alliance *Hippocrepido glaucae-Stipion austroitalicae*, order *Scorzoneretalia villosae*) it follows according to the International Code of Nomenclature that this suballiance, including

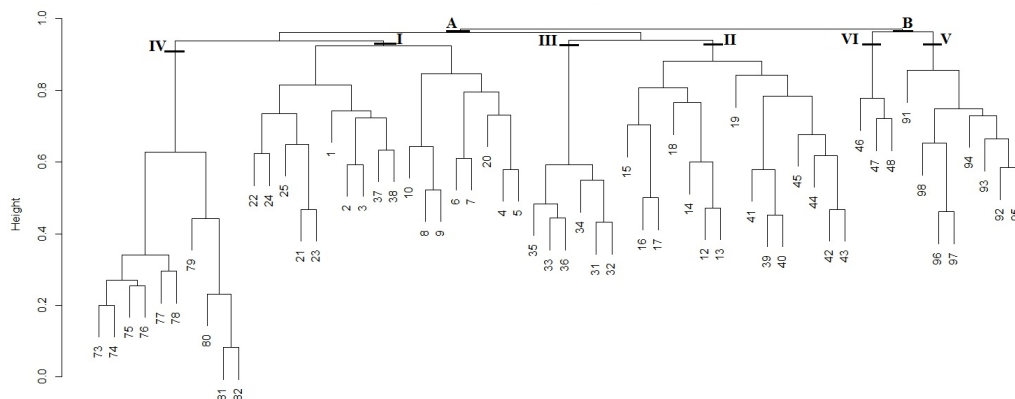


Fig. 6 - Dendrogram from phytosociological relevés in central and southern Apennines (the number of groups and the references are the same as Fig. 5): cluster A: IV - *Asphodeletum macrocarpi* (Lazio-Abruzzo Apennines); I - *Thalictro aquilegiifolii-Asphodelion macrocarpi* (Manche and Umbria-Marche Apennines); III - *Filipendulo vulgaris-Asphodeletum macrocarpi* (Lucan Apennines); II - *Cyano triumfettii-Asphodelion macrocarpi* (Umbria and Umbria-Marche Apennines); cluster B: VIII - *Meo athamantici-Asphodeletum macrocarpi* (Calabrian Apennines); V - *Hyperico calabrici-Asphodelion macrocarpi* (Calabrian Apennines).

Tab. 2 - Groups of phytosociological relevés belong to the *Asphodelus macrocarpus* communities recognized in central-southern Appennines (the number of groups and the references are the same as Fig. 5 and Fig. 6)

N. column	1	2	3	4	5	6	7	8	Presences
N. group from dendrogram (Fig. 6) and NMDS (Fig. 5)	I	I	I	IV	II	III	V	VIII	
N. rel. x column	8	5	5	10	14	6	3	8	
<i>Thalictrum aquilegifolii-Asphodeletum macrocarpi</i>									
Leontodon cichoraceus (Ten.) Sanguin.	IV	.	.	V	I	I	.	.	4
Laserpitium latifolium L.	II	.	I	.	.	.	.	.	2
Geranium sanguineum L.	III	.	.	.	.	.	.	.	1
Ferulago campestris (Besser) Grecescu	II	.	.	.	.	.	.	.	1
Orchis mascula (L.) L. subsp. mascula	II	.	.	.	.	.	.	.	1
Lathyrus sylvestris L. subsp. sylvestris	I	.	.	.	.	.	.	.	1
Euphorbia amygdaloides L. subsp. amygdaloides	I	.	.	.	.	.	.	.	1
<i>Trifolium ochroleuci-Asphodeletum macrocarpi</i>									
Linum bienne Mill.	I	V	I	.	.	.	.	.	3
Helleborus bocconeii Ten. subsp. bocconeii	I	III	.	.	I	.	.	.	3
Centaurea jacea L. subsp. gaudini (Boiss. & Reut.) Gremli	.	V	II	.	.	.	.	.	2
Prunella vulgaris L. subsp. vulgaris	.	III	.	.	.	.	.	.	1
<i>Senecio apennini-Asphodeletum macrocarpi</i>									
Galium mollugo subsp. erectum Syme	.	I	IV	.	.	.	.	I	3
Trifolium alpestre L.	.	.	IV	I	I	.	.	.	3
Campanula rapunculus L.	.	III	V	.	.	.	.	.	2
Rumex nebroides Campd.	.	.	V	.	I	.	.	.	2
Senecio apenninus Tausch	.	.	III	.	.	.	.	.	1
Festuca stricta ssp. trachyphylla (Hack.) Patzke ex Pils	.	.	V	.	.	.	.	.	1
Centaurea nigrescens Willd. (s.l.)	.	.	III	.	.	.	.	.	1
Cirsium lobelii Ten.	.	.	III	.	.	.	.	.	1
<i>Thalictrum aquilegifolii-Asphodelion macrocarpi</i>									
Brachypodium rupestre (Host) Roem. & Schult.	V	II	V	.	I	V	.	.	5
Thalictrum aquilegifolium L. subsp. aquilegifolium	I	II	IV	II	.	.	.	.	4
Helianthemum nummularium (L.) Mill. subsp. obscurum (Čelak.) Holub	III	IV	III	.	I	.	.	.	4
Lathyrus pratensis L. subsp. pratensis	II	I	IV	.	.	.	I	.	4
Cerastium arvense L. subsp. suffruticosum (L.) Ces.	.	II	III	.	I	.	.	.	3
Salvia pratensis L. subsp. pratensis	II	IV	III	.	.	.	.	.	3
Primula veris L. subsp. suaveolens (Bertol.) Gutermann et Ehrend.	.	I	III	.	.	.	.	.	2
Loncomelos pyrenaicus (L.) Hrouda ex J. Holub subsp. sphaerocarpus (A. Kern.) Holub	.	II	III	.	.	.	.	.	2
<i>Asphodeletum macrocarpi</i>									
Veronica prostrata L. subsp. prostrata	.	.	V	.	.	1	.	.	2
Aristolochia lutea Desf.	.	.	V	.	.	.	.	.	1
Luzula italica Parl.	.	.	V	.	.	.	.	.	1
Vicia sepium L.	.	.	III	.	.	.	.	.	1
<i>Senecio scopoli-Asphodeletum macrocarpi and Cyano triumfettii-Asphodelion macrocarpi</i>									
Rumex acetosella L.	.	.	V	I	.	1	II	.	4
Viola eugeniae Parl. subsp. eugeniae	.	.	III	IV	.	.	.	.	2
Hieracium cymosum L.	.	.	III	II	.	.	.	.	2
Senecio scopoli Hoppe et Hornsch. subsp. floccosus (Bertol.) Greuter	.	.	I	V	.	.	.	.	2
Campanula micrantha Bertol.	.	.	I	III	.	.	.	.	2
Festuca microphylla (St.-Yves ex Coste) Patzke	.	.	.	IV	.	.	IV	.	2
Tanacetum corymbosum (L.) Sch. Bip. subsp. achilleae (L.) Greuter	.	.	I	II	.	.	.	.	2
Brachypodium genuense (DC.) Roem. et Schult.	.	.	.	V	.	.	.	.	1
<i>Filipendulo-Asphodeletum macrocarpi and Viola pseudogracilis-Bromopsenion caprinae</i> * (Hippocrepido-Stipion austroitalicae, Scorzoneretalia villosae)									
Polygala alpestris Rchb.	.	.	.	I	IV	.	II	.	3
Geranium dissectum L.	.	III	.	.	V	.	.	.	2
Veronica austriaca L.	.	.	.	.	V	.	I	.	2
Seseli peucedanoides (M. Bieb.) Koso-Pol.	.	.	.	.	V	.	.	.	1
*Bromopsis caprina (A. Kern. ex Hack.) Banfi & N.G. Passal.	.	.	.	.	V	.	.	.	1
Thesium humifusum DC.	.	.	.	.	V	.	.	.	1
*Knaulia calycina (C. Presl) Guss.	.	.	.	.	IV	.	.	.	1
*Viola pseudogracilis Strobl (s.l.)	.	.	.	.	V	.	.	.	1
Festuca paniculata (L.) Schinz & Thell. subsp. paniculata	.	.	.	.	V	.	.	.	1
Genista januensis Viv.	.	.	.	.	V	.	.	.	1
<i>Meo athamantici-Asphodeletum macrocarpi</i>									
Meum athamanticum Jacq.	.	.	.	.	.	2	.	.	1
Alopecurus alpinus Vill.	.	.	.	.	.	2	.	.	1
Plantago media L. subsp. brutia (Ten.) Arcang.	.	.	.	.	.	3	.	.	1
<i>Hyperico calabrici-Asphodeletum macrocarpi and Hyperico calabrici-Asphodelion macrocarpi</i>									
Viola aethnensis subsp. calabra (A. Terracc.) Peruzzi	.	.	.	.	.	2	IV	.	2
Potentilla calabra Ten.	.	.	.	.	.	2	III	.	2
Cirsium vallis-demonis Lojac	.	.	.	.	.	.	V	.	1
Armeria brutia Brullo, Gangale & Uzunov	.	.	.	.	.	.	IV	.	1
Hypericum calabricum Spreng.	.	.	.	.	.	.	III	.	1
Anthemis cretica L. subsp. calabrica (Arcang.) R. Fern.	.	.	.	.	.	.	II	.	1
<i>Asphodeletalia macrocarpi</i>									
Asphodelus macrocarpus Parl. subsp. macrocarpus	V	V	V	V	V	V	3	V	8
Cruciata glabra (L.) Ehrend. subsp. glabra	V	V	V	III	IV	.	.	I	6
Trifolium ochroleucum Huds.	I	IV	III	.	I	III	1	.	6
Filipendula vulgaris Moench	V	V	III	.	V	V	.	.	5
Cyanus triumfetti (All.) Dostál ex Á. & D. Löve subsp. aligera	IV	IV	III	V	III	.	.	.	5
Gentiana lutea L. subsp. lutea	.	.	II	II	V	1	.	.	4
Knaulia purpurea (Vill.) Borbás	.	III	V	.	IV	.	.	.	3
Centaurea ambigua Guss.	I	.	.	.	I	.	.	.	2
<i>Trifolio-Geranietaea</i>									
Hypericum perforatum L. (s.l.)	II	I	IV	.	II	III	.	.	5
Fragaria vesca L. subsp. vesca	I	.	I	IV	I	.	.	.	4
Veronica chamaedrys L. subsp. chamaedrys	I	.	III	.	I	.	.	I	4
Teucrium chamaedrys L. subsp. chamaedrys	I	.	I	.	I	.	.	.	3

