PLANT SOCIOLOGY

formerly FITOSOCIOLOGIA

Volume 53(2) - December 2016

RIVISTA SEMESTRALE - POSTE ITALIANE S.P.A. - SPED. ABB. POST. - D.L. 353/2003 - (CONV. IN L. 27/02/2004 N. 46) ART. 1, COMMA 2, DCB ANCONA TASSA RISCOSSA-TAXE PERÇUE-CMPP AN
EDITO DALLA SOCIETA' ITALIANA DI SCIENZA DELLA VEGETAZIONE ONLUS - PAVIA - DIRETTORE RESPONSABILE PROF. E. BIONDI - VOLUME 2 - II° SEMESTRE 2016

Journal of the Italian Society for Vegetation Science

Plant Sociology, Vol. 53, No. 2, December 2016, pp. 3-18
DOI 10.7338/pls2016532/01

PLANT SOCIOLOGY

Post-abandonment dynamic on Mediterranean and sub-Mediterranean perennial grasslands: the edge vegetation of the new class *Charybdido pancratii-Asphodeletea ramosi*

E. Biondi, S. Pesaresi, D. Galdenzi, R. Gasparri, N. Biscotti, G. del Viscio, S. Casavecchia
Department of Agricultural, Food and Environmental Sciences (D3A), Marche Politechnic University - I-60131 Ancona, Italy.
E. Biondi and S. Pesaresi contributed equally to this paper

Abstract
A phytosociological study that was mainly aimed at describing the dynamic processes of Mediterranean and sub-Mediterranean perennial secondary grasslands is presented here, using the concepts tested previously for similar grasslands in temperate zones. The study was carried out in two different geographic areas: the Gargano peninsula, and the central Apennines between Marche and Umbria. Thirty-six phytosociological surveys were analyzed using cluster analysis. The study highlights that after the abandonment of agro-pastoral activities, in the ecotone zone between the grassland and the wood mantle, macrophytic, nitrophilous and sub-nitrophilous species spread rapidly. These species have underground organs of propagation (e.g., rhizomes, bulbs) that are mostly toxic to herbivorous animals, such as *Asphodelus* spp., *Charybdis* spp., *Ferula* spp., *Thapsia* spp., *Asphodeline* spp.. The communities that have participated in these processes are attributed to the new class *Charybdido pancratii-Asphodeletea ramosi*, within which the new order *Asphodeletalia ramosi* is described. This order includes four alliances: *Charybdido pancratii-Asphodelion ramosi*, *Asphodelo ramosi-Ferulion communis*, and *Asphodelion fistulosi* in the Mediterranean area; and *Asphodelino luteae-Ferulion glaucae* in the sub-Mediterranean area. Overall, six new associations and a new sub-association, *feruletosum glaucae* of the association *Cephalario leucanthae-Saturejetum montanae*, are described. Furthermore, the international literature on secondary perennial grasslands of much of the Mediterranean basin (i.e., Europe, north Africa, the Middle East) was studied to define the occurrence in these territories of the species considered to be important in the described dynamic processes. We can conclude that the same processes observed in the present study area occur across the whole Mediterranean basin.

Key words: Bioclimate, biogeography, dynamic process, edge communities, Mediterranean area, sub-Mediterranean area, syntaxonomy, vegetation.

Introduction

The study of the dynamism of the vegetation of perennial grasslands no longer maintained under grazing and farming has been investigated since the 50s of the last century. These studies have indicated that the ecotonal space between grasslands and forests represents the area where the natural dynamic processes start, which lead to their recovery through more complex forms of vegetation. Indeed, in this zone of transition at the edge of forests, there is a gradual change in the brightness of the light according to the gradient formed by the changes from shrublands (class *Rhamno-Prunetea*) to the herbaceous communities (class *Trifolio-Geranietea*). These communities are the architects of the transformation of phytocoenoses over time, and they lead to the recovery of the "current potential vegetation" (Biondi, 2011).

The latest studies deal with herbaceous communities that were previously detected mainly from the forest edge to the more open areas. Therefore, these communities mainly comprise shade-tolerant or semi-sciaphilous species, and for this reason, this kind of vegetation has been defined as 'forest edge'. The most recent study investigated instead the post-abandonment dynamics on the side of the abandoned grasslands, which is defined as the ecotonal area, and is also affected by the development of an equivalent edge zone that comprises heliophilous herbs and macrophytes, and is defined as 'meadow edge vegetation' or 'heliophilous edge vegetation' (Biondi *et al*., 2014a, b). These investigations were carried out in Italy, along the Apennines, and so in montane areas with a Temperate macrobioclimate, and mainly within the mesophilous grasslands that belong to different phytosociological classes, such as: *Festuco-Brometea*, *Molinio-Arrhenatheretea*, and *Nardetea strictae*. Some of these grasslands have been investigated in the central Apennines, and some in the southern Apennines (Biondi *et al*., 2014c), where they occur with very thick formations that are dominated by *Asphodelus macrocarpus*. As these are of particular importance, the order *Asphodeletalia macrocarpi* Biondi & Allegrezza 2014 (Biondi *et al*., 2014a, b) inside the class *Trifolio-Geranietea sanguinei* was proposed. Therefore, the order *Asphodeletalia macrocarpi*, which brings together heliophilous communities that develop in the same altitudinal zones after abandonment of agricultural and pastoral activities, was added to the order *Origanetalia vulgaris* Müller 1962. This order includes communities of the mesophilous forest edges that

Corresponding author: Simona Casavecchia. *Department of Agricultural, Food and Environmental Sciences (D3A), Marche Politechnic University - I-60131 Ancona, Italy; e-mail: s.casavecchia@univpm.it*

grow on mature soils that are rich in humus (Allegrezza *et al*., 2014, 2015; Biondi *et al*., 2014c, 2015b).

The present study was designed to define how similar heliophilous edge formations arise following abandonment of the perennial grasslands, focusing on areas in the Mediterranean macrobioclimate. This analysis followed dynamic schemes that are conceptually similar to those that occur in temperate areas. Very different species participate in these dynamic processes, because the biogeographical and ecological contexts are very different. Here, plant communities of post-abandonment originate. They are dominated by different species according to the different geographic areas investigated, which include: *Asphodelus* spp. (mainly *Asphodelus ramosus* or *Asphodelus fistulosus*) and *Ferula* spp. (mainly *Ferula communis* or *Ferula glauca*). These communities include a great number of macrophytes.

Materials and Methods

Study areas

The study area included two different geographic zones (Fig. 2): (i) part of the Gargano peninsula, in the southern part of the western Adriatic coast of the Italian peninsula, which is essentially formed of limestone and dolomite stone, and characterized by a Mediterranean macrobioclimate; and (ii) part of the central Apennines, bound by Marche and Umbria, with marly calcareous geological formations (Scaglia Bianca), and characterized by the sub-Mediterranean variant of the Temperate macrobioclimate.

Vegetation data

This analysis was carried out using 36 phytosociological relevés: 28 relevés on the Gargano promontory, at an altitudinal range from sea level up to 700 m a.s.l.; and 8 relevés in the Apennines, between Marche and Umbria, in three different rocky areas of the *Ferula glauca* vegetation.

The geo-location of the sampling sites (i.e., phytosociological relevés) allowed the bioclimatic map of Italy (Pesaresi *et al*., 2014) to be used to derive the values of some bioclimatic indices proposed by Rivas-Martínez *et al*. (2011): the Compensated Thermicity Index (Itc), the Annual Ombrothermic Index (Io), the Simple Continentality Index (Ic) and the Ombrothermic Index of the warmest summer bimester (Ios_2).

The taxonomic nomenclature was standardized by consulting 'The Plant List' (2013) and the 'anAnarchive' checklist (http://www.anarchive.it/; Lucarini *et al*., 2014), as well as Conti *et al*. (2005, 2007).

Vegetation analysis

The study of the plant communities was carried out following the phytosociological method of the Zurich-Montpelliere Sigmatist school.

The syntaxonomic nomenclature at the level of alliance, order, and class follows the 'Prodrome of the Italian Vegetation' (Biondi *et al*., 2014b), the subsequent integrations (Biondi *et al*., 2014a; 2014c; 2015a), and the variations and integrations of syntaxa indicated on the specific interactive site of the Italian Botanical Society, as recently upgraded (http://www.prodromo-vegetazioneitalia.org/).

Data analysis

The abundance values of the phytosociological matrix from the 36 relevés were converted into the Van der Maarel scale. Classification of the phytosociological matrix was then carried out through hierarchical cluster analysis (i.e., dis-similarity ratios, unweighted pair group method with arithmetic averages). Detrended Correspondence Analysis (DCA) was used to ordinate the species and relevés, and then to identify the main floristic gradients of the vegetation. The bioclimatic indices were interpolated according to the site DCA scores, and were overlaid (as contour lines) on the DCA biplot to highlight the relationships between the specific composition and the bioclimatic factors. The results of the cluster analysis were also superimposed on the DCA biplot. The analysis was carried out using the 'vegan' package (Oksanen *et al*., 2013) of the R software (R core team, 2015).

Floristic and ecological context in which the dynamic process takes place

In the Mediterranean macrobioclimate, when secondary grasslands are abandoned or their use for agricultural and pastoral activities is reduced, spontaneous dynamic processes start through the diffusion of macrophytes. These processes rapidly change the structure of the vegetation. Under these conditions, the edge communities are dominated prevalently by *Asphodelus ramosus* subsp. *ramosus*, the branched asphodel, a native species to the Mediterranean region that also occurs in southern Europe, northern Africa, and the Middle East. As the dominant species, the branched asphodel forms very thick plant edges, in which few species of the previous secondary grasslands are found, with a prevalence instead of tall herbaceous plants. These species are mainly rhizomatous or bulbous geophytes, as sub-nitrophilous to markedly nitrophilous species, depending on the structure of the soil, the type of grazing animals, and the livestock load. As for the branched asphodel, the aerial parts of these species dry out completely during the summer months, and they then begin to rebuild aerial biomass during the autumn, with the growth of new leaves to carry out photosynthesis even during the winter and spring months. At the end of winter, they begin to bloom, until the end of spring, although with the exception of some of the plants, such as the bulbous geophytes, among which the most important is *Charybdis pancration*, which blooms instead in summer.

This is a vegetation that predominantly consists of monocotyledons of the order *Asparagales* and the family *Xanthorrhoeaceae* (e.g., *Asphodelaceae*, *Hemerocallidaceae*) (Cole *et al*., 2016). The most significant species of this vegetation under study is *A. ramosus* L. (syn: *A. microcarpus* Salzm. et Viv., *A. chambeironi* Jord., *A. albus* Boiss., *A. aestivus* Brot.), while under drier conditions, the vegetation is dominated by *A. fistulosus* L. and *A. tenuifolius* Cav. (the latter for Italy only in Sicily and Sardinia). In these formations, some species of the genus *Asphodeline* add to the species already listed, including *A. lutea* (L.) Rchb. and *A. liburnica* (Scop.) Rchb.. Among the *Asparagaceae*, the genus *Charybdis* is of great importance. According to Brullo *et al*. (2007), the following taxa occur in Italy: *Charybdis maritima* (L.) Speta, a hexaploid (2n = 60), for the Tuscany archipelago; *C. pancration* (Steinh.) Speta, a diploid (2n = 20), spread throughout the central and southern regions and the islands; and *C. undulata* (Desf.) Speta, also a diploid (2n = 20), only for Sardinia, in terms of its Italian distribution (Martinoli, 1949). Furthermore, Bacchetta *et al*. (2012) described a new species named *Charybdis glaucophylla* that occurs throughout Sardinia, and was first found in the Iglesiente. According to Speta (1980), Boscaiu *et al*. (2003), Pfosser & Speta (2004), and Bacchetta *et al*. (2012), the diploid plants from the Italian peninsula, Sicily, Corsica, Malta, and Mallorca can be classified under *C. pancration* (Steinh.) Speta, while the 2x plants from the central Atlas (Morocco) can be classified under *C. maura* (Maire) Speta. The tetraploids from Italy (including Sardinia), the Balearic Islands, northern Africa, and Greece were ascribed to *C. numidica* (Jord. & Fourr.) Speta, those from the Canary Islands and northern Morocco to *C. hesperia* Webb & Berth, and the 4x plants from Israel and Turkey to *Charybdis aphylla* (Forssk.) Speta, whereas the hexaploids were maintained as *C. maritima* (L.) Speta. Other monocotyledons belonging to the order *Asparagales* that can occur in these types of vegetation include: *Asparagus acutifolius* L., *A. stipularis* Forsskål, and *A. horridus* L..

There are also several species of the genus *Ornithogalum*: *Ornithogalum umbellatum* L., *O. etruscum* Parl. and other endemic species to the study area such as *O. etruscum* Parl. subsp. *umbratile* (Tornad. & Garbari) Peruzzi & Bartolucci. Many other species belong to the family *Iridaceae*, such as: *Iris bicapitata* Colasante, endemic to the Gargano in the area between Apricena and Sannicandro (Colasante, 1996), *I. pseudopumila* Tineo, and *I. planifolia* (Mill.) Fiori [Syn: *Xiphion planifolium* Mill.; *I. planifolia* (Miller) Dur. et Sch.; *I. alata* Poir.; *Thelysia alata* (Poir.) Parl.], in Sardinia and Sicily.

