Hacquetia DOI: 10.2478/hacq-2022-0020 sciendo

A new *Asphodelus ramosus*-dominated association from the Murge Plateau (SE Italy)

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Key words: Alta Murgia, dry-grasslands, Mediterranean vegetation, phytosociology, *Scorzoneretalia villosae*, syntaxonomy.

Ključne besede: Alta Murgia, suha travišča, sredozemska vegetacija, fitosociologija, *Scorzoneretalia villosae*, sintaksonomija.

Abstract

The plant communities dominated by *Asphodelus ramosus* are quite common in the Mediterranean Basin, especially in the most degraded vegetation stages caused by grazing and fires. The aim of this paper is to provide a phytosociological description of the *Asphodelus ramosus*-dominated plant community of the Murge Plateau, in southeastern Italy, through 28 phytosociological relevés. Cluster analysis (flexible Beta method) and ordination (non-metric multidimentional scaling) were used to compare this plant community with other dry grassland associations in the same area and with other *Asphodelus ramosus*-dominated plant communities from Italy and western Balkans. The results allowed the description of a new association for the Murge Plateau: the *Gelasio columnae-Asphodeletum ramosi*. The new association has been tentatively classified in the alliance *Hippocrepido glaucae-Stipion austroitalicae* (*Scorzoneretalia villosae* order), because of the presence of several species typical of this alliance, although it is intermediate between this alliance and the more thermophilous vegetation of the *Lygeo sparti-Stipetea tenacissimae* class.

Izvleček

Rastlinske združbe s prevladujočo vrsto *Asphodelus ramosus* so v Sredozemlju precej pogoste, še posebej na najbolj degradiranih rastiščih, ki so posledica požarov in paše. Cilj tega članka je fitocenološki opis združbe s prevladujočo vrsto *Asphodelus ramosus* s platoja Murge v jugovzhodni Italiji na osnovi 28 fitocenoloških popisov. Za primerjavo rastlinskih združb z drugimi asociacijami suhih travišč z istega območja in drugimi združbami z vrsto *Asphodelus ramosus* iz Italije in Zahodnega Balkana, smo uporabili klastrsko analizo (metoda Beta flexible) in ordinacijo (nemetrično večrazsežnostno lestvičenje). Rezultati so nam omogočili opis nove asociacije na platoju Murge: *Gelasio columnae-Asphodeletum ramosi*. Novo asociacijo smo začasno uvrstili v zvezo *Hippocrepido glaucae-Stipion austroitalicae* (red *Scorzoneretalia villosae*) zaradi prisotnosti številnih značilnih vrst te zveze, čeprav je njen položaj med imenovano zvezo in bolj termofilno vegetacijo razreda *Lygeo sparti-Stipetea tenacissimae*.

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Received: 13. 1. 2023
Accepted: 13. 3. 2023

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Introduction

Grassland ecosystems are of great importance for biodiversity conservation (e.g. Wilson et al., 2012; Biurrum et al., 2019). The Habitats Directive (Council Directive 92/43/EEC), which aims to promote the maintenance of European biodiversity, lists many grassland types among the natural habitats involved in the formation of the European ecological network of special areas of conservation (see European Commission, 2013).

The Murge Plateau, in southeastern Italy, is characterized by large expanses of Mediterranean dry grasslands, already classified in the following three habitat types: "Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (*important orchid sites)" (code: 6210), "Pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*" (code 6220), and "Eastern sub-mediterranean dry grasslands" (code 62A0). A herbaceous vegetation dominated by *Asphodelus ramosus* inhabits the same area, but there are very few data on this vegetation type; consequently, the floristic relationships with the other grassland associations already described for the area are also poorly known.

Asphodelus ramosus L. is a steno-Mediterranean species occurring in all countries bordering the Mediterranean Basin (Pignatti, 1982; Euro+Med, 2022). It is found in many vegetation types (e.g. scattered matorral) but is most abundant in the degraded stages of the regression series of Mediterranean ecosystems subjected to overgrazing and recurrent fires (Giacomini et al., 1958; Le Houerou et al., 1981; Pantis & Margaris, 1988; Noy-Meir, 1990; Breckle, 2002). Indeed, *Asphodelus ramosus* is unpalatable for most domestic animals and is fostered by fires due to its ecological features and potential disruption of antagonistic interactions (Camarda et al., 2016; García et al., 2016).