Clinopodium vulgare L. subsp. vulgare	.	III	IV	.	I	.	.	.	3
Ranunculus serpens Schrank subsp. nemorosus (DC.) G. López	.	.	I	.	I	.	1	.	3
Paeonia officinalis L. subsp. italica N.G. Passal. <i>et</i> Bernardo	I	.	.	.	I	.	.	.	2
Pteridium aquilinum (L.) Kuhn subsp. aquilinum	I	.	.	.	.	II	.	.	2
Bupleurum falcatum L. subsp. cernuum (Ten.) Arcang.	I	.	.	.	.	II	.	.	2
Peucedanum cervaria L.	.	I	II	.	.	.	.	.	2
Trifolium rubens L.	.	I	.	.	I	.	.	.	2
Lilium bulbiferum L. subsp. croceum (Chaix) Jan	.	.	I	.	I	.	.	.	2
Myosotis sylvatica Hoffm. subsp. sylvatica	.	.	.	.	II	.	.	I	2
Genista tinctoria L.	.	.	I	.	.	IV	.	.	2
Geum urbanum L.	.	I	.	.	I	.	.	.	2
Ajuga reptans L.	.	.	I	.	I	.	.	.	2
Viola alba Besser subsp. dehnhardtii (Ten.) W. Becker	I	.	I	.	I	.	.	.	3
Hepatica nobilis Schreb.	I	.	.	.	I	.	.	.	2
Geranium pyrenaicum Burm. f. subsp. pyrenaicum	.	.	I	III	.	.	.	.	2
Veronica officinalis L.	.	.	I	.	I	.	.	.	2
Silene italica (L.) Pers. subsp. italica	.	.	I	.	II	.	.	.	2
Peucedanum oreoselinum (L.) Moench	.	.	I	.	.	.	.	.	1
Veronica orsiniana Ten. subsp. orsiniana	.	.	.	.	II	.	.	.	1
Stellaria holostea L. subsp. holostea	I	.	.	.	.	.	.	.	1
Stellaria nemorum L. (<i>s.l.</i>)	I	.	.	.	.	.	.	.	1
Inula salicina L.	I	.	.	.	.	.	.	.	1
Digitalis ferruginea L.	.	.	I	.	.	.	.	.	1
Vicia incana Gouan	.	.	II	.	.	.	.	.	1
Cachrys ferulacea (L.) Calest.	.	.	II	.	.	.	.	.	1
Grafia golaka (Hacq.) Rchb.	.	.	I	.	.	.	.	.	1
Potentilla erecta (L.) Raeusch.	.	.	I	.	.	.	.	.	1
Trifolium medium L. subsp. medium	.	.	.	.	I	.	.	.	1
Aristolochia rotunda L.	.	.	.	.	I	.	.	.	1
Laserpitium siler L. subsp. siculum (Spreng.) Santangelo, F. Conti <i>et</i> Gubellini	.	.	.	.	I	.	.	.	1
Ajuga tenorei C. Pres	.	.	.	.	.	.	2	.	1
<i>Molinio-Arrhenatheretea</i>									
Achillea millefolium L. subsp. millefolium /A. collina	I	V	V	.	III	.	3	I	6
Trifolium pratense L. subsp. pratense	I	IV	IV	III	I	V	.	.	6
Lotus corniculatus L. subsp. corniculatus	I	III	IV	V	I	.	.	III	6
Cynosurus cristatus L.	I	V	III	.	I	.	.	I	5
Dactylis glomerata L. subsp. glomerata	III	III	V	.	II	.	.	V	5
Ranunculus neapolitanus Ten.	II	I	IV	.	I	.	.	.	4
Tragopogon pratensis L.	I	II	IV	.	II	.	.	.	4
Poa trivialis L.	.	IV	V	.	I	.	.	II	4
Briza media L.	I	III	V	.	II	.	.	.	4
Plantago lanceolata L.	.	I	I	.	I	.	.	IV	4
Poa pratensis L.	I	I	III	.	.	.	.	.	3
Lolium perenne L.	.	II	I	III	.	.	.	.	3
Trifolium repens L. (<i>s.l.</i>)	.	.	I	.	.	.	1	III	3
Narcissus poeticus L.	.	.	I	III	I	.	.	.	3
Bellis perennis L.	.	.	.	.	I	.	1	II	3
Rhinanthus minor L.	.	.	.	.	II	II	.	I	3
<i>Nardetea strictae</i>									
Anthoxanthum odoratum L. subsp. odoratum	I	V	IV	V	.	V	2	III	7
Agrostis capillaris L.	.	IV	IV	.	I	III	.	.	4
Poa alpina L. subsp. alpina	.	.	I	.	II	.	2	.	3
Bellardiochloa variegata (Lam.) Kerguelen subsp. variegata	.	I	IV	.	I	.	.	.	3
Nardus stricta L.	.	.	I	.	I	.	.	I	3
<i>Festuco-Brometea</i>									
Bromopsis erecta (Huds.) Fourr. subsp. erecta	III	V	III	V	III	.	.	I	6
Galium verum L. subsp. verum	I	I	V	.	IV	IV	.	III	6
Potentilla rigoana Th. Wolf	.	.	I	IV	I	II	2	.	5
Trifolium montanum L. subsp. rupestre (Ten.) Nyman	III	III	V	.	II	.	.	.	4
Thymus longicaulis C. Presl subsp. longicaulis	.	.	III	V	I	V	.	I	5
Campanula glomerata L.	.	I	V	.	I	V	2	.	5
Muscari neglectum Guss. ex Ten./comosum	I	.	II	.	I	II	.	.	4
Bunium bulbocastanum L.	I	II	I	.	II	.	.	.	4
Stachys officinalis (L.) Trevis.	I	IV	IV	.	I	.	.	.	4
Sanguisorba minor Scop. subsp. balearica (Bourg. ex Nyman) Muñoz Garm. & C. Navarro	.	II	II	V	I	.	.	.	4
Dianthus carthusianorum L. (<i>s.l.</i>)	.	I	I	.	I	IV	.	.	4
Gymnadenia conopsea (L.) R. Br.	.	I	II	.	I	IV	.	.	4
Eryngium amethystinum L.	.	.	II	II	II	III	.	.	4
Poa bulbosa L.	.	.	.	V	I	.	2	I	4
Dactylorhiza sambucina (L.) Soó	I	.	I	.	II	.	.	III	4
Plantago argentea Chaix subsp. argentea	.	.	.	III	I	V	1	.	4
Festuca circummediterranea Patzke	I	.	II	.	IV	.	.	.	3
Armeria canescens (Host) Ebel	I	.	II	.	II	.	.	.	3
Luzula campestris (L.) DC.	.	.	II	.	II	.	.	III	3
Acinos alpinus (L.) Moench	I	.	.	IV	.	.	.	.	2
Phleum hirsutum Honck. subsp. ambiguum (Ten.) Tzvelev	.	I	.	V	.	I	.	.	3
Avenula praetutiana (Parl. ex Arcang.) Pignatti	.	.	IV	.	I	III	.	.	3
Armeria majellensis Boiss.	.	.	.	III	.	II	2	.	3
Allium vineale L.	.	III	III	.	I	.	.	.	3
Cirsium morisianum Rchb.	.	II	II	.	I	.	.	.	3
Luzula multiflora (Ehrh.) Lej.	.	.	I	.	.	V	2	.	3
<i>Other species</i>									
Rumex acetosa L. subsp. acetosa	IV	III	IV	III	II	.	.	I	6
Cruciata laevipes Opiz	I	I	II	.	.	I	1	III	6
Arabis hirsuta (L.) Scop.	.	I	II	.	I	II	.	.	4
Fagus sylvatica L. subsp. sylvatica <i>p.l.</i>	I	.	I	.	I	.	.	I	4
Quercus cerris L.	.	I	I	.	I	.	.	.	3
Rosa canina L. (<i>s.l.</i>)	I	I	II	.	.	.	.	.	3
Galium aparine L.	I	.	I	.	I	.	.	.	3
Rhinanthus alectorolophus (Scop.) Pollich subsp. alectorolophus	.	I	III	.	I	.	.	.	3
Cynosurus echinatus L.	.	II	II	.	.	.	.	I	3
Cerastium tomentosum L.	.	.	.	.	III	1	I	.	3
<i>Sporadic species</i>									
	16	20	71	18	46	17	17	26	