There are few dicotyledons, and these include some *Apiaceae*: *Thapsia garganica* L. and *Ferula communis* L., with all of the subspecies and varieties described, such as: *F. arrigonii* Bocchieri (endemic to Sardinia) and *F. glauca* L. [syn.: *F. communis* subsp. *glauca* (L.) Rouy & Camus E. G., *F. neapolitana* Ten.]. Other important dicotyledons are *Cachrys pungens* Jan ex Guss. and *C. sicula* L. both of which are south-west Mediterranean species that occur in southern Italy from Puglia to Sicily, and also *Ferulago nodosa* (L.) Boiss., a north-eastern steno-Mediterranean species that is found for Italy only in Sicily.

In the western area of the Mediterranean basin, a few species of this list can be found, with the most widespread as *C. pancration*, while *T. garganica* occurs only in the Balearic Islands (i.e., Ibiza, Formentera, and the nearby islets). However, in France, Spain, and Portugal, most of the other species are replaced by related species, such as *A. aestivus* Brot. and *Thapsia villosa* L. (Pinto-Gomes *et al*., 2007). In northern Africa, along the coasts of the Maghreb, and in Egypt and the Middle East, some of the dominant species in the European parts of the Mediterranean basin are present, but in different floristic contexts.

The characteristic and differential species of the new order are plants that are mainly toxic to grazing animals, which therefore exclude them from their diet. It is believed that this is the main reason for the wide spread of these species in the post-abandonment processes or during grazing reduction. The results of these processes are vegetation structures that are very compact, within which only a few species of the original floristic composition can flourish. Furthermore, some studies have attributed the spread of these species to the effects of fires in the Mediterranean grasslands (Giacomini *et al*., 1958; Pignatti, 1982; Cutini *et al*., 2009).

Dynamic processes already known for the study areas

The dynamic processes that occur in the Gargano where these surveys were carried out have been defined through phytosociological data that have allowed the description of some plant communities, such as *Olea europaea* subsp. *sylvestris* and *Prunus webbii* shrublands, and wood mantle formations with *Paliurus spina-christi* and sometimes *Prunus webbii*. Studies on the dynamics began in the 1980s, and during the following years these allowed the reconstruction of the dynamic processes that are followed by the vegetation (Biondi, 1985; Biondi *et al*., 2014c; Casavecchia *et al*., 2015). Prior knowledge made it possible to later recognize the plant-edge communities described here, and that have been found in different places around the Gargano.

Similar situations concern some aspects of the vegetation dynamics found in some areas of the Umbria-Marche Apennines, where the dynamic processes that occur in the abandoned grasslands have been studied over a long period of time. These studies led to the identification of *Spartium junceum* mantles of the alliance *Cytision sessilifolii* Biondi in Biondi, Allegrezza & Guitian 1988 (Biondi *et al*., 1988). These processes have also been studied through rigorous analyses in temperate areas, for the sub-Mediterranean variant, and these have allowed the identification of xerophilous grasslands of the alliance *Artemisio albae-Saturejion montanae* Allegrezza, Biondi, Formica & Ballelli 1997. This perennial herbaceous vegetation is linked in a dynamic way with the association *Junipero oxycedri-Cotinetum coggygriae* Biondi, Allegrezza & Guitian 1988, which has a thermophilous wood mantle, sometimes with pioneers, that occurs in rocky areas of the Umbria-Marche Apennines. Indeed, in the present study, some aspects of the transformation of the grassland are highlighted, such as those that lead to the development of heliophilous communities with *Ferula glauca*.

Results

The dendrogram of the hierarchical classification is shown in Figure 1a. The DCA ordered the sampling sites according to the main floristic gradients of the vegetation. In the DCA biplot (Fig. 1b), the relevés were sorted according to the DCA1 and DCA2 axes (eigenvalues of the first and second DCA axes, 0.77 and 0.3, respectively).

The DCA1 axis is directly correlated with the Io, Ios_2 and Ic, and inversely correlated with the Itc (Fig. 1b, where as bioclimatic indeces are collinear there is only an overlap of the Ios_2 in the DCA biplot). This represents both increasing thermo-xerophilous (annual and summer) and continental gradients. Therefore, this counters the oceanic, thermophilic and xeric plant communities, to the benefit of the more continental and mesophilous communities. At the same time, the DCA1 axis counters the plant communities that grow on sand to the benefit of those of mostly limestone substrates.

The clusters represented in the dendrogram (Fig. 1a, I to VII) and superimposed on the DCA biplot (Fig. 1b) identified six associations, three subassociations, and three new alliances that are attributed to the order *Asphodeletalia ramosi* in the class *Charybdido pancratii-Asphodeletea ramosi*. These sintaxa are described below.

Cluster I

CHARYBDIDO PANCRATII-ASPHODELETUM RAMOSI ass. nova *hoc loco* (*Holotypus*: rel. 3 of Tab. 1, this paper)

TYPICUM subass. nova *hoc loco* (*Holotypus*: rel. 3 of Tab. 1, this paper)

HYPARRHENIETOSUM HIRTAE subass. nova *hoc loco* (*Holotypus*: rel. 9 of Tab. 1, this paper)

Diagnostic species of the association: *Asphodelus ramosus* subsp. *ramosus*, *Charybdis pancration*, *Thapsia garganica*, *Asparagus acutifolius*, *Ornithogalum etruscum* subsp. *umbratile*, *Anemone hortensis*, *Carlina corymbosa*, *Hypochoeris radicata*, and *Iris bicapitata*.

This association is the type of the alliance and is dominated by *Asphodelus ramosus* subsp. *ramosus* and

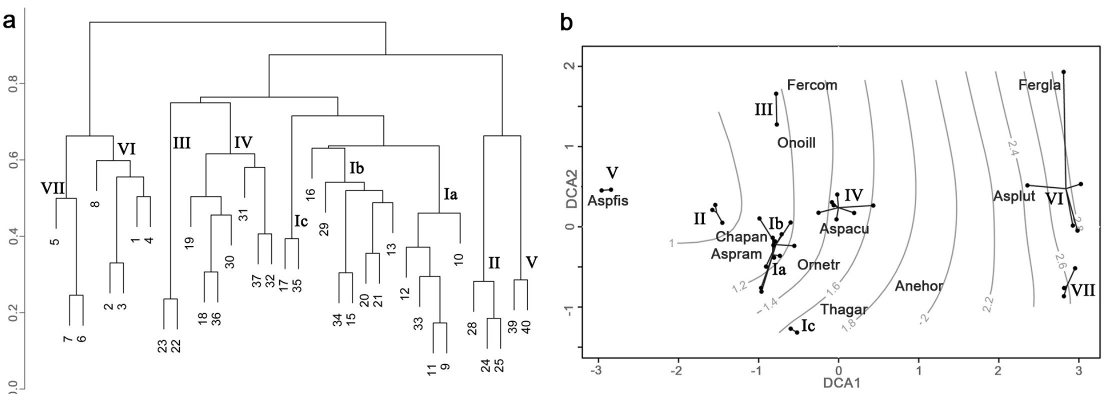

Fig. 1 - Classification and ordination of abundance vegetation data of heliophilous edges. a) Hierarchical cluster analysis dendrogram; b) Detrending Correspondence Analysis (DCA) biplot. Black lines (spiderplot), connect the relevés of the association, subassociation with its center. Gray contour lines is the Ios_2 fitted surface to DCA1 and DCA2 axis. Ia, *Charybdido pancratii-Asphodeletum ramosi typicum*; Ib, *Charybdido pancratii-Asphodeletum ramosi hyparrhenietosum hirtae*; Ic, *Charybdido pancratii-Asphodeletum ramosi* var. with *Euphorbia myrsinites*; II, *Alkanno tinctoriae-Asphodeletum ramosi*; III, *Asphodelo ramosi-Feruletum communis*; IV, *Asphodelino luteae-Feruletum communis*; V, *Verbasco garganici-Asphodeletum fistulosi* VI, *Asphodelino luteae-Feruletum glaucae*; VII, *Cephalario leucanthae-Saturejetum montanae feruletosum glaucae*. Anehor, *Anemone hortensis*; Aspacu, *Asparagus acutifolius*; Aspfis, *Asphodelus fistulosus*; Asplut, *Asphodeline lutea*; Aspram, *Asphodelus ramosus*; Chapan, *Charybdis pancration*; Fercom, *Ferula communis*; Fergla, *Ferula glauca*; Onoill, *Onopordum illyricum*; Ornetr, *Ornithogalum etruscum* subsp. *umbratile*; Thagar, *Thapsia garganica*.

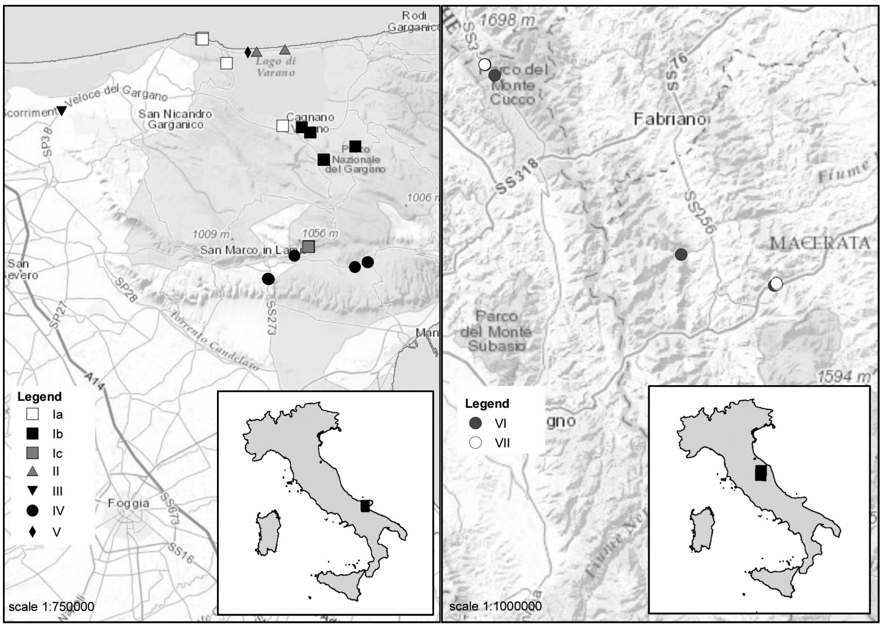

Fig. 2 - Distribution map of the phytocoenosis (identified by cluster analysis) on the two study area zones. On the left the Gargano peninsula; on the right, part of the central Apennines, bound by Marche and Umbria. Legend: Ia, *Charybdido pancratii-Asphodeletum ramosi typicum*; Ib, *Charybdido pancratii-Asphodeletum ramosi hyparrhenietosum hirtae*; Ic, *Charybdido pancratii-Asphodeletum ramosi Euphorbia myrsinites* var.; II, *Alkanno tinctoriae-Asphodeletum ramosi*; III, *Asphodelo ramosi-Feruletum communis*; IV, *Asphodelino luteae-Feruletum communis*; V, *Verbasco garganici-Asphodeletum fistulosi* VI, *Asphodelino luteae-Feruletum glaucae*; VII, *Cephalario leucanthae- Saturejetum montanae feruletosum glaucae*.

Charybdis pancration (Fig. 3). This vegetation colonizes hemicryptophyte grasslands grazed by large cattle, in areas characterized by slight slopes and few stones. This mainly develops in euoceanic areas with upper thermo-Mediterranean and lower meso-Mediterranean thermotypes, upper dry to lower sub-humid ombritypes, on limestone with Mediteranean terra rossa. The subassociation *typicum* subass. nova is characterized by the same species as those diagnostic for the association.

The subassociation *hyparrhenietosum hirtae* subass. nova (Fig. 4) develops in the secondary chamaephytic grasslands where *Hyparrhenia hirta* occurs, in addition to *A. ramosus* subsp. *ramosus* and *C. pancration*. This edge vegetation is found on rocky limestone substrata with relatively deep Mediterranean *terra rossa* soil deposits, in the lower meso-Mediterranean thermotype with lower sub-humid ombrotype. The differential species are: *H. hirta* subsp. *hirta*, *Satureja cuneifolia*, *Sideritis italica*, *Euphorbia myrsinites*, *Ruta divaricata*, *Hyoseris radiata*, and *Galium corrudifolium*.

Cluster Ic is indicated in Tab. 1 as a variant with *Euphorbia myrsinites*, and it is linked to this association in an intermediate ecological position, with reference to the above subassociations. This cluster appears to be closer to the subassociation *hyparrhenietosum hirtae* (cluster Ib), although it occurs at higher altitudes in rocky environments and upper mesomediterranean thermotype.

Cluster II

ALKANNO TINCTORIAE-ASPHODELETUM RAMOSI ass. nova *hoc loco* (*Holotypus*: rel. 1 of Tab. 2, this paper)

Diagnostic species: *Asphodelus ramosus* subsp. *ramosus*, *Charybdis pancration, Alkanna tinctoria,* and *Lotus cytisoides*.

Differential species: *Verbascum niveum* subsp. *garganicum*, and *Aetheorrhiza bulbosa*.

This association develops on dunes with compact sand, where there was previously vegetation attribu-

Fig. 3 - Typical aspect of the association *Charybdido pancratii-Asphodeletum ramosi*. Locality: Torre Mileto, Gargano. By E. Biondi.

Fig. 4 - *Charybdido pancratii-Asphodeletum ramosi hyparrhenietosum hirtae*. Locality: Cagnano Varano, Gargano. By E. Biondi.