From a phytosociological standpoint, *Asphodelus ramosus* is currently considered a species belonging to the classes *Ononido-Rosmarinetea* and *Lygeo sparti-Stipetea tenacissimae* (Brullo et al., 2010, 2020; FloraVeg.EU, 2022). On the other hand, some authors proposed a new class, the *Charybdido pancratii-Asphodeletea ramosi*, to represent the plant communities of "perennial herbaceous macrophytes" (Biondi et al., 2016), also including those dominated by *Asphodelus ramosus*.

In the Western Balkans, some *Asphodelus ramosus*-dominated plant communities have traditionally been arranged within the order *Scorzoneretalia villosae* [syn. *Scorzonero villosae-Chrysopogonetalia grylli*], currently framed in the class *Festuco-Brometea* (Horvatić, 1963; Šegulja, 1970; Royer, 1991; Stanišić-Vujačić et al., 2022 and references therein). This order is also present in southern Italy with the endemic alliance *Hippocrepido glaucae-Stipion austroitalicae*, particularly widespread along the Murge Plateau, in central Apulia (Figure 1, Forte et al., 2005). *Asphodelus ramosus* is quite common in this area and has often been recorded in various grassland associations of this alliance, although always in a subordinate position to other species, such as *Stipa austroitalica* (Forte et al., 2005; Biondi & Guerra, 2008; Terzi et al., 2010). The latter is by far one of the most important species in the area, being listed as a priority species under the Habitats Directive. However, in some areas, possibly in heavily grazed ones, grasslands dominated by *Stipa austroitalica* give way to another physiognomic type dominated by *Asphodelus ramosus*.

On the basis of the above, this paper aims to: 1) provide new phytosociological data of the *Asphodelus ramosus*-dominated plant community of the Murge Plateau, 2) assess the ecological and floristic differences of this plant community compared to the dry grassland associations already described for the area, and 3) determine its syntaxonomic framework by comparing it with other *Asphodelus ramosus*-dominated plant communities from Italy and the Western Balkans.

Methods

Study Area

The Murge Plateau stretches between central Apulia and eastern Basilicata, SE Italy. The northwestern area of the Murge, known as "Alta Murgia", is part of the Natura2000 network, and includes the "Alta Murgia National Park", and a Special Area of Conservation/ Special Protection Areas ("Murgia Alta").

The portion that extends into the Basilicata region is usually referred to as "Murgia Materana" whereas, to the southwest, the Murge slopes down towards the Ionian Sea along a semi-circular area (Ionian Arc) furrowed by deep karst canyons, and is usually referred to as "Murgia Tarantina".

Large expanses of dry rocky grasslands on limestone substrate, often outcropping, characterize the Murge landscape. Those grasslands are traditionally used as extensive pastures mainly for sheep and goats. Several dry grassland associations have been described in the area (Table S1): *Acino suaveolentis-Stipetum austroitalicae* (AcS, Forte et al., 2005, Alta Murgia), *Cytiso spinescentis-Stipetum austroitalicae* (CyS, Forte et al., 2005, Murgia Materana), *Irido pseudopumilae-Scorzoneretum columnae* (IrS, Terzi et al., 2010, between Alta Murgia and Murgia Tarantina), *Convolvulo elegantissimi-Stipetum austroitalicae* (CoS), *Centaureo apulae-Andropogonetum distachyi* (CeA) and *Stipo austroitalicae-Hyparrhenietum hirtae* (StH, Biondi & Guerra, 2008, Murgia Tarantina).

According to the bioclimatic classification system of Rivas-Martínez et al. (2011), the macrobioclimate of the area is Mediterranean, the bioclimate is pluviosesonal-oceanic with thermotypes ranging from lower Meso-Mediterranean to lower supra-Mediterranean and ombrotypes ranging from upper dry to lower subhumid (Pesaresi et al., 2014).

Data analysis

The new phytosociological data consist of 28 phytosociological relevés taken according to the Braun-Blanquet approach (Westhoff & van der Maarel, 1980) in dry herbaceous vegetation where *Asphodelus ramosus* was dominant (i.e. the species with the highest cover). The relevés were sampled in areas clearly subjected to sheep-goat grazing (also observed in the field during sampling), at an altitude of 320 to 665 m a.s.l., in the northwestern part of the Murge Plateau. Plot sizes ranged from 25 to 50 m^2 with the exception of one relevé of 70 m^2 (Table 1 and Table S5). The main physical and biological characteristics of the phytocoenoses (e.g. slope, exposure, vegetation cover) were recorded for each relevé, along with the complete list of vascular plants and their cover-abundance values estimated using the traditional Braun-Blanquet scale (Braun-Blanquet, 1932).