the associations *Filipendulo vulgaris-Asphodeletum macrocarpi*, *Luzulo sieberi-Festucetum paniculatae*, *Oxytropido caputoi-Seslerietum nitidae* and *Geranio cinerei-Bromopsetum caprinae*, should be included in the order *Asphodeletalia macrocarpi*. In effect, with the exception of *Oxytropido caputoi-Seslerietum nitidae* and *Geranio cinerei-Bromopsetum caprinae* that are included in the xerophilous open grasslands, the associations *Filipendulo vulgaris-Asphodeletum macrocarpi* and *Luzulo sieberi-Festucetum paniculatae* can be considered as the heliophilous edges, in line with the conceptual meaning of the order *Asphodeletalia macrocarpi*. It is therefore considered more appropriate here to keep the original syntaxonomic collocation of the alliance, hoping in addition for the eventual revision in the field of the relevés of older grasslands, especially of those in which the condition of edge formation is already clear, through the use of the recent methodological and ecological acquisitions, to provide further understanding of their dynamics.

Finally, for the cenoses in *Potentilla erecta* and *A. macrocarpus* described for the karst basin limestone of the low supratemperate thermotype of the Lucan Apennines included in the alliance *Phleo ambigu-Bromion erecti* as the *Potentillo erectae-Asphodelus macrocarpus* community (Fascetti *et al.*, 2013), the relevés were not considered in the present analysis. This is because in the original table, *A. macrocarpus* was not always present or sporadic, or it had low coverage values (it only reaches relevé values of coverage 2), for which the relevés are not significant for the purposes of comparisons made here. However, an analysis of the original table (Table 12 in Fascetti *et al.* 2013), from the first four relevés carried out in the gloomy macrothermal beech forest of *Geranio versicoloris-Fagion sylvaticae*, floristic affinity can be seen with the cenoses of the alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi* described herein, albeit with a more Mediterranean imprint. Further research into these areas on the actual presence of this vegetation with *A. macrocarpus* as clearly dominant will confirm the hypothesis that the distribution area of the alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi* can be extended to include the low supratemperate thermotype of the Lucan Apennines.

Based on the analyses performed, the syntaxonomical scheme is proposed below for the *Asphodelus macrocarpus* subsp. *macrocarpus* communities of the order *Asphodeletalia macrocarpi* for the central-southern Apennines in terms of the current state of knowledge (Table 3). In this table on the environmental characteristics and the dynamic relationships followed by each syntaxon (Table 3). In particular, there are three alliances recognized for the order *Asphodeletalia macrocarpi* for the central-southern Apennines, the distribution of which is shown in Figure 7: *Cyano*

triumfettii-Asphodelion macrocarpi (all. *typus*), *Thalictro aquilegiifolii-Asphodelion macrocarpi*, and *Hyperico calabricae-Asphodelion macrocarpi*.

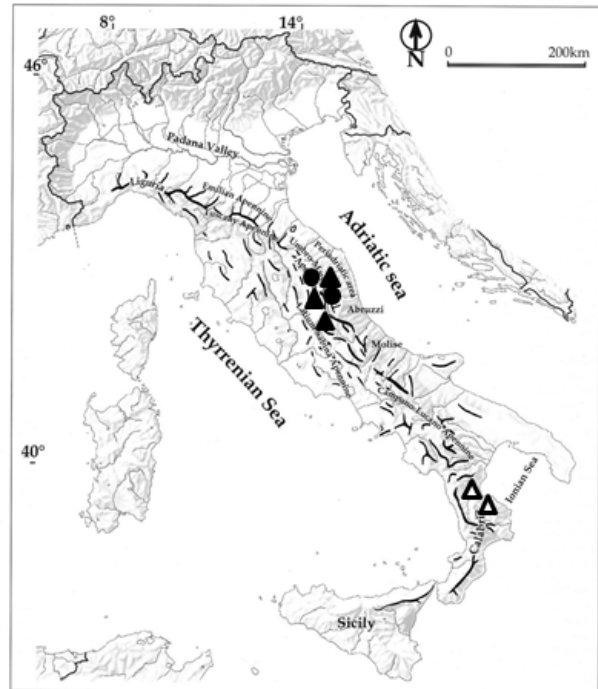


Fig. 7 - Geographical distribution of the alliances of the *Asphodeletalia macrocarpi* recognized for the Central-Southern Apennines: ● *Thalictro aquilegiifolii-Asphodelion macrocarpi*; ▲ *Cyano triumfettii-Asphodelion macrocarpi*; △ *Hyperico calabricae-Asphodelion macrocarpi*.

Conclusions

This floristic-vegetation study of the herbaceous plant communities dominated by *A. macrocarpus* present in various sectors of the central Apennines in the low supratemperate thermotype within the Natura 2000 areas has allowed the description within the order *Asphodeletalia macrocarpi* of the new alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi*, vicariant of the alliance *Cyano triumfettii-Asphodelion macrocarpi* typical of the upper supratemperate thermotype. The new alliance, of which the association *Leontodo cichoracei-Asphodeletum macrocarpi* represents the association *typus*, brings together the heliophilous and mesophilous edges with a dominance of *A. macrocarpus* of the low supratemperate thermotype of the central-southern Apennines on limestone and flysch lithologies and with deep and humid soils.