Tab. 1 - *Charybdido pancratii-Asphodeletum ramosi* ass. nova *hoc loco* (*holotypus*: rel. 3); *typicum* subass. nova *hoc loco* (rels. 1-5, *holotypus*: rel. 3); variant with *Euphorbia myrsinites* (rels. 6-7); *hyparrhenietosum hirtae* subass. nova *hoc loco* (rels. 8-14, *holotypus*: rel. 9).

Relevé (N.)	1	2	3*	4	5	6	7	8	9**	10	11	12	13	14	Presences
Altitude (m a.s.l.)	31	39	11	143	20	689	689	297	61	135	139	292	293	448	
Aspect	N	N	SW	W	-	SW	SW	NE	SE	NE	NE	E	E	NE	
Slope (%)	-	10	5	10	10	35	35	40	25	20	20	35	35	30	
Area (m^2)	200	150	-	200	-	300	300	300	250	180	250	200	200	200	
Coverage (%)	95	100	100	100	-	90	100	90	100	100	100	95	90	95	
H veg. (m)	1.6	1.5	1.5	1.2	-	1.5	0.6	0.7-1.5	1.5-2	1.2	1.2	1.5-3	1.5	1	
N. dendrogram	9	11	33	12	10	17	35	16	13	21	20	15	34	29	
Char. species of the ass. *Charybdido pancratii-Asphodeletum ramosi*															
Asphodelus ramosus L. subsp. ramosus	4.5	4.5	5.5	5.5	1.2	4.5	4.5	3.4	5.5	3.3	5.5	4.5	4.5	5.5	14
Charybdis pancration (Steinh.) Speta	1.2	3.3	2.3	3.3	3.4	1.1	1.1	1.2	3.4	4.4	3.3	3.4	3.3	3.3	14
Hypochoeris radicata L.	1.2	+	1.2	1.2	.	.	.	.	.	.	.	.	.	.	4
Ranunculus bullatus L.	1.2	1.2	.	.	1.2	.	.	.	.	.	.	.	.	.	3
variant with *Euphorbia myrsinites*															
Euphorbia myrsinites L.	.	.	.	.	.	2.3	2.3	.	.	.	.	.	.	.	2
Marrubium incanum Desr.	.	.	.	.	.	2.2	1.2	.	.	.	.	.	.	.	2
Thymus longicaulis Presl	.	.	.	.	.	+	1.2	.	.	.	.	.	.	.	2
Diff. species of the subass. *hyparrhenietosum hirtae*															
Satureja cuneifolia Ten.	.	.	.	+	.	.	.	1.2	2.2	1.2	1.2	2.3	3.4	2.3	8
Hyoseris radiata L.	.	.	.	.	.	1.2	+	.	.	.	3.4	2.2	2.2	2.3	6
Sideritis italica (Mill.) Greuter & Burdet	.	.	.	.	.	1.2	2.2	1.1	.	.	.	2.3	2.3	1.2	6
Micromeria graeca (L.) Bentham	.	.	.	.	.	1.2	1.2	1.2	+.2	.	.	1.2	1.2	.	6
Hyparrhenia hirta (L.) Stapf subsp. hirta	.	.	.	.	.	.	.	.	3.4	2.2	+	1.2	2.2	.	5
Galium corrudifolium Vill.	.	.	.	.	.	+	.	.	.	+	+	+	.	+	5
Char. and diff. specie of the all. *Charybdido pancratii-Asphodelion ramosi* and upper levels															
Asparagus acutifolius L.	2.2	2.2	2.2	2.2	2.2	.	.	.	2.2	1.1	1.2	1.2	1.2	1.1	11
Ornithogalum etruscum Parl. subsp. umbratile (Tornad. & Garbari) Peruzzi & Bartolucci	1.2	2.2	1.1	1.2	1.2	.	.	+	1.1	+	.	1.1	1.2	1.2	11
Thapsia garganica L.	2.3	2.3	1.1	1.1	2.2	3.3	3.4	1.2	.	.	.	.	.	2.3	9
Anemone hortensis L.	1.2	1.2	1.1	.	.	.	+	1.2	.	+.2	1.1	.	+	2.2	9
Carlina corymbosa L.	.	.	.	1.2	.	.	.	+	1.2	1.2	1.2	1.1	.	2.2	7
Carlina vulgaris L.	.	.	.	1.2	.	1.1	1.1	1.2	.	.	.	.	.	.	4
Iris bicapitata Colasante	.	.	.	.	.	.	.	.	.	.	+	2.3	2.2	2.3	4
Arisarum vulgare Targ.-Tozz.	.	.	1.2	.	.	.	.	1.1	1.2	.	.	.	.	.	3
Allium subhirsutum L.	.	.	.	.	.	.	.	.	+.2	.	.	+	+	.	3
Orchis papilionacea L.	.	.	.	.	.	.	.	.	.	1.2	+.2	.	.	+.2	3
Hermodactylus tuberosus (L.) Salisb.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	2
Asphodeline lutea (L.) Rchb.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	1
Other species															
Dactylis hispanica Roth	1.2	+	1.2	1.2	1.2	1.2	1.2	1.2	.	2.2	2.2	1.2	1.2	1.2	13
Geranium molle L.	1.2	+	1.1	1.2	.	.	.	+	1.2	.	.	+.2	1.2	+	9
Theligonum cynocrambre L.	1.2	1.2	1.2	1.2	1.2	.	.	.	1.2	.	+.2	+.2	1.2	.	9
Reichardia picroides (L.) Roth	.	.	.	.	.	+.2	.	.	+	1.1	+	1.1	.	+	6
Teucrium polium L.	.	.	.	.	.	+.2	1.2	.	1.2	+	1.1	+	.	.	6
Olea europaea L. var. sylvestris	.	.	.	.	.	.	.	1.1	2.2	2.2	1.2	2.2	+	.	6
Stachys germanica L.	.	.	.	1.2	.	.	.	1.2	1.2	1.1	.	.	1.2	1.2	6
Paliurus spina-christi Miller	+	.	.	1.2	.	.	.	.	1.2	+	1.1	.	2.2	.	6
Crepis sancta (L.) Babc.	.	.	.	+.2	.	.	.	+	1.2	1.2	.	+	.	+	6
Vicia sativa L.	+	.	.	1.2	.	.	.	.	1.1	+	1.2	.	.	+	6
Piptatherum miliaceum (L.) Coss.	.	.	1.2	+	2.2	.	.	1.2	1.2	.	.	.	.	.	5
Lotus corniculatus L.	+	.	.	.	.	.	.	.	+	1.2	+	1.2	.	.	5
Ruta divaricata Ten	.	.	.	1.2	.	.	.	.	.	1.1	1.1	1.1	+	.	5
Euphorbia characias L.	.	.	.	.	.	4.4	.	+	.	+	.	2.3	4.4	.	5
Sherardia arvensis L.	.	.	+	+	.	.	.	.	1.2	1.1	.	.	.	+	5
Anagallis arvensis L.	+	+	+	+	.	.	.	.	+	.	.	.	.	.	5
Sanguisorba minor Scop.	.	.	.	.	.	.	.	+	+	1.2	1.2	.	.	.	4
Plantago lanceolata L.	.	.	.	.	.	.	1.2	.	.	+	+	.	.	+	4
Daucus carota L.	+	.	.	.	.	.	.	.	.	1.1	+	.	.	+	4
Pallenis spinosa (L.) Cass.	.	.	.	.	.	.	.	.	.	1.1	+	+	+.2	.	4
Sporadic species	6	1	7	5	4	3	3	10	6	9	14	13	8	12	

ted to the association *Verbasco garganici-Euphorbietum terracinae* Biondi, Casavecchia & Biscotti 2007 (Biondi *et al.*, 2007). The compact sand favors the development of *A. ramosus* subsp. *ramosus*, *C. pancration*, and other species that are considered as characteristic and differential of the alliance and the upper level of edge vegetation. However, there are several species of dune vegetation that are also characteristics of the association that remain within this vegetation, such as *Alkanna tinctoria*, *Lotus cytisoides* and *Aetheorrhiza bulbosa*. The other species that belong to the primitive communities assume the role of the differential association: *Verbascum niveum* subsp. *garganicum*, *Euphorbia terracina* and *Lobularia maritima*. It develops in the euoceanic areas with upper dry ombrotype and upper thermo-Mediterranean thermotype (Fig. 5).

CHARYBDIDO PANCRATII-ASPHODELION RAMOSI all. nova *hoc loco* (*Holotypus*: *Charybdido pancratii-Asphodeletum ramosi* ass. nova, this paper)

Diagnostic species: *Asphodelus ramosus* subsp. *ramosus*, *Charybdis pancration*, *Thapsia garganica*, *Asparagus acutifolius*, *Ornithogalum etruscum* subsp. *umbratile*, *Anemone hortensis*, *Carlina corymbosa*, *Hypochoeris radicata*, *Iris bicapitata*, and *Asphodeline liburnica*.

Differential species: *Hyparrhenia hirta*, *H. sinaica*, *Stipa capensis*, *Sideritis italica*, *Satureja cuneifolia*, *Micromeria graeca*, *Euphorbia characias*, *E. myrsinites*, *Alkanna tinctoria*, *Lotus cytisoides,* and *Aetheorrhiza bulbosa*.

Tab. 2 - *Alkanno tinctoriae-Asphodeletum ramosi* ass. nova *hoc loco* (*holotypus*: rel. 1).

Relevé (N.)	1*	2	3	Presences
Altitude (m a.s.l.)	4	5	4	
Aspect	flat	flat	flat	
Slope (%)	0	0	0	
Area (m^2)	300	300	200	
Coverage (%)	100	100	100	
H veg. (m)	1.6	1.6	1.6	
N. dendrogram	24	25	28	
Char. and diff. species of the ass. and the upper levels				
Asphodelus ramosus L. subsp. ramosus	5.5	5.5	5.5	3
Alkanna tinctoria (L.) Tausch	2.3	2.2	1.2	3
Verbascum niveum Ten. ssp. garganicum (Ten.) Murb.	1.2	2.2	+	3
Euphorbia terracina L.	2.2	2.2	1.2	3
Rubus ulmifolius Schott	1.2	1.2	1.2	3
Lotus cytisoides L.	1.2	+.2	+	3
Aetheorrhiza bulbosa (L.) Cass.	1.2	+.2	+	3
Asparagus acutifolius L.	2.3	2.3	2.3	3
Charybdis pancration (Steinh.) Speta	2.2	2.2	.	2
Lobularia maritima (L.) Desv.	+	.	+	2
Other species				
Hypochoeris achyrophorus L.	1.2	1.2	2.2	3
Psoralea bituminosa L.	1.2	+	2.2	3
Teucrium polium L.	1.1	1.2	+	3
Lagurus ovatus L.	+	+	+	3
Crepis sancta (L.) Babc.	2.2	+.2	.	2
Scabiosa maritima L.	+	2.2	.	2
Daucus carota L.	1.1	1.2	.	2
Pistacia lentiscus L.	+	1.1	.	2
Briza maxima L.	1.1	.	+	2
Dactylis hispanica Roth	1.2	.	1.2	2
Geranium purpureum Vill.	.	1.2	+	2
Dasypyrum villosum (L.) Borbas	.	1.2	+	2
Sporadic species	6	5	13	

This alliance represents the nomenclatural *typus* of the order, given that the formations of *A. ramosus* and *C. pancration* are together the widest spread of the heliophilous edge vegetation detected. Moreover, these invade distinct grasslands that can sometimes be included in other alliances of the same class, with the addition of other species that together allow the recognition of different types from the floristic and ecological points of view.

This alliance occurs mainly on soils of Mediterranean terra rossa in the oceanic Mediterranean bioclimate, upper thermo-Mediterranean and lower meso-Mediterranean thermotypes, upper dry to lower sub-humid ombrotypes.

Cluster III

ASPHODELO RAMOSI-FERULETUM COMMUNIS ass. nova *hoc loco* (*Holotypus*: rel. 1 of Tab. 3, this paper)

Diagnostic species: *Ferula communis*, *Asphodelus ramosus* subsp. *ramosus*, and *Iris pseudopumila*.

Differential species: *Onopordum illyricum*, and *Cynoglossum creticum*.

The communities of this association are dense grasslands with *F. communis* and *A. ramosus* subsp. *ramosus* that are found on Mediterranean *terra rossa* soil in the euoceanic areas with upper thermo-Mediterranean and lower meso-Mediterranean thermotypes and upper dry ombrotype (Fig. 6). The nitrophilous differential species belong to the edge communities that grow on soils affected by animal manure and those that are directly related to traditional agricultural activities.

Cluster IV

ASPHODELINO LUTEAE-FERULETUM COMMUNIS ass. nova *hoc loco* (*Holotypus*: rel. 2 of Tab. 4, this paper)

Diagnostic species: *Ferula communis*, *Asphodeline lutea*, and *Thapsia garganica*.

The edge communities that belong to this association grow in weak semicontinental areas with upper meso-Mediterranean thermotype and lower subhumid ombrotype, on both deep and fertilized soils, where there are no longer any agricultural activities, and on

Fig. 5 - *Alkanno tinctoriae-Asphodeletum ramosi*. Locality: Varano lake, Gargano, on dunes with compact sand. By E. Biondi.

Fig. 6 - *Asphodelo ramosi-Feruletum communis*. Locality: Cagnano Varano, Gargano, in the thermo-Mediterranean thermotype. By E. Biondi.

Tab. 3 - *Asphodelo ramosi-Feruletum communis* ass. nova *hoc loco* (*holotypus*: rel. 1).