The new relevés were analysed together with 82 other, taken from the scientific literature and belonging to the dry grassland associations already described for the Murge hills (Table S1). The taxa recorded only at the genus level were removed from the data set, as well as bryophytes and lichens that were recorded inconsistently (see also Guarino et al., 2022). Thus, the whole data set formed a matrix of 110 relevés (28 + 82) sharing 376 taxa.

The taxon scores originally recorded according to the Braun-Blanquet scale, were replaced by the midpoints of the relevant percentage cover intervals, or their estimates (Lepš & Hadincová, 1992: r = 0.1; + = 0.5; 1 = 3; 2 = 15; 3 = 37.5; 4 = 62.5; 5 = 87.5). In order to reduce the influence of dominant taxa, the taxon scores were square root transformed before cluster analysis and ordination (see also Tichy et al., 2020). The data matrix was subjected to hierarchical agglomerative Q-mode clustering using the Flexible Beta method, setting $\beta = -0.25$, on a Bray-Curtis dissimilarity matrix. The dendrogram was cut to such a level as to obtain clearly phytosociological interpretable clusters.

Since the new relevés were taken in phytocoenoses selected on the basis of a dominance criterion (i.e. *Asphodelus ramosus* dominant), a second clustering was performed after transforming the data to presence/absence form in order to assess the importance of the specific composition of the main clusters, by seeking common clusters between the two dendrograms (based on quantitative and presence/absence data respectively).

Non-metric multidimensional scaling ordination (NMS), using the Bray–Curtis dissimilarity index, was used to visualize the floristic relationships among the relevés and the main clusters. Cluster analysis and NMS were performed in PC-ORD 6.22; NMS through the "slow and thorough" option of the autopilot mode, which implies 6 starting axes, a maximum of 500 iterations with 250 real runs and 250 randomized runs, and an instability criterion of 0.0000001 (McCune & Mefford, 2011). The ordination diagram was ecologically interpreted by passively projecting the Ellenberg Ecological Indicator Values (EIVs) and life-forms spectra, both weighted by taxa cover values, into the ordination space, with a cut-off level at $r^2 = 0.3$.

The Kruskal-Wallis test was used to find statistically significant differences in EIVs and life-forms among the main clusters of relevés. Subsequent non-parametric pairwise comparisons were performed with correction for multiple comparisons according to Siegel & Castellan (1988), by using the R software (R Core Team, 2022) through the packages FSA 0.9.3 (Ogle et al., 2022) and pgirmess 2.0.0 (Giraudoux, 2022).

The Indicator Species Analysis (ISA) according to Dufrêne & Legendre (1997) was used to identify the Indicator Species (IndSp) associated with main clusters of relevés and their combinations in larger groups (see De Caceres et al., 2010). The Indicator Values (IndVal) were calculated for all taxa occurring in at least three relevés. The statistical significance of the relationship between a taxon and the group for which its IndVal yielded the highest value, was tested by a Monte Carlo test with 10000 permutations. The ISA was run in R software (R Core Team, 2022) through the package indicspecies 1.7.12 (De Caceres & Legendre, 2009)

In order to visualize the floristic relationships between the *Asphodelus ramosus*-dominated plant community from the Murgia Plateau and other *Asphodelus ramosus*-dominated plant communities/associations from Italy and western Balkans (Figure 1; Table S2), a NMS was run on a second data matrix, relevés × taxa [104 × 416]. The NMS was performed through the "slow and thorough" option of the PC-ORD autopilot mode, as described above. Given the importance of chorological information for the definition of high rank syntaxa (Pignatti et al., 1995), chorological spectra based on presence/absence data of each relevé were calculated and projected in the ordination diagram as joint plots, with a cut-off level at $r^2 = 0.3$.

Chorotypes, EIVs and life-forms were retrieved from Pignatti et al. (2005). Figure 1 was carried out by using R software (R Core Team, 2022), and the packages ggmap (Kahle & Wickham, 2013), sf (Pebesma, 2018), and rnaturalearth (South, 2017).