This study of the dynamic and catenal contacts has allowed the definition of the ecological position of plant communities of the alliance *Thalictro aquilegiifolii-Asphodelion macrocarpi*, and the clarification

Sintaxa	Apennine geographic sector	Biogeography/Ecoregion	Thermotype	Substrata	Grasslands	Sciophilous forest edges	Ecotonal shrubs	Forest
<i>Thalictrum aquilegifolium</i> - <i>Asphodelion macrocarpi</i>								
<i>Leontodon cichoracei</i> - <i>Asphodelion macrocarpi</i>	Marche and Umbria-Marche Apennines	Central and Southern Apennine	Low supratemperate with penetrations in the upper mesotemperate in the upper mesotemperate	Limestone	<i>Brachypodium genensis</i>	<i>Digitalis</i> - <i>Trifolium</i> medii and <i>Geranium sanguineum</i>	<i>Berberidion vulgaris</i>	<i>Lathyrus verni</i> - <i>Fagenion sylvaticae</i>
<i>Trifolium ochroleucum</i> - <i>Asphodelion macrocarpi</i>	Umbria-Marche Apennines	Central and Southern Apennine	Low supratemperate with penetrations in the upper mesotemperate	Limestone (fertile soils)	<i>Cynosurion cristati</i>	<i>Digitalis</i> - <i>Trifolium</i> medii	<i>Berberidion vulgaris</i>	<i>Pummaria apenninae</i> - <i>Caprinion betuli</i>
<i>Senecio apennin</i> - <i>Asphodelion macrocarpi</i>	Umbria-Marche Apennines	Central and Southern Apennine	Low supratemperate with penetrations in the upper supratemperate	flysh, Laga Basin and flysch-lacustrine deposits	<i>Ranunculo neapolitani</i> - <i>Arrhenatherion elatioris</i> and <i>Ranunculo-Nardion</i>	<i>Digitalis</i> - <i>Trifolium</i> medii	<i>Berberidion vulgaris</i>	<i>Lathyrus verni</i> - <i>Fagenion sylvaticae</i> and <i>Veronica urticifoliae</i> - <i>Fagenion sylvaticae</i>
<i>Cyano triumfettii</i> - <i>Asphodelion macrocarpi</i>								
<i>Senecio scopoli</i> - <i>Asphodelion macrocarpi</i>	Umbria and Umbria-Marche Apennines	Central and Southern Apennine	Upper supratemperate	Limestone	<i>Brachypodium genensis</i> and <i>Ranunculo-Nardion strictae</i>	<i>Digitalis</i> - <i>Trifolium</i> medii	<i>Berberidion vulgaris</i>	<i>Cardamine kitabellii</i> - <i>Fagenion sylvaticae</i>
<i>Asphodelion macrocarpi</i>	Lazio-Abruzzo Apennines	Central and Southern Apennine	Upper supratemperate	Limestone	<i>Brachypodium genensis</i> and <i>Ranunculo-Nardion strictae</i>	<i>Origanetalia</i>	<i>Prunetalia spinosae</i>	<i>Cardamine kitabellii</i> - <i>Fagenion sylvaticae</i> and <i>Veronica urticifoliae</i> - <i>Fagenion sylvaticae</i>
<i>Hyperico calabrici</i> - <i>Asphodelion macrocarpi</i>								
<i>Hyperico calabrici</i> - <i>Asphodelion macrocarpi</i>	Calabrian Apennines	Southern Tyrrhenian	Upper supratemperate	Siliceous	<i>Ranunculo-Nardion strictae</i>	<i>Origanetalia</i> , <i>Melampyrum holcetae</i> mollis	<i>Prunetalia spinosae</i>	<i>Lamio flexuosi</i> - <i>Fagenion sylvaticae</i>
<i>Meo a thamantici</i> - <i>Asphodelion macrocarpi</i>	Calabrian Apennines	Southern Tyrrhenian	Upper supratemperate	Limestone and Siliceous	<i>Ranunculo-Nardion strictae</i>	<i>Origanetalia</i> , <i>Melampyrum holcetae</i> mollis	<i>Prunetalia spinosae</i>	<i>Lamio flexuosi</i> - <i>Fagenion sylvaticae</i>

Tab. 3 - Summary on the distribution of *Asphodelion macrocarpi* heliophilous edge syntaxa which belong to the *Asphodelion macrocarpi* order in the central-southern Apennines in relation to environmental characteristics and dynamic relationships preferential.

of the dynamic and landscape context of reference. The new alliance represents the low altitudinal limit of the order *Asphodelion macrocarpi* in the central-southern Apennines, in dynamic link with sciophilous forest edges of the order *Origanetalia vulgaris* and in catenal contact with those thermoxerophilous of the order *Antherico-Geranietalia sanguinei*.

The comparison with the currently available literature data has allowed a biogeographical overview to be obtained at the European scale of the communities described with *A. albus* and *A. macrocarpi*, and a syntaxonomic revision that is critical of the various plant communities indicated for the central-southern Apennines. It has become apparent that there is the need to correct the nomenclature on the basis of recent taxonomic acquisitions. Based on the analysis carried out for the heliophilous edges with a dominance of *A. macrocarpi* three alliances are recognized for the order *Asphodelion macrocarpi* for the central-southern Apennines: *Cyano triumfettii*-*Asphodelion macrocarpi* (all. *typus*), *Thalictrum aquilegifolium*-*Asphodelion macrocarpi*, and *Hyperico calabricae*-*Asphodelion macrocarpi*. The indications for the environmental characteristics and the preferred dynamic relationships of each syntaxon considered has contributed to both the definition and clarification of the ecological and landscape range of the order *Asphodelion macrocarpi* according to the present state of knowledge, and to the completion of the main landscape units described for the central-southern Apennines (Blasi, 2010; Blasi et al., 2014).

The vegetation dynamics that were triggered by the progressive abandonment of traditional anthropic practices is progressing rapidly, for which it is hoped that the use of the recent methodological and ecological acquisitions can provide further understanding of their dynamics. Further research in this direction will confirm the hypothesis that the order *Asphodelion macrocarpi* can have many more syntaxa included than those currently described, at both the Apennines and European levels.

In terms of the conservation of the biodiversity of the Apennine grasslands that are affected by the colonisation of *A. macrocarpi* and are referred to several syntaxa, most of these are included in the SCIs, including alliance *Phleo ambiguus*-*Bromion erecti* (habitat 6210*), alliance *Ranunculo neapolitani*-*Arrhenatherion elatioris* (habitat 9510), alliance *Ranunculo polinensis*-*Nardion strictae* (habitat 6530*) and alliance *Cynosurion cristati*. There remains the need for detailed ecological studies on the possible infraspecies and interspecies interactions of the vegetation dynamics triggered by the underuse and/or abandonment of traditional anthropogenic practices, with the aim being to define the most effective management for the recovery of the biodiversity.