Relevé (N.)	1*	2	Presences
Altitude (m a.s.l.)	34	35	
Aspect	SE	SW	
Slope (%)	15	10	
Area (m^2)	200	200	
Coverage (%)	100	100	
H veg. (m)	2.5	2.5	
N. dendrogram	23	22	
Char. species of the *Asphodelo ramosi-Feruletum communis* ass. nova			
Ferula communis L.	5.5	4.5	2
Onopordum illyricum L.	1.2	1.1	2
Cynoglossum creticum Miller	+	1.1	2
Char. species of the *Asphodelo ramosi-Ferulion communis* all. nova and *Asphodeletalia ramosi* ordo novo			
Asphodelus ramosus L. subsp. ramosus	2.3	3.4	2
Asparagus acutifolius L.	1.2	1.2	2
Charybdis pancration (Steinh.) Speta	+	2.2	2
Carlina corymbosa L.	+	1.1	2
Iris pseudopumila Tineo	.	1.2	1
Anemone hortensis L.	.	+	1
Ornithogalum etruscum Parl. subsp. umbratile (Tornad. & Garbari) Peruzzi & Bartolucci	.	+	1
Euphorbia myrsinites L.	.	+	1
Charact. and diff. species of the suball. *Oleo-Paliurenion* and of the ord. *Pistacio-Rhamnetalia*			
Olea europaea L. var. sylvestris	2.2	2.2	2
Pyrus spinosa Forssk.	2.2	1.1	2
Paliurus spina-christi Miller	1.2	1.2	2
Anagyris foetida L.	.	1	1
Other species			
Bunias erucago L.	1.1	+	2
Geranium molle L.	1.2	1.2	2
Avena barbata Potter	2.2	1.1	2
Crepis sancta (L.) Babc.	1.1	1.1	2
Calamintha nepeta (L.) Savi	1.1	+	2
Mercurialis annua L.	+	1.1	2
Sonchus oleraceus L.	1.1	+	2
Theligonum cynocrambre L.	1.2	+.2	2
Sherardia arvensis L.	1.1	+	2
Anagallis arvensis L.	+	1.1	2
Euphorbia helioscopia L.	+	1.2	2
Medicago arabica (L.) Hudson	2.2	.	1
Solanum sodomaeum L.	+	.	1
Beta vulgaris L.	+	.	1
Urtica pilulifera L.	+.2	.	1
Scandix pecten-veneris L.	+	.	1
Cynara cardunculus L.	.	+	1
Lotus corniculatus L.	.	1.2	1
Scrophularia peregrina L.	.	+	1
Fumaria capreolata L.	.	+	1
Stellaria media (L.) Vill.	.	+	1

rocky-pebbly substrata with less organic matter. This community has been surveyed for the San Giovanni Rotondo plateau and in the Monte Sant'Angelo locality (Fig. 7; Foggia, Apulia).

ASPHODELO RAMOSI-FERULION COMMUNIS all. nova *hoc loco* (*Holotypus*: *Asphodelo ramosi-Feruletum communis* ass. nova, this paper)

Diagnostic species: *Ferula communis*, *F. communis* subsp. *cardonae*, *F. communis* subsp. *catalaunica*, *F. arrigonii*.

The edge communities that belong to this alliance are dominated by *Ferula* spp. and *Asphodelus* spp., and they invade the land that has been abandoned by agricultural and pastoral activities. These develop on both calcareous stony soils and deep and fertilized soils, in the oceanic Mediterranean bioclimate, upper thermo-Mediterranean to lower meso-Mediterranean thermotypes, upper dry to lower sub-humid ombrotypes.

Cluster V

VERBASCO GARGANICI-ASPHODELETUM FISTULOSI ass. nova *hoc loco* (*Holotypus*: rel. 2 of Tab. 5, this paper)

Diagnostic species: *Asphodelus fistulosus*, *Verbascum niveum* subsp. *garganicum*, *Euphorbia terracina*, and *Lotus cytisoides*.

This association grows on dunes that are characterized by noncompacted sand, as caused by the process of wind deflation and/or in terms of sand movements due to cultivation (Fig. 8).

After these lands were abandoned, there was invasion by *A. fistulosus* populations. Even here, vegetation persists that characterizes the previous nitrophilous vegetation that colonized the sands and was included in the association *Verbasco garganici-Euphorbietum terracinae* Biondi, Casavecchia & Biscotti 2007. It occurs in euoceanic areas with the upper thermo-Mediterranean thermotype and the upper dry ombrotype.

Fig. 7 - *Asphodelino luteae-Feruletum communis*. Locality: S. Giovanni Rotondo, Gargano, in the meso-Mediterranean thermotype. By E. Biondi.

Fig. 8 - *Verbasco garganici-Asphodeletum fistulosi*. Locality: Varano lake, Gargano, on dunes with noncompacted sand. By E. Biondi.

Tab. 4 - *Asphodelino luteae-Feruletum communis* ass. nova *hoc loco* (*holotypus*: rel. 2).

Relevé (N.)	1	2*	3	4	5	6	7	
Altitude (m a.s.l.)	520	520	523	613	496	538	526	
Aspect	S	W	SW	SW	S	S	SW	
Slope (%)	10	5	10	15	10	10	20	
Area (m^2)	120	200	400	200	200	200	250	
Coverage (%)	100	100	100	100	95	100	100	
H veg. (m)	0.80	2	2.5	2.5	1	1.2	1.2	
N. dendrogram	19	18	36	30	31	37	32	Presences
Charact. species of the *Asphodelino luteae-Feruletum communis* ass. nova								
Ferula communis L.	1.2	5.5	4.5	3.3	1.1	2.2	1.2	7
Asphodeline lutea (L.) Rchb.	2.3	3.4	3.3	4.5	2.2	2.2	2.2	7
Thapsia garganica L.	3.3	3.4	2.3	2.3	3.3	3.3	2.2	7
Char. and diff. species of the *Asphodelo ramosi-Ferulion communis* all. nova and the *Asphodeletalia ramosi* ordo novo								
Asphodelus ramosus L. subsp. ramosus	5.5	+	3.4	2.2	5.5	4.5	5.5	7
Asparagus acutifolius L.	1.1	1.2	1.2	+	.	1.2	1.2	6
Ornithogalum etruscum Parl. subsp. umbratile (Tornad. & Garbari) Peruzzi & Bartolucci	.	1.2	1.2	1.1	1.2	2.2	.	5
Onopordum illyricum L.	.	+	1.2	+	1.1	.	.	4
Charybdis pancration (Steinh.) Speta	.	1.2	3.2	+	.	+	.	4
Anemone hortensis L.	.	1.2	1.2	.	.	2.2	1.2	4
Iris pseudopumila Tineo	.	.	+.2	.	2.3	1.2	.	3
Orchis papilionacea L.	1.2	1.1	1.1	.	.	.	.	3
Euphorbia myrsinites L.	.	+.2	1.1	.	2.3	.	.	3
Leopoldia comosa (L.) Parl.	.	.	.	1.2	.	1.2	+	3
Carlina corymbosa L.	.	+.2	.	.	.	1.2	.	2
Ophrys sphegodes subsp. passionis (Sennen) Sanz & Nuet	+	.	.	.	.	+	.	2
Hermodactylus tuberosus (L.) Salisb.	.	1.2	+	.	.	.	.	2
Scorzonera villosa Scop.	.	.	.	.	+	1.1	.	2
Iris bicapitata Colasante	.	.	.	.	.	2.3	3.4	2
Opopanax chironium (L.) Koch	.	.	.	.	.	2.2	2.3	2
Other species								
Dactylis glomerata L.	2.3	2.2	2.2	+	.	1.2	.	5
Plantago lanceolata L.	.	+.2	1.1	+.2	+.2	1.2	.	5
Euphorbia helioscopia L.	.	+	.	.	1.1	+	+	4
Dasypyrum villosum (L.) Borbas	.	.	.	2.2	+.2	1.2	1.1	4
Eryngium campestre L.	+	+	.	+	.	.	+	4
Hypericum perforatum L.	.	+	+	.	.	1.2	1.1	4
Bunias erucago L.	.	.	.	.	+	+	+	3
Geranium molle L.	.	.	+	.	+	.	+	3
Tordylium apulum L.	.	.	+	1.2	+.2	.	.	3
Convolvulus elegantissimus Miller	.	.	.	1.2	.	1.2	+.2	3
Reichardia picroides (L.) Roth	.	.	1.2	+.2	.	+	.	3
Scabiosa maritima L.	.	.	.	1.2	+	.	1.1	3
Carduus nutans L.	.	.	.	.	+	1.1	1.2	3
Daucus carota L.	.	1.1	1.2	.	.	+	.	3
Stachys germanica L.	.	.	.	.	2.2	2.2	+	3
Sporadic species	2	6	4	8	12	14	16	

ASPHODELION FISTULOSI all. nova *hoc loco* (*Holotypus*: *Verbasco garganici-Asphodeletum fistulosi* ass. nova, this paper)

Diagnostic species: *Asphodelus fistulosus*, *A. tenuifolius*, and *A. ayardii* (= *A. cirerae*).

This alliance includes the edge vegetation dominated by the indicated *Asphodelus* spp. that grow on sandy and sandy-stony substrata. Therefore, this includes edaphophilous and xerophilous communities. This occurs mainly in coastal and subcoastal areas in the Mediterranean basin. It occurs in euoceanic areas with upper thermo-Mediterranean thermotype and upper dry ombrotype.

Cluster VI

ASPHODELINO LUTEAE-FERULETUM GLAUCAE Biondi & Casavecchia ass. nova *hoc loco* (*Holotypus*: rel. 4 of Tab. 6, this paper)

Diagnostic species: *Ferula glauca*, *Asphodeline lutea*, *Anemone hortensis*, *Muscari neglectum*, and *Leopoldia comosa*.

Differential species: *Cephalaria leucantha*, *Artemisia alba*, and *Sedum rupestre*.

This association is a heliophilous edge vegetation that is dominated by *Ferula glauca* and *Asphodeline lutea*. This develops in abandoned areas in semi-rocky or rocky situations, in mountainous inland areas of the Apennines between Umbria and Marche. The continuing dynamics are related to the previous communities, and lead to dense formations dominated by *F. glauca* and other species that are part of the order *Asphodeletalia ramosi*, such as: *A. lutea*, *A. hortensis*, *M. neglectum*, and *L. comosa*. Moreover, these can also be considered as the differential species of the association, which constitutes the association *Cephalario leucanthae-Saturejetum montanae*, where the following

Tab. 5 - *Verbasco garganici-Asphodeletum fistulosi* ass. nova *hoc loco* (*holotypus*: rel. 2).

Relevé (N.)	1	2*	
Altitude (m a.s.l.)	5	6	
Aspect	flat	W	
Slope (%)	0	5	
Area (m^2)	200	200	
Coverage (%)	85	85	
H veg. (m)	1.7	1.7	
N. dendrogram	39	40	Presences
Char. and diff. species of the *Verbasco garganici-Asphodeletum fistulosi* ass. nova and the upper levels			
Asphodelus fistulosus L.	4.5	5.5	2
Lotus cytisoides L.	2.3	1.2	2
Verbascum niveum Ten. ssp. garganicum (Ten.) Murb.	2.2	2.3	2
Alkanna tinctoria (L.) Tausch	1.2	1.2	2
Euphorbia terracina L.	.	1.2	1
Scabiosa maritima L.	1.2	.	1
Other species			
Anagallis arvensis L.	+	1.1	2
Bromus rigidus Roth	1.2	1.2	2
Sherardia arvensis L.	+	+	2
Verbascum sinuatum L.	1.1	+	2
Pinus halepensis Mill.	+	+	2
Ajuga chamaepitys (L.) Schreber	.	2.2	1
Catapodium marinum (L.) C.E.Hubb.	+	.	1
Crepis sancta (L.) Babc.	+.2	.	1
Dasypyrum villosum (L.) Borbas	.	+	1
Medicago litoralis Rohde	.	+.2	1
Silene conica L.	.	+	1
Phleum arenarium L.	+.2	.	1

Fig. 9 - *Asphodelino luteae-Feruletum glaucae*. Locality: Bistocco, Caldarola, Umbria-Marche Apennines. By E. Biondi.

are found most frequently: *Cephalaria leucantha*, *Artemisia alba*, and *Sedum rupestre*. It occurs in weak semicontinental areas with mesotemperate thermotype (submediterranean) and upper subhumid to humid ombrotypes (Fig. 9).

ASPHODELINO LUTEAE-FERULION GLAUCAE all. nova *hoc loco* (*Holotypus*: *Asphodelino luteae-Feruletum glaucae* ass. nova, this paper)

Diagnostic species: *Ferula glauca*, *Asphodeline lutea*, *Anemone hortensis*, *Muscari neglectum*.

This alliance brings together the communities dominated by *F. glauca*. This is found on carbonate rock with soil pockets, in the sub-Mediterranean variant of the oceanic temperate Bioclimate with mesotemperate thermotype and upper subhumid to humid ombrotypes. The vegetation that was invaded during the dynamic processes was mainly of chamaephytic communities.

Ferula glauca (glaucous giant fennel) is a species with a southern euroMediterranean distribution. This species has an ecology that is a little different from that of *F. communis* as, for example, it prefers rocky or scree areas. Therefore, is most commonly found along the slopes of the Apennine and pre-Apennine limestone heights, as well as in areas that are more or less ruderal. Along the Italian Adriatic coast, is found in various areas in the Regions of Puglia, Molise, and Abruzzo, along the interior valleys of the Apennines. In montane locations, it reaches the northern limits of its distribution in the pre-Apennine areas of the Marche Region (Anzalone *et al*., 1992). The appearance of in these last areas was reported from the late 1980s, before which it had not been noted. Recently, the distribution of in central Italy has been better defined according to its increasing population, which is probably due to climate changes (Biondi *et al*., 2012).

This vegetation represents a new way of seeing the dynamic processes that affect the Mediterranean grasslands after their abandonment from agricultural and pastoral activities. The communities that then arise are not related to the orders and classes of the vegetation that occurred in the Temperate macroclimate, and as a consequence, it is considered necessary to describe a new Mediterranean order and class.

ASPHODELETALIA RAMOSI Biondi ordo novo *hoc loco* (*Holotypus*: *Charybdido pancratii-Asphodelion ramosi* all. nova, this paper)

Diagnostic species: the same as the class.

This order is the nomenclatural type of the class, and it is the Mediterranean vicariant of the *Asphodeletalia albi* order (*Trifolio-Geranietea* class). This occurs in the oceanic Mediterranean bioclimate, thermo-Mediterranean to meso-Mediterranean thermotypes, dry to sub-humid ombrotypes and in the oceanic temperate Bioclimate sub-Mediterranean variant, thermo- to mesotemperate thermotypes and subhumid to humid ombrotypes.

CHARYBDIDO PANCRATII-ASPHODELETEA RAMOSI Biondi classis nova *hoc loco* (*Holotypus*: *Asphodeletalia ramosi* Biondi ordo novo, this paper)

Diagnostic species: *Asphodelus ramosus* subsp. *ramosus*, *A. fistulosus*, *A. tenuifolius*, *A. ayardii* (=*A. cirerae*), *Charybdis pancration*, *C. maritima*, *C. glaucophylla*, *C. aphylla* (Israel and Turkey), *C. hesperia* (Canary Islands and northern Morocco), *C. maura* (endemic to Central Atlas, Morocco), *Thapsia garganica*, *Asparagus acutifolius*, *Ornithogalum etruscum* subsp. *umbratile*, *Anemone hortensis*, *Carlina corymbosa*, *Hypochoeris radicata*, *Iris planifolia*, *I. bicapitata*,

Tab. 6 - *Asphodelino luteae-Feruletum glaucae* ass. nova *hoc loco* (*holotypus*: rel. 4).

Relevé (N.)	1	2	3	4*	5	Presences
Altitude (m a.s.l.)	570	560		580	400	
Aspect	-	S	W	SE	E	
Slope (°)	-	25	40	30		
Area (m^2)	50	50	300	50	70	
Coverage (%)	100	100	100	70	95	
N. dendrogram	4	1	3	2	8	
Char. and diff. species of the *Asphodelino luteae-Feruletum glaucae* ass. nova and the upper levels						
Ferula glauca L.	5.5	4.5	5.5	5.5	4.5	5
Asphodeline lutea (L.) Rchb.	1.2	4.4	3.3	2.3	2.3	5
Muscari neglectum Guss.	+	1.2	+.2	1.2	1.2	5
Cephalaria leucantha (L.) Schrader	.	1.2	+	1.2	1.2	4
Sedum rupestre L.	.	+.2	+.2	+.2	.	3
Artemisia alba Turra	.	2.2	.	1.2	2.2	3
Anemone hortensis L.	.	1.1	+	.	.	2
Asparagus acutifolius L.	.	.	1.2	.	1.2	2
Leopoldia comosa (L.) Parl.	.	.	.	.	1.1	1
Other species						
Dactylis glomerata L.	1.2	+.2	1.1	.	.	3
Geranium rotundifolium L.	.	.	+	.	+	2
Geranium lucidum L.	.	+	.	1.2	.	2
Hypochoeris achyrophorus L.	.	+	.	+	.	2
Galium aparine L.	1.1	.	1.2	.	.	2
Brachypodium rupestre (Host) R. et S.	3.4	.	.	1.2	.	2
Helianthemum apenninum (L.) Miller	.	1.2	.	1.2	.	2
Fraxinus ornus L.	.	1.2	.	.	+	2
Teucrium flavum L.	.	+	.	.	2.2	2
Osyris alba L.	.	.	+.2	.	1.2	2
Dianthus longicaulis	.	.	.	+	+	2
Echium vulgare L.	.	+	.	2.2	.	2
Sedum sexangulare L.	.	+	.	+.2	.	2
Spartium junceum L.	.	+.2	.	+	.	2
Thymus longicaulis Presl	.	+.2	.	+.2	.	2
Sanguisorba minor Scop.	.	+	.	+	.	2
Hedera helix L.	+.2	.	.	.	1.2	2
Geranium sanguineum L.	.	.	.	+.2	1.2	2
Stachys recta L.	.	.	+.2	+.2	.	2
Arum italicum Miller	.	.	+	.	+	2
Sporadic species	9	5	4	8	12	

and other mediterranean species belonging to the genus *Iris*, *Asphodeline liburnica*, *A. lutea*, *Ferula communis*, *F. communis* subsp. *cardonae*, *F. communis* subsp. *catalaunica*, *F. glauca*, *F. arrigonii*, and *Hermodactylis tuberosus*.

This class brings together the communities of perennial herbaceous macrophytes that invade perennial grasslands, and sometimes grasslands of biennial or annual species, that are abandoned or underused or were previously under cultivation. This is found in the oceanic Mediterranean bioclimate, thermo-Mediterranean to meso-Mediterranean thermotypes, dry to sub-humid ombrotypes and in the oceanic temperate Bioclimate sub-Mediterranean variant, thermo- to mesotemperate thermotypes and subhumid to humid ombrotypes.

As a result of the dynamic processes arising from the forward movement of the species in the heliophilous edges, there can be rapid and intense invasion of the grasslands by the heliophilous edge species. The most active species are rhizomatous geophytes that can synthesize compounds that are toxic or poisonous for herbivores, allowing their spread without obstacles. This class has a distribution area that extends across the central and eastern Mediterranean basin, although at present, its distribution has only been confirmed for the south-western Adriatic territories. In the Mediterranean, this replaces the class *Trifolio-Geranietea*, in terms of the aspects that characterize the heliophilous edges.

Cluster VII

CEPHALARIO LEUCANTHAE- SATUREJETUM MONTANAE Allegrezza, Biondi, Formica & Ballelli 1997

FERULETOSUM GLAUCAE subass. nova *hoc loco* (*Holotypus*: rel. 2 of Tab. 7, this paper)

Diagnostic species: *Ferula glauca*, *Asphodeline lutea*, *Muscari neglectum*, and *Anemone hortensis*.

In the Apennines between Umbria and Marche, the investigated vegetation that is attributable to this new class occupies limited areas, and it is found in the oceanic temperate Bioclimate sub-Mediterranean variant, mesotemperate thermotype and upper subhumid to humid ombrotypes. This is a vegetation dominated by *Ferula glauca* that invades some aspects of the secondary grasslands related to the association *Cephalario*

Tab. 7 - *Cephalario leucanthae-Saturejetum montanae* Allegrezza, Biondi, Formica & Ballelli 1997 subass. *feruletosum glaucae* subass. nova (*holotypus*: rel. 2).

Relevé (N.)	1	2*	3	Presences
Altitude (m a.s.l.)	340	350	575	
Aspect	E	W	S-SW	
Slope (°)	40	40	25	
Area (m^2)	120	100	70	
Coverage (%)	90	95	85	
N. dendrogram	6	7	5	
Char. and diff. species of the ass. *Cephalario leucanthae-Saturejetum montanae*				
Sedum rupestre L.	1.2	1.2	1.2	3
Helianthemum apenninum (L.) Miller	2.3	+	1.2	3
Cephalaria leucantha (L.) Schrader	2.3	2.3	1.2	3
Artemisia alba Turra	1.2	1.2	3.4	3
Satureja montana L.	4.4	3.4	4.4	3
Allium sphaerocephalon L.	1.1	1.1	.	2
Diff. species of the *feruletosum glaucae* subass. nova				
Ferula glauca L.	2.2	2.2	+.2	3
Asphodeline lutea (L.) Rchb.	2.3	4.4	3.4	3
Muscari neglectum Guss.	+.2	+.2	1.2	3
Anemone hortensis L.	2.3	2.3	1.2	3
Char. and diff. species of the all. *Artemisio albae-Saturejion montanae*, order *Artemisio albae-Saturejetalia montanae* and class *Cisto cretici-Micromerietea*				
Eryngium amethystinum L.	1.1	1.1	1.1	3
Teucrium flavum L.	2.2	+	.	2
Teucrium flavum L.	2.2	+	.	2
Galium lucidum All.	2.3	2.2	.	2
Globularia punctata Lapeyr.	1.2	.	+.2	2
Dianthus longicaulis	2.3	1.2	.	2
Sedum album L.	+.2	1.2	.	2
Helichrysum italicum (Roth) Don	1.2	2.2	.	2
Orchis morio L.	.	+	+	2
Onosma echioides L.	+	.	.	1
Thymus longicaulis Presl	2.2	.	.	1
Convolvulus althaeoides L.	.	.	+.2	1
Char. and diff. species of the class *Rhamno-Prunetea*				
Asparagus acutifolius L.	1.2	1.2	.	2
Osyris alba L.	+.2	2.2	.	2
Other species				
Brachypodium rupestre (Host) R. et S.	+.2	1,2	+.2	3
Phleum ambiguum Ten.	+	+	1.2	3
Reichardia picroides (L.) Roth	1.1	1.1	+	3
Fraxinus ornus L.	1.1	.	+	2
Geranium rotundifolium L.	+	+	.	2
Sedum album L.	+.2	1.2	.	2
Pistacia terebinthus L.	+	+	.	2
Cercis siliquastrum L.	+	+	.	2
Seseli viarum Calest.	+	1.1	.	2
Hypochoeris achyrophorus L.	1.1	.	+.2	2
Crepis vesicaria L.	1.2	+	.	2
Crepis sancta (L.) Babc.	+.2	+	.	2
Sporadic species	5	1	8	

leucantahe-Saturejetum montanae Allegrezza, Biondi, Formica & Ballelli 1997 (Allegrezza *et al*., 1997). The evolution of the *F. glauca* vegetation occurs as for the other coenoses already considered, thus through progression that develops over time and that is documented in terms of its initial aspects in Tab. 7. As already indicated, this association includes the subassociation *feruletosum glaucae* subass. nova *hoc loco*, for which the differential species are: *F. glauca, A. lutea, M. neglectum*, and *A. hortensis*. This new subassociation refers to the formations with *F. glauca* and *A. lutea* that develop within the mountainous garigues on *scaglia bianca*, corresponding to the deeper soil pockets.

Discussion

Some different types of vegetation that originate as a spontaneous consequence of the abandonment of the Mediterranean secondary grasslands are presented here for the first time as heliophilous edge formations. The vegetation dominated by branched asphodels and other tall herbs that are a part of this vegetation have already been observed, but these were considered as part of the floristic composition of the secondary grasslands. For example, Giacomini *et al*. (1958) highlighted *Asphodelus ramosus* formations and described them as "Asphodel grasslands", and they included them in a chapter on "Steppes and Mediterranean grasslands." Similarly, in phytosociological studies on the Mediterranean secondary grasslands, *A. ramosus* was attributed to different classes and orders.

In the international and national scientific literature, it is possible to find studies that have analyzed reconstitution types of vegetation similar to those described in the present study. In Italy, on the island of Pianosa (Tuscan archipelago), Foggi *et al*. (2008) described the association *Thapsio garganicae-Asphodeletum ramosi* that is dominated by *A. ramosus* and characterized by *Thapsia garganica* and *Allium subhirsutum*. Indeed, this association is similar to those that are described in the present study, but this previous study included this in the class *Artemisietea vulgaris* Lohmeyer, Preising & Tüxen ex Von Rochow 1951, in the order *Brachypodio ramosi-Dactyletalia hispanicae* Biondi, Filigheddu & Farris 2001, and in the alliance *Thero-Brachypodion ramosi* Br.-Bl. 1925 *nom. mut. propos*. Rivas-Martínez *et al*. 2002.

In Sicily, communities dominated by species that are considered here as characteristic species of the new class have been included in the class *Lygeo-Stipetea* and in the order *Hyparrhenetalia hirtae*. Among these, there is the association *Thapsio garganicae-Feruletum communis* Brullo 1984, which has also been described for Calabria, here in the Aspromonte territory, where it colonizes uncultivated fields characterized by calcarenitic outcrops, in the thermo-Mediterranean thermotype, from a dry to sub-humid ombrotypes, and under high edaphic humidity conditions, as part of the *Oleo-Euphorbietum dendroidis* maquis series (Brullo *et al*., 2001).

For Sicily, on Linosa Island, a steppes vegetation that is dominated by *Hyparrhenia hirta* and *Ferula communis* has also been described, which was attributed to the association *Ferulo communis-Hyparrhenietum hirtae* Brullo & Siracusa 1996 (Brullo & Siracusa, 1996). For the island of Lampedusa (Pelagian archipelago), the association *Thapsietum pelagicae* C. Brullo & Brullo in Brullo *et al*. 2010 was described (syn.: *Thapsio garganicae-Feruletum communis* Bartolo, Brullo, Minissale & Spampinato 1990, not Brullo 1984); this is characterized and dominated by *Thapsia pelagica* Brullo, Guglielmo, Pasta, Pavone & Salmeri, which is considered endemic to Sicily. This is an association that is markedly thermophilic, and occurs in the thermo-Mediterranean bioclimatic belt, in serial relationship with *Periplocion angustifoliae* shrublands.