Syntaxonomic scheme

TRIFOLIO MEDII-GERANIETEA SANGUINEI Müller 1962

ASPHODELETALIA MACROCARPI Biondi & Allegrezza in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge & Blasi 2014

Cyano triumfettii-Asphodelion macrocarpi Biondi & Allegrezza in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge & Blasi 2014

Senecio scopolii-Asphodeletum macrocarpi Biondi & Allegrezza in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge & Blasi 2014

senecionetosum scopolii Biondi & Allegrezza in Allegrezza Ballelli, Ciucci, Mentoni & Pesaresi 2014

luzuletosum sieberi Biondi & Allegrezza in Allegrezza Ballelli, Ciucci, Mentoni & Pesaresi 2014

Asphodeletum macrocarpi Tommaselli 1952 corr. *hoc loco* (= *Asphodelus albus* association Tommaselli 1952)

Thalictro aquilegifolii-Asphodelion macrocarpi all. nova *hoc loco*

Leontodo cichoracei-Asphodeletum macrocarpi ass. nova *hoc loco*

asphodeletosum macrocarpi subass. nova *hoc loco*

ferulagetosum campestre subass. nova *hoc loco*

Trifolio ochroleuci-Asphodeletum macrocarpi ass. nova *hoc loco*

Senecio apennini-Asphodeletum macrocarpi ass. nova *hoc loco*

Hyperico calabricae-Asphodelion macrocarpi Biondi, Gangale & Uzunov in Biondi, Casavecchia, Pesaresi, Gangale & Uzunov 2014

Hyperico calabricae-Asphodeletum macrocarpi Biondi, Gangale & Uzunov in Biondi, Casavecchia, Pesaresi, Gangale & Uzunov 2014

Meo athamantici-Asphodeletum macrocarpi Bonin 1972 corr. *hoc loco* (= *Meo-Asphodeletum* Bonin 1972)

Others syntaxa quoted in the text, figures and tables

Antherico-Geranietalia sanguinei Julve ex Dengler in Dengler, Berg, Eisenberg, Isermann, Jansen, Koska, Löbel, Manthey, Pätzolt, Spangenberg, Timmermann & Wollert 2003; *Aremonio agrimonoidis-Fagion sylvaticae* (Horvat) Borhidi in Török, Podani & Borhidi 1989; *Arrhenatheretalia elatioris* Tüxen 1931; *Asphodelo arrondeaui-Epilobietum angustifolii* Izco, Guitián & Amigo 1986 corr. Izco & Amigo, 2001; *Asphodelo macrocarpi-Laserpietum siler* Misset 2014; *Asphodelo macrocarpi-Pteridetum aquilini* Brullo, Scelsi & Spampinato 2001; *Berberidion vulgaris* Br.-Bl. 1950; *Brachypodion genuensis* Biondi, Ballelli, Allegrezza & Zuccarello 1995 ex Biondi & Galdenzi 2012; *Briza mediae-Brometum erecti* Bruno in Bruno & Covarelli 1968 Biondi & Ballelli 1982; *Cardamino kitaibelii-Fagetum sylvaticae* Ubaldi, Zanotti, Puppi, Speranza & Corbetta ex Ubaldi 1995; *Carici sylvaticae-Quercetum cerridis* Catorci & Orsomando 2001; *Carpinion orientalis* Horvat 1958; *Colchico lusitanici-Cynosuretum cristati* Biondi & Ballelli 1995; *Cynosurion cristati* Tüxen 1947; *Cytisetea scopario-striati* Rivas-Martínez 1975; *Dictamno albi-Ferulagion galbaniferae* (Van Gils, Keyser & Launsdachs 1975) De Foucault, Rameau & Royer ex Čarni & Dengler in Mucina, Dengler, Bergmeier, Čarni, Dimopoulos, Jahn & Matevski 2009; *Digitalidi micranthae-Helleboretum bocconeii* Biondi, Čarni, Vagge, Taffetani & Ballelli 2001; *Digitalidi micranthae-Trifolienion medii* Čarni 2005; *Festuco circummediterraneae-Arrhenatheretum elatioris* Allegrezza 2003; *Festuco valesiacae-Brometea erecti* Br.-Bl. & Tüxen ex Br.-Bl. 1949; *Filipendulo vulgaris-Asphodeletum macrocarpi* Corbetta, Ubaldi & Puppi 1984 ex Biondi, Ballelli, Allegrezza & Zuccarello 1995 corr. *hoc loco* (= *Filipendulo vulgaris-Asphodeletum albi* Corbetta, Ubaldi & Puppi 1984 ex Biondi, Ballelli, Allegrezza & Zuccarello 1995); *Geranio cinerei-Bromopsetum caprinae* Corbetta, Ubaldi et Puppi ex Biondi, Ballelli, Allegrezza et Zuccarello 1995; *Geranio versicoloris-Fagion sylvaticae* Gentile 1970; *Geranion sanguinei* Tüxen in Müller 1962; *Hieracio virgaureae-Luzuletum sylvaticae* Allegrezza 2003; *Hippocrepido glaucae-Stipion austroitalicae* Forte & Terzi in Forte, Perrino & Terzi 2005; *Lamio flexuosi-Fagenion sylvaticae* Gentile 1970; *Lathyro veneti-Fagenion sylvaticae* Zitti, Casavecchia, Pesaresi, Taffetani & Biondi 2014; *Luzulo sieberi-Festucetum paniculatae* Corbetta, Ubaldi & Puppi ex Biondi, Ballelli, Allegrezza & Zuccarello 1995; *Melampyro pratensis-Holcetalia mollis* Passarge 1979; *Nardetea strictae* Rivas Goday in Rivas Goday & Rivas-Martínez 1963; *Nardetalia strictae* Oberdorfer ex Preising 1949; *Origanetalia vulgaris* Müller 1962; *Oxytropido caputoi-Seslerietum nitidae* Corbetta, Ubaldi & Puppi ex Biondi, Ballelli, Allegrezza & Zuccarello 1995; *Phleo ambigu-Brometalia erecti* Biondi, Allegrezza, Blasi & Galdenzi in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge & Blasi 2014; *Phleo ambigu-Bromion erecti* Biondi, Ballelli, Allegrezza & Zuccarello ex Biondi & Galdenzi 2012; *Physospermo verticillati-Quercion cerris* Biondi Casavecchia & Biscotti ex Biondi, Casavecchia & Biscotti in Biondi, Allegrezza, Casavecchia, Galdenzi, Gigante & Pesaresi 2013; *Potentillo cinerae-Brometum erecti* Biondi, Pinzi & Gubellini 2004; *Potentillo erectae-Asphodelus macrocarpus* community Fascetti, Pirone & Rosati 2013; *Potentillo montanae-Asphodeletum albi* Bouzillé & De Fou-

cault 1988; *Prunetalia spinosae* Tuxen 1952; *Pulmonario apenninae-Carpinenion betuli* Biondi, Casavecchia, Pinzi, Allegrezza & Baldoni 2002; *Ranunculo neapolitani-Arrhentatherion elatioris* Allegrezza & Biondi 2011; *Ranunculo pollinensis-Nardion strictae* Bonin 1972; *Rhamno catharticae-Prunetea spinosae* Rivas Goday & Borja ex Tuxen 1962; *Scorzonetalia villosae* Horvatić 1975; *Scorzonero villosae-Chrysopogonetalia grylli* Horvatić & Horvat in Horvatić 1963; *Trifolietum medii-ochroleuci* Biondi, Čarni, Vagge, Taffetani & Ballelli 2001; *Trifolion medii* Müller 1962; *Trifolio medii-Geranietea sanguinei* Müller 1962; *Veronico urticifoliae-Fagenion sylvaticae* Di Pietro 2007; *Violion messanensis* Barbagallo, Brullo, Furnari, Longhitano & Signorello 1982; *Violo pseudogracilis-Bromopsenion caprinae* (Terzi 2011) Biondi & Galdenzi 2012.