The association *Carlino siculae-Feruletum communis* Gianguzzi, Ilardi & Raimondo 1996 has been described for Monte Pellegrino, near the city of Palermo. This association occurs on extensive rocky outcrops that had been used for pasture for centuries (Gianguzzi *et al*., 1996). According to the authors of the association, the characteristic and differential species are: *Carlina sicula*, *Asphodelus microcarpus*, *Ferula communis* subsp. *communis*, *Rumex thyrsoides*, *Mandragora autumnalis*, *Cynoglossum creticum*, and *Iris planifolia*. Furthermore, there are other characteristic species of the class, such as: *Thapsia garganica*, *Urginea maritima*, *Hyoseris radiata*, and *Hermodactylus tuberosus*. Therefore, it is clear that these relevés correspond to the same vegetation typologies discussed in the present study, and so they can be referred to the order *Asphodeletalia ramosi*. The authors of the association recognized that it can grow on degraded pastures that occur on calcareous lithosoils of north-western Sicily, and they included it in the class *Artemisietea vulgaris*, subclass *Onopordenea acanthii*, order *Carthametalia lanati*, and alliance *Onopordion illyrici*. The association was also found in other areas of Sicily, including Mount Cofano (Gianguzzi & La Mantia, 2008) in the Site of Community Importance of Rocche di Entella in western Sicily (Gianguzzi *et al*., 2007), and in the province of Enna (Marcenò *et al*., 2011). For the syndynamic issues, the association *Carlino siculae-Feruletum communis* is part of the coastal Tyrrhenian hilly, mesophilous, thermos-Mediterranean series of *Quercus virgiliana* and *Olea sylvestris* (*Oleo-Querco virgilianae* sigmetum) (Gianguzzi *et al*., 2007).

The association *Asphodelo microcarpi-Brachypodietum ramosi* Biondi & Mossa 1992 has been described for the promontory of Capo Sant'Elia near Cagliari (south-eastern Sardinia), on limestone, where it was described for the first time (Biondi & Mossa, 1992). Later, the same association was found in north-western Sardinia, in the area around Nurra (Biondi *et al*., 2001), and in north-eastern Sardinia, for the archipelago of La Maddalena (Biondi & Bagella, 2005). Biondi & Bagella (2005) described some different aspects that represent more advanced stages towards the establishment of the heliophilous edges of the association *Asphodelo-Brachypodietum ramosi*. The differential species for these more developed aspects include: *Urginea maritima*, *Pancratium illyricum*, and *Ferula arrigonii*, which are important taxa for Sardinia, and they indicate development toward heliophilous edge coenoses that can be included in the new order. For the archipelago of La Maddalena, this vegetation is part of the series of *Prasio majoris-Querco ilicis phillyreetosum angustifoliae*, as the Sardinian, climatophilous, acidophilous, thermo-Mediterranean, dry to sub-humid series of holm oak.

This association is included in the class *Artemisieta vulgaris* Lohmeyer, Preising & Tüxen ex von Rochow 1951, in the order *Brachypodio ramosi-Dactyletalia hispanicae* Biondi, Filigheddu & Farris 2001, and in the alliance *Thero-Brachypodion ramosi* Br.-Bl. 1925.

The same syntaxonomical scheme is followed in the Prodrome of the Italian Vegetation (Biondi *et al*., 2014), and for the implementation of the Italian Vegetation Prodrome for the current state of the art, and available from the website of the Italian Botanical Society (IBS) in a special forum that is still partly upgradeable, at: http://www.prodromo-vegetazione-italia.org.

Horvatić (1934) described the association *Bromo-Chrysopogonetum grylli* subass. *asphodeletosum microcarpi* for Croatia, and later raised the subassociation to the rank of association (Horvatić, 1958a, 1958b): *Asphodelo-Chrysopogonetum grylli*. In a later study that was carried out on the vegetation of the island of Pag (Horvatić, 1963), it clearly appears that the association refers to a thick expanding edge of *A. ramosus*. Horvatić (1963) included the association in the class *Brachypodio-Chrysopogonetea* Horvatić (1956) 1958 (now considered as a synonym of the class *Festuco vallesiacae-Brometea erecti* Br.-Bl. & Tüxen ex Klika & Hadač 1944), in the order *Scorzonero-Chrysopogonetalia* Horvatić & Horvat in Horvatić 1963, and in the alliance *Chrysopogono-Saturejion* Horvat & Horvatić in Horvatić 1934. The *Asphodelo-Chrysopogonetum grylli* association was also found by Fanelli *et al*. (2015) in Albania, where a community with *A. ramosus* was also described. This community was in dynamic succession with *Paliurus spina-christi* shrubs, and these are both part of the same processes of grasslands invasion, as also observed for the Gargano.

In the vegetation Prodromes of Spain (Rivas-Martinez *et al*., 2001) and Portugal (Costa *et al*., 2012), the association *Simethido mattiazi-Asphodeletum ovoidei* Bellot ex Izco & Amigo 2001 is included in the alliance *Carici piluliferae-Epilobion angustifolii* Tüxen ex von Rochow 1951, and the order *Atropetalia belladonnae* Vlieger 1937, *Epilobietea angustifolii* Tüxen & Preising ex von Rochow 1951. However, the association is recognised as an infra-forest edge community. These kinds of plant formation do not occur in Italy. Indeed, they only occur as dynamic aspects of recolonization of grasslands by woods. According to Lorda López (2010), in Ebro Valley, four taxa of the genus *Asphodelus* coexist: *A. ayardii* Jahand. & Maire, *A. cerasiferus* J. Gay, *A. fistulosus* L., and *A. serotinus* Wolley-Dod.

In south-eastern France, the vegetation dominated by

A. fistulosus was investigated in a very particular area, as that of La Crau plain, where the association *Asphodeletum fistulosi* R. Mol. & Tallon 1950 was described (Molinier & Tallon, 1950), with Loisel (1976) describing the association *Asphodelo fistulosi-Stipetum retortae* Loisel 1976. Both are included by these French authors in the alliance *Thero-Brachypodion*. More recently, the south-eastern plant *A. fistulosus* was changed to *A. ayardii*.

In Egypt, plant formations of *A. ramosus* have been found in the desert, where they colonize barley fields in western Mediterranean coastal areas (Zahran & Willis, 1992). In these areas, two associations occur: *Plantagineto-Asphodeletum microcarpae* Tadros & Atta 1958, and *Asphodelo microcarpi-Thymelaetum hirsutae* Ayyad 1976. The first of these occurs on thin and stony soils where the salinity is weak, and also in hilly calcareous areas (Tadros & Atta, 1958), while the second colonizes soil with a fine texture (Ayyad, 1976). Both of these communities are included in the alliance *Thymelaeion hirsutae*.

For Morocco, *A. microcarpus* and *Urginea maritima* are part of the forest series of cork oak, of the association *Quercetum rotundifolio-suberis* that was described for the Central Plateau (Chkhichekh *et al.*, 2015). The abundant presence of these two species in the reliefs of the forests, and in particular in the aspects of the degraded forest after repeated fires, demonstrates the role that they have in the formation of heliophilous edges that penetrate the open woods.

Conclusion

A new class for heliophilous edges has been described here, starting from phytosociological relevés mainly carried out on the Gargano promontory in the Mediterranean macrobioclimate, in the thermo-Mediterranean and meso-Mediterranean thermotypes. Other relevés were carried out in the Umbria-Marche Apennines, under temperate macrobioclimate conditions, even if this is the sub-Mediterranean variant.

The new class has a Mediterranean distribution range that covers the whole of the Mediterranean basin, from Europe to the Middle East and northern Africa. A new order is described, along with three new alliances that belong to the class. Further studies will allow more precise classification of this kind of vegetation in other biogeographic contexts that can for the moment only be speculated upon.

This study of these investigated dynamic processes relates mainly to the Mediterranean area, and in part also to Temperate areas, limited to the sub-Mediterranean variant.

Syntaxonomic scheme

CHARYBDIDO PANCRATII-ASPHODELETEA RAMOSI Biondi classis nova *hoc loco*
ASPHODELETALIA RAMOSI Biondi ordo novo *hoc loco*
Charybdido pancratii-Asphodelion ramosi all. nova *hoc loco*
Charybdido pancratii-Asphodeletum ramosi ass. nova *hoc loco*
typicum subass. nova *hoc loco*
hyparrhenietosum hirtae subass. nova *hoc loco*
variant with *Euphorbia myrsinites*
Alkanno tinctoriae-Asphodeletum ramosi ass. nova *hoc loco*
Thapsio garganicae-Asphodeletum ramosi Foggi *et al*. 2008
Asphodelo ramosi-Ferulion communis all. nova *hoc loco*
Asphodelo ramosi-Feruletum communis ass. nova *hoc loco*
Asphodelino luteae-Feruletum communis ass. nova *hoc loco*
Carlino siculae-Feruletum communis Gianguzzi, Ilardi & Raimondo 1993
Thapsio garganicae-Feruletum communis Brullo 1984
Asphodelion fistulosi all. nova *hoc loco*
Verbasco garganici-Asphodeletum fistulosi ass. nova *hoc loco*
Asphodelo ramosi-Ferulion glaucae all. nova *hoc loco*
Asphodelino luteae-Feruletum glaucae Casavecchia & Biondi ass. nova *hoc loco*

CISTO CRETICI-MICROMERIETEA JULIANE Oberdorfer ex Horvatic 1958
ARTEMISIO ALBAE-SATUREJETALIA MONTANAE (Allegrezza, Biondi, Formica & Ballelli 1997) Biondi & Allegrezza in Biondi, Allegrezza, Casavecchia, Galdenzi, Gasparri, Pesaresi, Vagge & Blasi 2014
Artemisio albae-Saturejion montanae Allegrezza, Biondi, Formica & Ballelli 1997
Cephalario leucanthae-Saturejetum montanae Allegrezza, Biondi, Formica & Ballelli 1997
feruletosum glaucae subass. nova *hoc loco*

Aknowledgements

The Authors wish to thank Daniele Bonsanto for his contribution in the vegetation survey.

References

Allegrezza M., Ballelli S., Ciucci V., Mentoni M. & Pesaresi S., 2014. The vegetation and the plant landscape of Monte Sassotetto (Sibillini Mountains, Central Apennines). Plant Sociology 51: 59-87.

Allegrezza M., Biondi E., Ballelli S., Tesei G. & Ottaviani C., 2015. The edge communities of *Asphodelus macrocarpus* subsp. *macrocarpus*: the different ecological aspects and a new case study in the central Apennines. Plant Sociology 52: 19-40.

Allegrezza M., Biondi E., Formica E. & Ballelli S., 1997. La vegetazione dei settori rupestri calcarei dell'Italia centrale. Fitosociologia 32: 91-120.

Anzalone B., Lattanzi E. & Leporatti M.L., 1992. Il gruppo di *Ferula communis* L. (*Umbelliferae*) in Italia: Ricerche sistematiche e corologiche. Archivio Botanico Italiano 67 (3/4): 221-236.

Ayyad M.A., 1976. Vegetation and environment of the Western Mediterranean coastal land of Egypt. IV: The habitat of non-saline depressions. J. Ecol. 64: 713-722.

Bacchetta G., Brullo S., D'emerico S., Pontecorvo C. & Salmeri C., 2012. *Charybdis glaucophylla* (*Asparagaceae*), a new species from Sardinia. Phytotaxa 69: 16-26.

Biondi E., 1985. Indagine fitosociologica sulle cenosi riferibili alla classe *Quercetea ilicis* presenti sul promontorio del Gargano (Adriatico meridionale). Not. Soc. Ital. di Fitosociol. 22: 59-75.

Biondi E., Allegrezza M., Casavecchia S., Galdenzi D., Gasparri R., Pesaresi S., Vagge I. & Blasi C., 2014a. New and validated syntaxa for the checklist of Italian vegetation. Plant Biosyst. 148: 318-332.

Biondi E., Allegrezza M., Casavecchia S., Galdenzi D., Gasparri R., Pesaresi S., Poldini L., Sburlino G., Vagge I. & Venanzoni R., 2015a. New syntaxonomic contribution to the Vegetation Prodrome of Italy. Plant Biosyst. 149: 1-14.

Biondi E., Allegrezza M., Casavecchia S., Galdenzi D., Gasparri R., Pesaresi S., Soriano, P., Tesei G. & Blasi C., 2015b. New insight on Mediterranean and sub-Mediterranean syntaxa included in the Vegetation Prodrome of Italy. Flora Mediterranea 25: 77-102.

Biondi E., Allegrezza M., Guitian J., 1988. Mantelli di vegetazione nel piano collinare dell'Appennino centrale. Doc. Phytosoc. 11: 479-490.

Biondi E. & Bagella S., 2005. Vegetazione e paesaggio vegetale dell'arcipelago di La Maddalena (Sardegna nord-orientale). Fitosociologia 42 (2) suppl.1: 3-99.

Biondi E., Blasi C., Allegrezza M., Anzellotti I., Azzella M.M., Carli E., Casavecchia S., Copiz R., Del Vico E., Facioni L., Galdenzi D., Gasparri R., Lasen C., Pesaresi S., Poldini L., Sburlino G., Taffetani F., Vagge I. & Zitti S., 2014b. Plant communities of Italy: The Vegetation Prodrome. Plant Biosyst. 148: 728-814.

Biondi E., Casavecchia S. & Biscotti N., 2007. Sull'interpretazione dell'habitat 2220 (Direttiva 92/43/CEE) "Dune con presenza di Euphorbia terracina": l'analisi nei SIC "Dune e Lago di Lesina-Foce del Fortore" e "Isola e Lago di Varano" (Gargano). Fitosociologia 44 (2) Suppl. 1: 263-270.

Biondi E., Casavecchia S. & Pesaresi S., 2012. Nitrophilous and ruderal species as indicators of climate change. Case study from the Italian Adriatic coast. Plant Biosystems 146 (1): 134-142.

Biondi E., Casavecchia S., Pesaresi S., Gangale C. & Uzunov D., 2014c. New syntaxa for the prodrome of Italian vegetation. Plant Biosyst. 148: 723-727.

Biondi E., Filigheddu R. & Farris E., 2001. Il Paesaggio vegetale della Nurra (Sardegna nord-occidentale). Fitosociologia 38 (2) Suppl. 1: 3-105.

Biondi E. & Mossa L., 1992. Studio fitosociologico del promontorio di Capo S. Elia e dei colli di Cagliari (Sardegna). Doc. Phytos. 14: 1-44.

Boscaiu M., Bacchetta G. & Güemes J., 2003. Morphological differentiation within the diploid cytotypes of *Urginea maritima s.l.* (*Hyacinthaceae*). Bocconea 16: 549-555.

Brullo C., Brullo S., Giusso del Galdo G., Guarrino R., Minissale P., Scuderi L., Siracusa G., Sciandrello S. & Spampinato G., 2010. The *Lygeo-Stipetea* class in Sicily. Ann. Bot. (Roma) 0: 57-84.

Brullo S., Guglielmo A., Pavone P. & Salmeri C., 2007. Indagine biosistematica su *Scilla s.l.* in Italia e generi affini (*Hyacinthaceae*). Inform. Bot. Ital. 39: 165-169.

Brullo S., Scelsi F. & Spampinato G., 2001. La Vegetazione dell'Aspromonte. Laruffa edit. 372 pp.

Brullo S. & Siracusa G., 1996. Studio fitosociologico dell'Isola di Linosa. Doc. Phytosoc. 16: 123-174.

Casavecchia S., Biscotti N., Pesaresi S. & Biondi E., 2015. The *Paliurus spina-christi* dominated vegetation in Europe. Biologia, Section Botany 70 (7): 879-892.

Chkhichekh A., El Aboudi A., Aafi A., Wahid N. & Benabid A., 2015. A contribution to the knowledge of the Moroccan forest ecosystems: association of *Quercetum rotundifolio-suberis* ass. nova in the Central Plateau of Morocco. Plant Sociology 52: 57-68.

Colasante M., 1996. Taxonomic note on some Italian Bearded Irises: *Iris relicta* Colas. nom. nov. and Iris bicapitata Colas. sp. nov. Flora Mediterranea 6: 213-217.

Cole T.C.H., Hilger H.H. & Selvi F., 2016. Filogenesi delle Angiosperme - Sistematica delle piante a fiore (Italian translation of: Angiosperm Phylogeny Poster Flowering Plant Systematics).

Conti F., Abbate G., Alessandrini A. & Blasi C., 2005. An Annotated Checklist of the Italian Vascular Flora. Palombi Editori, Roma.

Conti F., Alessandrini A., Bacchetta G., Banfi E., Barberis G., Bartolucci F., Bernardo L., Bonacquisti S., Bouvet D., Bovio M., Brusa G., Del Guacchio E., Foggi, B., Frattini S., Galasso G., Gallo L., Gangale C., Gottschlich G., Grunanger P. & Gubellini L., 2007. Integrazioni Alla Checklist Della Flora Vascolare Italiana., 10th ed.

Costa J.M., Aguiar C., Capelo J., Espírito Santo M.D., Honrado J., Pinto-Gomes C., Monteiro-Henriques T., Sequeira M. & Lousã M., 2012. Vascular plant communities in Portugal (Continental, Azores and Madeira). Global Geobotany 2: 1-180.

Cutini M., Caneva G., Cancellieri L., Ceschin S., Raggi F., Butera M. & Battisti A., 2009. Lineamenti Della Vegetazione. In: Giulia Caneva & Mauro Cutini (a cura di): Flora, vegetazione e tradizioni etnobotaniche di Maratea. pp: 73-138. Gangemi Editore.

Fanelli G., De Sanctis M., Gjeta E., Attorre F. & Mullaj A., 2015. The vegetation of the Buna river protected landscape (Albania). Hacquetia 15: 1-46.

Foggi B., Cartei L. & Pignotti L., 2008. La vegetazione dell'Isola di Pianosa (Arcipelago Toscano, Livorno). Braun-Blanquetia 43: 3-41.

Giacomini V., Fenaroli L. & Ferlan L., 1958. La Flora. Conosci l'Italia Vol. II., Touring Club Italiano. 275 pp.

Gianguzzi L., D'Amico O. & Caldarella A., 2007. Habitat e specie vegetali d'interesse prioritario nel SIC Rocche di Entella (Sicilia occidentale). Fitosociologia 44 (2) suppl.1: 201-205.

Gianguzzi L., Ilardi V. & Raimondo F.M., 1996. La vegetazione del Promontorio di Monte Pellegrino (Palermo). Quad. Bot. Ambientale Appl. 4 (1993): 79-137.

Gianguzzi L. & La Mantia A., 2008. Contributo alla conoscenza della vegetazione e del paesaggio vegetale della Riserva Naturale 'Monte Cofano' (Sicilia occidentale). Fitosociologia 45 (1) suppl.1: 3-55.

Horvatić S., 1934. Flora und vegetation der Nordadriatischen Insel Pag. Bullet. Intern. De l'Acad. Yugosl. 28. Zagreb.

Horvatić S., 1958a. Classification typologique de la végétation des Garrigues arbustives de foret de Pine dan les littoral Adriatique oriental. Acta Botanica Croatica XVIII: 7-98. Zagreb.

Horvatić S., 1958b. Geographisch-typologische Gliederung der Niederungs-Wiesen und Weiden Kroatiens. Angewandte Pflanzensoziologie, heft 15, Stolzenau/Weser.

Horvatić S., 1963. Vegetacijska karta Otoka Paga S Općim Pregledom vegetacijskih Jedinica Hrvatskog Primorja. (Carte des groupements végétaux de l'Ile Nord-Adritique de Pag avc aperçu général des unités Végétables du littoral Croate). Prirodoslovna Istraživanja. Knjiga 33. Acta Biologica IV: 1-188.

Loisel R., 1976. La végétation de l'étage méditerranéen dans le sud-est continental français. Thèse de doctorat d'État. Université d'Aix-Marseille III, Marseille.

Lorda López M., 2010. El complejo *Asphodelus fistulosus-A. ayardii* (*Asphodelaceae*) en el Valle medio del Ebro. Flora Montiberica 45: 21-41.

Lucarini D., Gigante D., Landucci F., Panfili E. & Venanzoni R., 2014. The anArchive taxonomic Checklist for Italian botanical data banking and vegetation analysis: Theoretical basis and advantages. Plant Biosystem, DOI:10.1080/11263504.2014.984010. http: // www.anarchive.it/(last accessed on october 2016).

Marcenò C., Falci A. & Pasta S., 2011. Su alcuni lembi di vegetazione pre-forestale e forestale della Provincia di Enna (Sicilia centrale). Naturalista sicil. Serie. IV: 295-312.

Martinoli G., 1949. Ricerche citotassonomiche sui generi *Urginea* e *Scilla* della flora sarda. Caryologia 1: 329-357.

Molinier R. & Tallon G., 1950. La végétation de la Crau (Basse-Provence). Revue générale de botanique 56: 1-111.

Oksanen J., Blanchet F.G., Kindt R., Legendre P., Minchin P.R., O'Hara R.B., Simpson G.L., Solymos P., Stevens M.H.H. & Wagner H., 2013. Vegan: Community Ecology Package.

Pfosser M.F. & Speta F., 2004. From *Scilla* to *Charybdis* is our voyage safer now? Plant Systematics and Evolution 246: 245-263.

Pignatti S., 1982. Flora d'Italia. Edagricole, Bologna.

Pinto-Gomes C., Paiva-Ferreira R. & Meireles C., 2007. New Proposals on Portuguese Vegetation. Lazaroa 28: 67-77.

R Core Team, 2015. R: A Language and Environment for Statistical Computing.

Rivas-Martínez S., Fernandez-Gonzalez F., Loidi J., Lousã M. & Penas A., 2001. Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. Itinera Geobotanica 14: 5-341.

Speta F., 1980. Karyosystematik, Kultur und Verwendung der Meerzwiebel (*Urginea* Steinh., *Liliaceae s.l.*. Katalog Oberösterr Landesmuseum 105: 193-238.

Tadros T.M. & Atta B.A.M., 1958. The plant communities of barley fields and uncultivated desert areas of Mareotis (Egypt). Vegetation 8 (3): 161-175.

Zahran M.A. & Willis A.J., 1992. The Vegetation of Egypt. Springer Netherlands. 437 pp.

Supplementary material associated with this article (Appendix I "Other syntaxa quoted in the text", Appendix II "Sporadic species", and Appendix III "Relevès dates and localities") is embedded in the pdf of this article. The online version of *Plant Sociology* is hosted at the journal's website www.scienzadellavegetazione.it/sisv/rivista/rivista_elenco.jsp..

Appendix I: Other syntaxa quoted in the text

Trifolio medii-Geranietea sanguinei Müller 1962; *Rhamno catharticae-Prunetea spinosae* Rivas Goday & Borja ex Tüxen 1962; *Festuco valesiacae-Brometea erecti* Br.-Bl. & Tüxen ex Br.-Bl. 1949; *Molinio-Arrhenatheretea* Tüxen 1937; *Nardetea strictae* Rivas Goday in Rivas Goday & Rivas-Martínez 1963; *Asphodeletalia macrocarpi* Biondi & Allegrezza 2014; *Brachypodio ramosi-Dactyletalia hispanicae* Biondi, Filigheddu & Farris 2001; *Origanetalia vulgaris* Müller 1962; *Junipero oxycedri-Cotinetum coggygriae* Biondi, Allegrezza & Guitian 1988; *Thero-Brachypodion ramosi* Br.-Bl. 1925 *nom. mut. propos.* Rivas-Martinez *et al.* 2002; *Hyparrhenetalia hirtae* Rivas-Martínez 1978 Brullo stat. nov.; *Ferulo communis-Hyparrhenietum hirtae* Brullo & Siracusa 1996; *Thapsietum pelagicae* C. Brullo & Brullo in Brullo *et al.* 2010; *Onopordion illyrici* Oberdorfer 1954; *Asphodelo microcarpi-Brachypodietum ramosi* Biondi & Mossa 1992; *Bromo-Chrysopogonetum grylli* subass. *asphodeletosum microcarpi* Horvatić 1934; *Asphodelo microcarpi-Chrysopogonetum grylli* Horvatić 1958; *Brachypodio-Chrysopogonetea* Horvatić (1956) 1958; *Scorzonero-Chrysopogonetalia* Horvatić & Horvat in Horvatić 1963; *Chrysopogono-Saturejion* Horvat & Horvatić in Horvatić 1934; *Simethido mattiazi-Asphodeletum ovoidei* Bellot ex Izco & Amigo 2001; *Carici piluliferae-Epilobion angustifolii* Tüxen ex von Rochow 1951; *Atropetalia belladonae* Vlieger 1937; *Epilobietea angustifolii* Tüxen & Preising ex von Rochow 1951; *Asphodeletum fistulosi* R. Mol. & Tallon 1950; *Asphodelo fistulosi-Stipetum retortae* Loisel 1976; *Plantagineto-Asphodeletum microcarpae* Tadros & Atta 1958; *Asphodelo microcarpi-Thymelaetum hirsutae* Ayyad 1976; *Thymelaeion hirsutae* Eig 1946; *Quercetum rotundifolio-suberis* Chkhichekh, El Aboudi, Aafi, Wahid & Benabid 2015; *Cytision sessilifolii* Biondi in Biondi, Allegrezza & Guitian 1988; *Verbasco garganici-Euphorbietum terracinae* Biondi, Casavecchia & Biscotti 2007.