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Appendix I: Sporadic species

Tab. 1 - Rel. 1: *Rubus hirtus* (group) +2, *Corylus*

avellana L. +.2, *Ranunculus millefoliatus* Vahl +, *Smyrniolum perfoliatum* L. (s.l.) +.2; Rel. 2: *Rubus hirtus* (group) 1.1, *Smyrniolum perfoliatum* L. (s.l.) +.2, *Galium aparine* L. 1.1; Rel. 3: *Rubus hirtus* (group) +.2, *Euphorbia dulcis* L. +, *Luzula sylvatica* (Huds.) Gaudin subsp. *sylvatica* +.2, *Pilosella officinarum* Vaill. +, *Lamium maculatum* L. +, *Carex macrolepis* DC. +; Rel. 5: *Acinos alpinus* (L.) Moench +.2; Rel. 6: *Rubus caesius* L. (+.2), *Cornus mas* L. +, *Euonymus europaeus* L. +, *Acinos alpinus* (L.) Moench +, *Rosa spinosissima* L. +.2; Rel. 7: *Quercus pubescens* Willd. (s.l.) +, *Galium lucidum* All. subsp. *lucidum* +.2; Rel. 8: *Rubus caesius* L. +.2, *Crataegus laevigata* (Poir.) DC. +.2, *Prunus spinosa* L. subsp. *spinosa* +.2; Rel. 9: *Quercus cerris* L. +, *Lolium perenne* L. +, *Geranium dissectum* L. +, *Viola arvensis* Murray subsp. *arvensis* +, *Erodium cicutarium* (L.) L'Hér. +, *Ranunculus repens* L. +, *Sorbus aria* subsp. *aria* (L.) Crantz +; Rel. 10: *Linum catharticum* L. (s.l.) +, *Lolium perenne* L. 1.1, *Bromus hordeaceus* L. +, *Geranium dissectum* L. +.2, *Capsella rubella* Reut. +, *Lamium maculatum* L. +, *Viola arvensis* Murray subsp. *arvensis* +.2, *Stellaria media* (L.) Vill. subsp. *media* +; Rel. 11: *Carex pendula* Hudson +.2; Rel. 12: *Viola reichenbachiana* Jord. ex Boreau +.2, *Ononis spinosa* L. subsp. *spinosa* 1.2, *Geranium dissectum* L. + *Vulpia muralis* (Kunth) Nees +.2; Rel. 13: *Dianthus carthusianorum* L. (s.l.) +.2, *Phleum hirsutum* Honck. subsp. *ambiguum* (Ten.) Tzvelev +, *Daucus carota* L. (s.l.) +.2; Rel. 14: *Scabiosa columbaria* L. (s.l.) +.2, *Arrhenatherum elatius* (L.) P. Beauv. ex J. & C. Presl subsp. *elatius* +, *Myosotis arvensis* (L.) Hill subsp. *arvensis* 1.1, *Alchemilla* sp. +.2, *Veronica arvensis* L. +, *Bistorta officinalis* Delarbre +, *Carduus nutans* L. (s.l.) +, *Cynoglossum montanum* L. +, *Dianthus deltoideus* L. subsp. *deltoides* +.2, *Draba muralis* L. +, *Koeleria cristata* (L.) Roem. & Schult. +, *Luzula multiflora* (Ehrh.) Lej. +, *Myosotis alpestris* F.W. Schmidt F.W. Schmidt +, *Saxifraga bulbifera* L. +, *Stellaria graminea* L. 1.1, *Thlaspi caerulescens* J. & C. Presl +; Rel. 15: *Veronica officinalis* L. +, *Carlina acaulis* L. subsp. *caulescens* (Lam.) Schübl. & G. Martens +, *Trisetaria flavescens* (L.) Baumg. subsp. *flavescens* 1.2, *Ranunculus serpens* Schrank subsp. *nemorosus* (DC.) G. López +, *Bistorta officinalis* Delarbre +.2, *Cerastium holeosteoides* Fr. 1.1, *Nardus stricta* L. 1.1, *Campanula scheuchzeri* Vill. (s.l.) +, *Chaerophyllum aureum* L. +.2, *Cirsium arvense* (L.) Scop. 1.1, *Dactylorhiza maculata* (L.) Soó subsp. *fuchsii* (Druce) Hyl. +, *Alchemilla* sp. +.2, *Carex pallescens* L. +, *Polygala vulgaris* L. subsp. *vulgaris* +.2, *Phyteuma orbiculare* L. +, *Pimpinella major* (L.) Huds. +, *Trifolium repens* L. (s.l.) +; Rel. 16: *Ononis spinosa* L. subsp. *spinosa* +.2, *Scabiosa columbaria* L. (s.l.) +, *Linum catharticum* L. (s.l.) +, *Trifolium campestre* Schreb. +.2, *Ranunculus millefoliatus* Vahl +, *Colchicum lusitanum* Brot. +, *Trisetaria flavescens*

(L.) Baumg. subsp. *flavescens* 1.2, *Daucus carota* L. (s.l.) 1.1, *Galium aparine* L. +, *Myosotis arvensis* (L.) Hill subsp. *arvensis* 1.1, *Capsella rubella* Reut. +, *Crocus vernus* (L.) Hill +, *Veronica arvensis* L. +, *Cerastium holeosteoides* Fr. +, *Aira elegantissima* Schur 1.1, *Arabidopsis thaliana* (L.) Heynh. +, *Arenaria serpyllifolia* L. +.2, *Carex caryophyllea* Latourr. +.2, *Geranium columbinum* L. +, *Medicago falcata* L. subsp. *falcata* 1.1, *Medicago lupulina* L. +, *Plantago media* L. subsp. *media* +, *Scorzonera purpurea* L. 1.1, *Sherardia arvensis* L. +, *Trifolium micranthum* Viv. +, *Valeriana officinalis* L. +, *Valerianella muricata* (Stev. ex M. Bieb.) J.W. Loudon 1.1; Rel. 17: *Quercus pubescens* Willd. (s.l.) +, *Quercus cerris* L. +, *Sorbus aria* (L.) Crantz subsp. *aria* +, *Pyrus pyraeaster* Burgsd. +, *Ononis spinosa* L. subsp. *spinosa* 1.2, *Scabiosa columbaria* L. (s.l.) 1.1, *Koeleria splendens* C. Presl (s.l.) +.2, *Daucus carota* L. (s.l.) +, *Cytisus hirsutus* subsp. *polytrichus* (M. Bieb.) Hayek +.2, *Myosotis arvensis* (L.) Hill subsp. *arvensis* +, *Carex flacca* Schreb. subsp. *flacca* +.2, *Anthyllis vulneraria* L. (s.l.) +, *Crepis* sp. +, *Festuca arundinacea* Schreb. subsp. *arundinacea* +.2, *Potentilla reptans* L. +.2; Rel. 18: *Dianthus carthusianorum* L. (s.l.) +, *Lolium perenne* L. +, *Arrhenatherum elatius* (L.) P. Beauv. ex J. & C. Presl subsp. *elatius* 2.3, *Carex flacca* Schreb. subsp. *flacca* +.2, *Picris hieracioides* L. subsp. *hieracioides* +; Rel. 19: *Alyssum montanum* L. subsp. *montanum* +.2, *Arabis sagittata* (Bertol.) DC. 1.2, *Helianthemum oelandicum* subsp. *incanum* +, *Colchicum lusitanum* +, *Taraxacum officinale* 1.1, *Valeriana tuberosa* 1.2; Rel. 20: *Alyssum montanum* subsp. *montanum* +.2, *Arabis sagittata* +, *Helianthemum oelandicum* (L.) Dum. Cours. subsp. *incanum* (Willk.) G. López +, *Colchicum lusitanum* Brot. +, *Crocus vernus* (L.) Hill 1.1, *Geranium molle* L. +, *Lithospermum officinale* L. +.2, *Pedicularis acaulis* Scop. +, *Plantago major* L. (s.l.) +; Rel. 21: *Arabis sagittata* (Bertol.) DC. +, *Taraxacum officinale* Weber (aggregato) 1.2, *Geranium molle* L. +.2; Rel. 22: *Rubus caesius* L. +.2, *Quercus cerris* L. +, *Galium aparine* L. +, *Knautia integrifolia* (L.) Bertol. subsp. *integrifolia* 1.2, *Lithospermum officinale* L. 1.2, *Orchis pauciflora* Ten. +; Rel. 23: *Alyssum montanum* L. subsp. *montanum* +, *Cytisus hirsutus* subsp. *polytrichus* (M. Bieb.) Hayek +.2, *Festuca rubra* L. (s.l.) +.2; Rel. 24: *Knautia integrifolia* (L.) Bertol. subsp. *integrifolia* +; Rel. 26: *Helianthemum oelandicum* (L.) Dum. Cours. subsp. *incanum* (Willk.) G. López +.2, *Ranunculus millefoliatus* Vahl 1.1, *Bellis perennis* L. 1.2, *Cytisus hirsutus* subsp. *polytrichus* (M. Bieb.) Hayek 1.2, *Saxifraga granulata* L. subsp. *granulata* +, *Valeriana tuberosa* L. +, *Poa bulbosa* L. +, *Trinia glauca* (L.) Dumort. subsp. *carniolica* (A. Kern. ex Janch.) H. Wolff +, *Polygala alpestris* Rchb. +.2, *Globularia bisnagarica* L. +.2, *Scilla bifolia* L. 1.2, *Tulipa australis* Link 1.2; Rel. 27: *Rhamnus alpina* L. subsp. *alpina* +.2, *Fraxinus*

excelsior L. subsp. excelsior +, Ranunculus apenninus (Chiov.) Pignatti +; Rel. 28: Rhamnus alpina L. subsp. alpina +.2, Dianthus carthusianorum L. (s.l.) +, Picris hieracioides L. subsp. hieracioides +; Rel. 29: Plantago argentea subsp. argentea +, Allium sphaerocephalon +, Leucanthemum adustum +, Linum alpinum +; Rel. 30: Veronica officinalis +, Koeleria splendens +.2, Plantago argentea Chaix subsp. argentea +.2, Galium corrudifolium Vill. +, Anthoxanthum odoratum L. subsp. nipponicum (Honda) Tzvelev +.2, Ranunculus serpens Schrank subsp. polyanthemophyllus (W. Koch & H.E. Hess) Kerguélen +.2, Saxifraga granulata L. subsp. granulata +, Silene ciliata Pourr. subsp. graefferi (Guss.) Nyman +, Asperula cynanchica L. +, Barbarea bracteosa Guss. +, Galium mollugo L. subsp. mollugo +, Sedum sexangulare L. +.2, Sedum rupestre L. subsp. rupestre +, Thymus praecox Opiz subsp. polytrichus (Borbás) J alas 1.2; Rel. 31: Silene ciliata Pourr. subsp. graefferi (Guss.) Nyman 1.1; Rel. 32: Anthoxanthum odoratum L. subsp. nipponicum (Honda) Tzvelev +, Nardus stricta L. +.2.

Tab. 2 - Rel. 1: Pilosella officinarum Vaill. I, Quercus pubescens Willd. (s.l.) I, Rubus caesius L. I, Prunus spinosa L. subsp. spinosa I, Cornus mas L. I, Corylus avellana L. I, Crataegus laevigata (Poir.) DC. I, Euonymus europaeus L. I, Euphorbia dulcis L. I, Luzula sylvatica (Huds.) Gaudin subsp. sylvatica I, Rosa spinosissima L. I, Rubus hirtus (group) II, Carex macrolepis DC. I, Galium lucidum All. subsp. lucidum I, Smyrnium perfoliatum L. (s.l.) I, Vicia cracca L. I; Rel. 2: Linum catharticum L. (s.l.) I, Ononis spinosa L. subsp. spinosa I, Onobrychis viciifolia Scop. I, Allium carinatum subsp. pulchellum Bonnier & Layens II, Leontodon hispidus L. IV, Holcus lanatus L. subsp. lanatus II, Sorbus aria (L.) Crantz subsp. aria I, Carex pendula Hudson I, Viola reichenbachiana Jord. ex Boreau I, Leucanthemum vulgare Lam. subsp. vulgare III, Ranunculus repens L. I, Bromus hordeaceus L. I, Stellaria media (L.) Vill. subsp. media I, Carex flacca Schreb. subsp. flacca I, Capsella rubella Reut. I, Daucus carota L. (s.l.) I, Lamium maculatum L. I, Erodium cicutarium (L.) L'Hér. I, Viola arvensis Murray subsp. arvensis II, Vulpia muralis (Kunth) Nees I; Rel. 3: Euphorbia cyparissias L. I, Linum catharticum L. (s.l.) I, Ononis spinosa L. subsp. spinosa II, Onobrychis viciifolia Scop. IV, Allium carinatum subsp. pulchellum Bonnier & Layens II, Dianthus monspessulanus L. IV, Anthyllis vulneraria L. (s.l.) I, Deschampsia flexuosa (L.) Trin. subsp. flexuosa II, Polygala vulgaris L. subsp. vulgaris I, Ranunculus pollinensis (N. Terracc.) Chiov. I, Colchicum lusitanum Brot. I, Ranunculus millefoliatus Vahl I, Leontodon hispidus L. III, Holcus lanatus L. subsp. lanatus III, Sorbus aria (L.) Crantz subsp. aria I, Quercus pubescens Willd. (s.l.) I, Luzula sylvatica (Huds.) Gaudin subsp. sieberi (Tausch) K.

Richt. I, Pyrus pyrastrer Burgsd. I, Listera ovata (L.) R. Br. I, Festuca arundinacea Schreb. subsp. arundinacea I, Arrhenatherum elatius (L.) P. Beauv. ex J. & C. Presl subsp. elatius II, Trisetaria flavescens (L.) Baumg. subsp. flavescens II, Dianthus deltoides L. subsp. deltoides I, Genista sagittalis L. II, Carex caryophylla Latourr. I, Carlina acaulis subsp. caulescens (Lam.) Schübl. & G. Martens I, Aira elegantissima Schur I, Koeleria cristata (L.) Roem. & Schult. I, Thesium lino-phyllon L. II, Picris hieracioides L. subsp. hieracioides I, Crocus vernus (L.) Hill I, Draba muralis L. I, Myosotis alpestris F.W. Schmidt I, Myosotis arvensis (L.) Hill subsp. arvensis III, Silene italica (L.) Pers. subsp. italica I, Verbascum longifolium Ten. I, Veronica arvensis L. II, Cytisus hirsutus L. subsp. polytrichus (M. Bieb.) Hayek I, Carex flacca Schreb. subsp. flacca I, Capsella rubella Reut. I, Daucus carota L. (s.l.) II, Cynoglossis barrelieri (All.) Vural & Kit Tan subsp. barrelieri I, Trifolium campestre Schreb. I, Stachys tymphaea Hausskn. I, Phyteuma orbiculare L. I, Plantago media L. subsp. media I, Stellaria graminea L. I, Arabidopsis thaliana (L.) Heynh. I, Arenaria serpyllifolia L. I, Bistorta officinalis Delarbre II, Campanula scheuchzeri Vill. (s.l.) I, Carduus nutans L. (s.l.) I, Carex pallescens L. I, Cerastium holeosteoides Fr. I, Chaerophyllum aureum L. I, Cirsium arvense (L.) Scop. I, Dactylorhiza maculata (L.) Soó subsp. fuchsii (Druce) Hyl. I, Geranium columbinum L. I, Medicago falcata L. subsp. falcata I, Medicago lupulina L. I, Pimpinella major (L.) Huds. I, Potentilla reptans L. I, Ranunculus serpens Schrank subsp. polyanthemophyllus (W. Koch & H.E. Hess) Kerguélen I, Saxifraga bulbifera L. I, Scabiosa columbaria L. (s.l.) III, Scorzonera purpurea L. I, Sherardia arvensis L. I, Thlaspi caerulescens J. & C. Presl I, Trifolium micranthum Viv. I, Valeriana officinalis L. I, Veronica serpyllifolia L. subsp. tenella All. I; Rel. 4: Viola canina L. subsp. rupestris III, Hippocrepis comosa L. subsp. comosa IV, Festuca gigantea (L.) Vill. V, Cerastium arvense Gaud. V, Helianthemum nummularium (L.) Mill. subsp. grandiflorum (Scop.) Schinz & Thell. III, Alyssum campestre (L.) L. (s.l.) III, Pedicularis comosa L. subsp. comosa III, Myosotis alpestris F.W. Schmidt III, Cynoglossis barrelieri (All.) Vural & Kit Tan subsp. barrelieri III, Iberis carnosa Willd. subsp. carnosa III, Polygala major Jacq. III, Lapsana communis L. subsp. communis III, Bellis sylvestris Cirillo III, Carex brizoides L. subsp. eu-brizoides I, Elymus caninus (L.) L. subsp. caninus I, Lathyrus nissolia L. I, Orchis provincialis Balb. ex Lam. & DC. III, Sedum hispanicum L. III; Rel. 5: Euphorbia cyparissias L. II, Thymus praecox Opiz subsp. polytrichus (Borbás) J alas I, Dianthus monspessulanus L. I, Koeleria splendens C. Presl (s.l.) I, Deschampsia flexuosa (L.) Trin. subsp. flexuosa I, Ranunculus pollinensis (N. Terracc.) Chiov. I, Colchicum lusitanum Brot. I, Ranunculus millefoliatus Vahl