Appendix II: Sporadic species

Tab. 1 - Rel. 1: Galactites tomentosa Moench +, Echium plantagineum L. 1.2, Leontodon cichoraceus (Ten.) Sanguin. 2.2, Clematis flammula L. 1.2, Cynodon dactylon (L.) Pers. 2.2, Eryngium campestre L. +. Rel. 2: Galactites tomentosa Moench +. Rel. 3: Galactites tomentosa Moench +.2, Crepis vesicaria L. 1.2, Sonchus asper (L.) Hill +, Arum italicum Miller +, Salvia multifida S. et S. 1.2, Rubus ulmifolius Schott +.2, Buglossoides arvensis (L.) Johnston +. Rel. 4: Bellis sylvestris Cyr. +.2, Arum italicum Miller +, Salvia multifida S. et S. 1.2, Carex flacca Schreber 1.2, Scolymus hispanicus L. 1.2. Rel. 5: Hypericum montanum L. (gruppo) 1.2, Tamus communis L. +, Anemone ranunculoides L. 1.2, Prasium majus L. +.2. Rel. 6: Onopordum illyricum L. +, Plantago major subsp. pleiosperma Pilg. 1.2, Hypericum perforatum L. +. Rel. 7: Euphorbia spinosa L. 2.3, Narcissus tazetta L. +, Pulicaria dysenterica (L.) Bernh. 1.1. Rel. 8: Bellis sylvestris Cyr. +, Cyclamen hederifolium Aiton 1.2, Hypericum montanum L. (gruppo) 1.1, Rubus ulmifolius Schott +, Selaginella denticulata (L.) Link +.2, Cirsium vulgare (Savi) Ten. +, Asphodeline liburnica (Scop.) Rchb. 1.2, Anchusa undulata subsp. hybrida (Ten.) Bég. 1.1, Arum lucanum Cavara et Grande +.2, Cistus salvifolius L. 2.3. Rel. 9: Tordylium apulum L. 1.2, Vicia sativa L. ssp. angustifolia (Grufb.) Gaudin +, Mercurialis annua L. +, Myosotis arvensis (L.) Hill +.2, Lagurus ovatus L. +, Cyclamen hederifolium Aiton +.2. Rel. 10: Vicia sativa L. ssp. angustifolia (Grufb.) Gaudin 1.1, Pyrus amygdaliformis Vill. +, Scabiosa maritima L. 1.2, Lagurus ovatus L. +, Ophrys tenthredinifera subsp. neglecta (Parl.) E.G.Camus +, Ophrys sphegodes subsp. passionis (Sennen) Sanz & Nuet 1.2, Muscari neglectum Guss. +.2, Helichrysum italicum (Roth) Don +, Barlia robertiana (Loisel.) Greuter +. Rel. 11: Vicia sativa L. ssp. angustifolia (Grufb.) Gaudin 1.2, Bellis sylvestris Cyr. +, Pyrus amygdaliformis Vill. 1.2, Scabiosa maritima L. 1.2, Ophrys tenthredinifera subsp. neglecta (Parl.) E.G.Camus +, Convolvulus althaeoides L. +, Plantago major subsp. pleiosperma Pilg. 1.2, Hypericum perforatum L. +, Ophrys sphegodes subsp. passionis (Sennen) Sanz & Nuet 1.1, Ophrys lutea Cav. +, Scandix pecten-veneris L. +, Anagyris foetida L. +, Orchis morio L. +, Convolvulus arvensis L. +. Rel. 12: Tordylium apulum L. +, Pyrus amygdaliformis Vill. 1.2, Scabiosa maritima L. 1.2, Mercurialis annua L. +, Myosotis arvensis (L.) Hill +, Foeniculum vulgare Miller ssp. piperitum (Ucria) Coutinho +, Convolvulus althaeoides L. 1.2, Sinapis pubescens L. 1.2, Stachys recta L. +, Ceterach officinarum DC. +, Crataegus monogyna Jacq. 3.3, Lonicera etrusca Santi +.2, Pistacia lentiscus L. +. Rel. 13: Tordylium apulum L. +, Foeniculum vulgare Miller ssp. piperitum (Ucria) Coutinho 1.1, Sinapis pubescens L. 1.2, Reseda alba L. +, Pistacia terebinthus L. +, Parietaria judaica L. +, Pimpinella tragium Vill. 1.1, Lobularia maritima (L.) Desv. +. Rel. 14: Crepis vesicaria L. 1.1, Sonchus asper (L.) Hill +, Onopordum illyricum L. +, Ophrys lutea Cav. +.2, Lotus ornithopodioides L. +, Trifolium nigrescens Viv. +.2, Medicago lupulina L. +.2, Iris pseudopumila Tineo +.2, Convolvulus elegantissimus Miller 1.2, Ophrys bombyliflora Link +, Aceras anthropophorum (L.) R. Br. +.2, Cytisus decumbens (Durande) Spach 1.1.
Tab. 2 - Rel. 1: Geranium dissectum L. +.2, Micromeria graeca (L.) Bentham 1.2, Euphorbia helioscopia L. +, Hypericum perforatum L. +, Avena barbata Potter +, Lotus corniculatus L. +. Rel. 2: Centaurium erythraea Rafn +, Pinus halepensis Miller +, Ophrys passionis Sennen +, Galium aparine L. +, Bromus rigidus Roth +. Rel. 3: Myrtus communis L. 1.1, Quercus ilex L. (plantula) +,

Hypochoeris radicata L. +.2, Pallenis spinosa (L.) Cass. +, Sherardia arvensis L. +.2, Oryzopsis miliacea (L.) Asch. et Schweinf. 2.2, Carex flacca Schreber +, Cistus salvifolius L. 3.4, Allium subhirsutum L. +, Lotus ornithopodioides L. +.2, Dittrichia viscosa (L.) Greuter +, Ononis pusilla L. +, Cistus creticus subsp. eriocephalus (Viv.) Greuter & Burdet +.

Tab. 4 - Rel. 1: Calamintha nepeta (L.) Savi +, Osyris alba L. 1.2. Rel. 2: Osyris alba L. 1.1, Carlina vulgaris L. 1.1, Sonchus asper (L.) Hill +.2, Ophrys passionis Sennen +, Ophrys tenthredinifera Willd. +, Calendula arvensis L. 1.1. Rel. 3: Galium corrudifolium Vill. 1.2, Salvia argentea L. +.2, Lagurus ovatus L. +, Pyrus amygdaliformis Vill. 1.2. Rel. 4: Crepis sancta (L.) Babc. +, Galium corrudifolium Vill. +, Tragopogon porrifolius L. +, Crepis rubra L. +, Pallenis spinosa (L.) Cass. +, Serapias vomeracea (Burm.) Briq. +, Sinapis pubescens L. +, Bromus molliformis Lloyd 1.2. Rel. 5: Avena barbata Potter +, Crepis sancta (L.) Babc. 1.1, Anchusa azurea Mill. 1.2, Aethionema saxatile (L.) R. Br. +.2, Euphorbia spinosa L. 1.2, Crepis rubra L. 2.2, Hypochoeris achyrophorus L. 1.1, Rhamnus saxatilis Jacq. ssp. infectorius (L.) P. Fourn. 2.2, Verbascum pulverulentum Vill. +, Marrubium incanum Desr. +, Salvia multifida S. et S. +.2, Crepis vesicaria L. +. Rel. 6: Avena barbata Potter +, Calamintha nepeta (L.) Savi +, Tragopogon porrifolius L. +.2, Anthyllis vulneraria L. +, Sideritis italica (Mill.) Greuter & Burdet +, Pallenis spinosa (L.) Cass. +, Hypochoeris achyrophorus L. 1.2, Crepis vesicaria L. ssp. taraxacifolia (Thuill.) Thell. 2.2, Lagurus ovatus L. +, Foeniculum vulgare Miller ssp. piperitum (Ucria) Coutinho +, Arabis collina Ten. +, Ajuga chamaepitys (L.) Schreber +, Briza minor L. +, Cynosurus echinatus L. +. Rel. 7: Anchusa azurea Mill. +.2, Salvia argentea L. +, Aethionema saxatile (L.) R. Br. +, Euphorbia spinosa L. 1.2, Anthyllis vulneraria L. 1.1, Sideritis italica (Mill.) Greuter & Burdet +, Crepis vesicaria L. ssp. taraxacifolia (Thuill.) Thell. 1.2, Isatis tinctoria L. +, Smyrnium rotundifolium Miller +, Biscutella laevigata L. +, Ranunculus millefoliatus Vahl 1.1, Teucrium chamaedrys L. 1.2, Hypochoeris radicata L. +, Orchis morio L. +, Satureja cuneifolia Ten. +, Galium aparine L. +.

Tab. 6 - Rel. 1: Rosa canina L. sensu Bouleng. 1.2, Robinia pseudoacacia L. +, Prunus avium L. 1.2, Clematis vitalba L. 1.2, Acer campestre L. +, Alliaria petiolata (Bieb.) Cavara et Grande +, Calamintha nepeta (L.) Savi 1.2, Veronica hederifolia L. +, Picris echioides L. +. Rel. 2: Galium lucidum All. +, Satureja montana L. 1.2, Astragalus monspessulanus L. +, Prunus spinosa L. +.2, Urospermum picroides (L.) Schmidt +. Re. 3: Phleum ambiguum Ten. +.2, Foeniculum vulgare Miller +.2, Teucrium chamaedrys L. +.2, Geranium purpureum Vill. +. Rel. 4: Helianthemum nummularium (L.) Miller +.2, Carex humilis Leyser +.2, Buxus sempervirens L. 1.2, Carduus pycnocephalus L. 1.2, Orchis sambucina L. +, Carex flacca Schreber +, Erodium malacoides (L.) L'Hér. +, Crepis sancta (L.) Babc. +. Rel. 5: Erysimum pseudorhaeticum Polatschek +, Allium sphaerocephalon L. +, Sedum album L. +.2, Pistacia terebinthus L. 2.2, Silene italica (L.) Pers. 2.2, Quercus ilex L. +, Cyclamen repandum S. et S. 1.2, Alyssoides utriculata (L.) Medicus 1.2, Arabis turrita L. 2.2, Arabis collina Ten. +, Ceterach officinarum DC. +, Bromus gussonei Parl. 1.2.

Tab. 7 - Rel. 1: Erysimum pseudorhaeticum Polatschek 1.1, Orchis tridentata Scop. +, Rhus coriaria L. +, Sherardia arvensis L. +, Hieracium pilosella L. +. Rel. 2: Lactuca viminea (L.) Presl 1.2. Rel. 3: Sedum sexangulare L. +.2, Centaurea rupestris L. +.2, Allium lusitanicum Lam. 1.2, Bromus erectus Hudson 1.2, Sanguisorba minor Scop. 1.2, Spartium junceum L. 1.2, Orchis sambucina L. +.2, Linum bienne Miller 1.2.

Appendix III: Relevès dates and localities

Tab. 1 – Rel. 1: 01.04.2015, Torre Mileto (FG), X=553246, Y=4641524; Rel. 2: 01.04.2015, Torre Mileto (FG), X=553395, Y=4641480; Rel. 3: 01.04.2015, Cagnano Varano (FG), X=556006, Y=4638922; Rel. 4: 01.04.2015, Cagnano Varano (FG), X=562170, Y=4632191; Rel. 5: 01.04.2015, Torre Mileto (FG), X=553376, Y=4641619; Rel. 6: 01.04.2015, Cagnano Varano-San Giovanni Rotondo route (FG), X=565149, Y=4619114; Rel. 7: 01.04.2015, Cagnano Varano (FG), X=565117, Y=4619063; Rel. 8: 01.04.2015, Cagnano Varano (FG), X=566677, Y=4628561; Rel. 9: 01.04.2015, Cagnano Varano (FG), X=564260, Y=4632032; Rel. 10: 01.04.2015, Sannicandro (FG), X=565232, Y=4631494; Rel. 11: 01.04.2015, near Lake of Varano (FG), X=565165, Y=4631489; Rel. 12: 01.04.2015, Cagnano Varano (FG), X=566676, Y=4628568; Rel. 13: 01.04.2015, Cagnano Varano (FG), X=566721, Y=4628515; Rel. 14: 24.04.2015, Cagnano Varano (FG), X=570116, Y=4630043.

Tab. 2 – Rel. 1: 24.04.2015, Cagnano Varano (FG), X=562361, Y=4640492; Rel. 2: 24.04.2015, Cagnano Varano (FG), X=562363, Y=4640495; Rel. 3: 24.04.2015, Cagnano Varano (FG), X=559285, Y=4640240.

Tab. 3 – Rel. 1: 01.04.2015, Cagnano Varano (FG), X=538103, Y=4633552; Rel. 2: 01.04.2015, Cagnano Varano (FG), X=538083, Y=4633584.

Tab. 4 – Rel. 1: 01.04.2015, San Giovanni Rotondo (FG), X=560732, Y=4615576; Rel. 2: 01.04.2015, San Giovanni Rotondo (FG), X=560795, Y=4615523; Rel. 3: 01.04.2015, San Giovanni Rotondo (FG), X=560698, Y=4615563; Rel. 4: 25.04.2016, San Giovanni Rotondo (FG), X=563618, Y=4618114; Rel. 5: 25.04.2016, Valle carbonara (FG), X=570201, Y=4616913; Rel. 6: 25.04.2016, crossroads between Monte Sant'Angelo and San Giovanni Rotondo, X=571574, Y=4617442; Rel. 7: 25.04.2016, X=571652, Y=4617453.

Tab. 5 – Rels. 1-2: 24.04.2015, Lago di Varano (FG),

X=558346, Y=4640132.
Tab. 6 – Rel. 1: May 2008, Bistocco locality (Caldarola, MC), X=310148, Y=4809958; Rel. 2: 14.04.2009, Passo della Scheggia (MC), X=350427, Y=4777718; Rel. 3: 14.04.2009, Passo della Scheggia (MC), X=310163, Y=4809936; Rel. 4: 14.04.2009, Passo della Scheggia (MC), X=311427, Y=4808380; Rel. 5: 14.04.2009, Pioraco (MC), X=337272, Y=4782400.

Tab. 7 – Rel. 1: 24.04.2009, Bistocco locality (Caldarola, MC), X=350789, Y=4777842; Rel. 2: 24.04.2009, Bistocco locality (Caldarola, MC), X=350748, Y=4778014; Rel. 3: 14.04.2009, Passo della scheggia (MC), X=310108, Y=4809982.

Reference system: UTM (WGS84) Zone 33 N