I, *Rubus caesius* L. I, *Scilla bifolia* L. I, *Luzula sylvatica* (Huds.) Gaudin subsp. *sieberi* (Tausch) K. Richt. II, *Fraxinus excelsior* L. subsp. *excelsior* I, *Juniperus communis* L. subsp. *communis* I, *Rhamnus alpina* L. subsp. *alpina* I, *Galium mollugo* L. subsp. *mollugo* I, *Taraxacum officinale* Weber (aggregato) I, *Ranunculus apenninus* (Chiov.) Pignatti I, *Alyssum montanum* L. subsp. *montanum* I, *Asperula cynanchica* L. I, *Galium corrudifolium* Vill. I, *Leucanthemum adustum* (W.D.J. Koch) Gremler I, *Allium sphaerocephalon* L. I, *Helianthemum oelandicum* (L.) Dum. Cours. subsp. *incanum* (Willk.) G. López I, *Knautia integrifolia* (L.) Bertol. subsp. *integrifolia* I, *Thesium linophyllum* L. I, *Picris hieracioides* L. subsp. *hieracioides* I, *Crocus vernus* (L.) Hill I, *Geranium molle* L. I, *Silene italica* (L.) Pers. subsp. *italica* II, *Verbascum longifolium* Ten. I, *Cytisus hirsutus* L. subsp. *polytrichus* (M. Bieb.) Hayek I, *Valeriana tuberosa* L. I, *Festuca rubra* L. (s.l.) I, *Globularia bisnagarica* L. I, *Arabis sagittata* (Bertol.) DC. I, *Barbarea bracteosa* Guss. I, *Linum alpinum* Jacq. I, *Lithospermum officinale* L. I, *Orchis pauciflora* Ten. I, *Pedicularis acaulis* Scop. I, *Plantago major* L. (s.l.) I, *Saxifraga granulata* L. subsp. *granulata* I, *Sedum sexangulare* L. I, *Sedum rupestre* L. subsp. *rupestre* I, *Trinia glauca* (L.) Dumort. subsp. *carniolica* (A. Kern. ex Janch.) H. Wolff I, *Tulipa australis* Link I; Rel. 6: *Helianthemum apenninum* (L.) Mill. subsp. *apenninum* IV, *Koeleria splendens* C. Presl (s.l.) II, *Pilosella officinarum* Vaill. IV, *Rosa villosa* L. III, *Asperula* cfr. *aristata* L. f. II, *Carlina acanthifolia* All. subsp. *acanthifolia* V, *Pedicularis comosa* L. subsp. *comosa* II, *Myosotis arvensis* (L.) Hill subsp. *arvensis* II, *Silene vulgaris* (Moench) Garcke subsp. *commutata* I, *Carlina vulgaris* L. subsp. *vulgaris* IV, *Galium anisophyllum* Vill. III, *Campanula foliosa* Ten. II, *Euphrasia liburnica* Wettst. II, *Narcissus* cfr. *radiiflorus* Salisb. II, *Orobancha gracilis* Sm. II, *Ranunculus illyricus* L. I, *Trinia dalechampii* (Ten.) Janch. II; Rel. 7: *Thymus praecox* Opiz subsp. *polytrichus* (Borbás) Jalas 2, *Anthyllis vulneraria* L. (s.l.) 1, *Hippocrepis comosa* L. subsp. *comosa* 2, *Helianthemum apenninum* (L.) Mill. subsp. *apenninum* 1, *Polygala vulgaris* L. subsp. *vulgaris* 2, *Scilla bifolia* L. 1, *Potentilla hirta* L. 1, *Phleum alpinum* L. 1, *Alchemilla vulgaris* L. 1, *Crepis aurea* (L.) Coss. subsp. *lucida* 1, *Leontodon tuberosus* L. 1, *Silene vulgaris* (Moench) Garcke subsp. *vulgaris* 1, *Chenopodium bonus-henricus* L. 1, *Galium rubrum* L. 1, *Veronica serpyllifolia* subsp. *tenella* All. 1, *Genista sericea* Wulf. var. *rigida* Pamp. 1, *Alsine verna* Whub. var. *montana* Fenzl. 2; Rel. 8: *Trifolium pratense* L. subsp. *semipurpureum* (Strobl) Pignatti IV, *Phleum pratense* L. I, *Tragopogon dubius* Scop. I, *Helianthe-*

mum nummularium (L.) Mill. (s.l.) I, *Draba muralis* L. I, *Geranium molle* L. I, *Leontodon tuberosus* L. IV, *Stellaria media* (L.) Vill. subsp. *media* I, *Veronica arvensis* L. I, *Cerastium semidecandrum* L. I, *Silene latifolia* Poir. subsp. *latifolia* II, *Hypochaeris radicata* L. I, *Barbarea sicula* C. Presl I, *Cerinthe auriculata* Ten. I, *Clinopodium alpinum* (Nyman) Govaerts subsp. *meridionale* I, *Cruciata pedemontana* (Bellardi) Ehrend. I, *Geum molle* Vis. & Pančić II, *Milium effusum* L. I, *Oenanthe pimpinelloides* L. I, *Plantago maritima* subsp. *serpentina* (All.) Arcang. I, *Ranunculus polyanthemus* L. subsp. *thomasii* (Ten.) Tutin I, *Romulea bulbocodium* (L.) Sebast. & Mauri I, *Rumex thyrsoides* Desf. I, *Secale strictum* (C. Presl) C. Presl I, *Silene italica* (L.) Pers. subsp. *sicula* (Ucria) Jeanm. I, *Valeriana wallrothii* Kreyer I.

Appendix II: Relevés dates and localities

Tab. 1 - Rel. 1: 11/07/2011, Monte San Vicino mountain group (Marche Apennines). Rel. 2: 09/07/2011, Monte San Vicino mountain group (Marche Apennines). Rel. 3: 28/06/2012, Monte Cafaggio mountain group (Umbria-Marche Apennines). Rel. 4: 08/07/2011, Monte San Vicino mountain group (Marche Apennines). Rel. 5: 07/07/2011, Monte San Vicino mountain group (Marche Apennines). Rel. 6: 02/07/2011, Monte Rogedano mountain group (Umbria-Marche Apennines). Rel. 7: 03/07/2011, Monte Rogedano mountain group (Umbria-Marche Apennines). Rel. 8: 04/07/2011, Monte Rogedano mountain group (Umbria-Marche Apennines). Rel. 9: 28/06/2012, Monte Cafaggio mountain group (Umbria-Marche Apennines). Rel. 10: 28/06/2012, Monte Cafaggio mountain group (Umbria-Marche Apennines). Rel. 11: 28/06/2012, Monte Cafaggio mountain group (Umbria-Marche Apennines). Rel. 12: 22/06/2012, Monte Cafaggio mountain group (Umbria-Marche Apennines). Rel. 13: 22/06/2012, Monte Cucco mountain group (Umbria-Marche Apennines). Rel. 14: 26/06/2013, Pian Perduto (Sibillini mountains, Umbria-Marche Apennines). Rel. 15: 08/07/2013, Piè Vettore (Sibillini mountains, Umbria-Marche Apennines). Rel. 16: 08/07/2013, Piè Vettore (Sibillini mountains, Umbria-Marche Apennines). Rel. 17: 18/07/2013, Monte Vettore (Sibillini mountains, Umbria-Marche Apennines). Rel. 18: 18/07/2013, Pian Pecorelle (Sibillini mountains, Umbria-Marche Apennines); rels 19-26 from Tab. II in Biondi *et al.*, 2014 (Coscerino mountain, Umbria Apennines), rels 27-32 from Tab. 9 in Allegrezza *et al.*, 2014 (Sassotetto mountain, Sibillini mountains, Umbria-Marche Apennines).