Taxonomic nomenclature follows the online flora Euro+Med (2022), with the exception of *Koeleria splendens*. Different taxonomic interpretations of the variability and distribution areas of *Koeleria splendens* and related species (e.g. *Koeleria lobata*, *K. subcaudata*) have

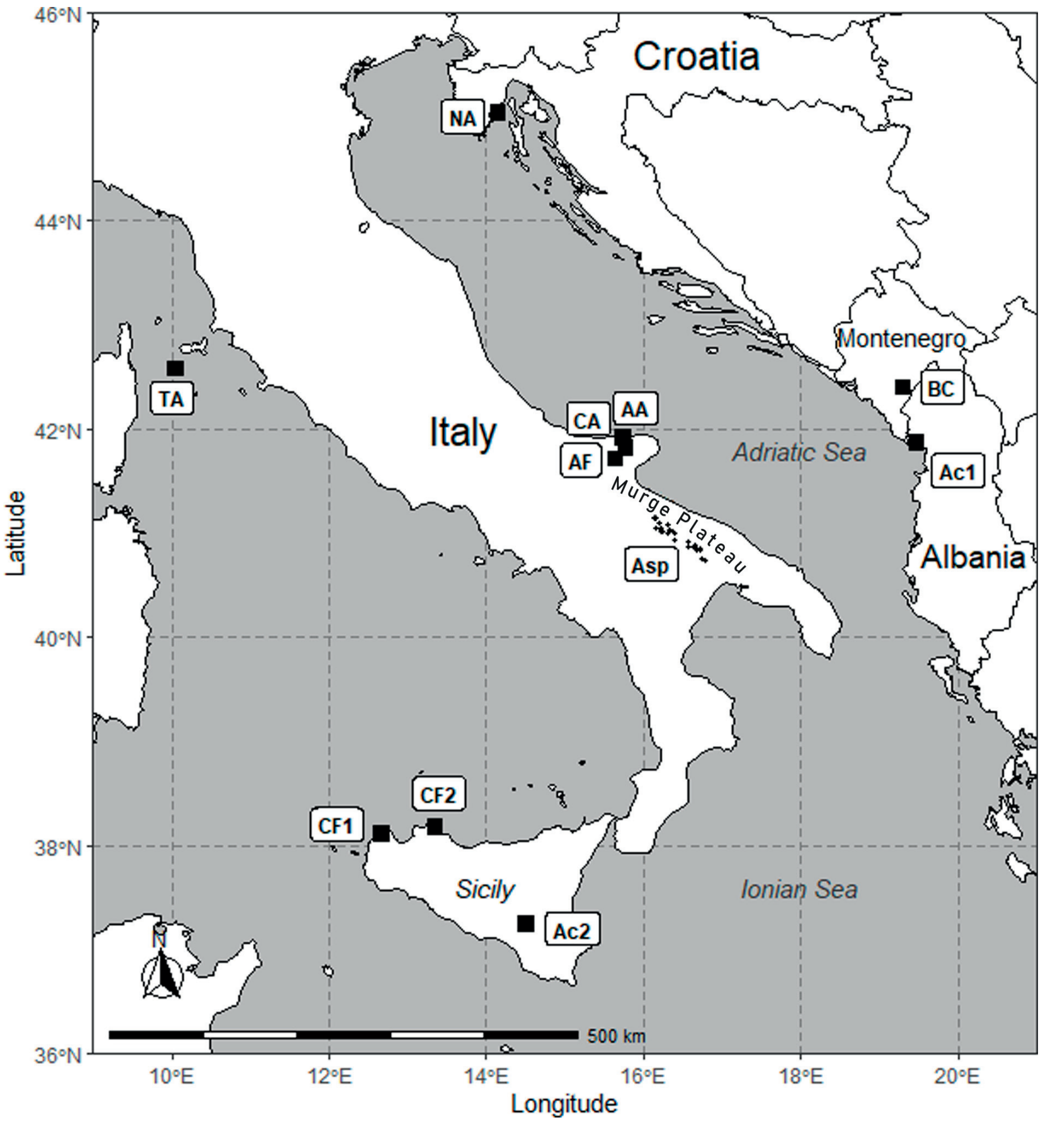

Figure 1: Study area. *Asphodelus ramosus*-dominated associations and plant communities from Italy and Western Balkans (see also Table S2): AA = *Alkanno tinctoriae-Asphodeletum ramosi*, from Gargano (IT); Ac1 = *Asphodelus ramosus* community, from the Buna River area (AL); Ac2 = *Asphodelus ramosus* community from Caltagirone, Sicily (IT); AF = *Asphodelino luteae-Feruletum communis*, from Gargano (IT); Asp = *Gelasio columnae-Asphodeletum ramosi,* the new association from the Murge Plateau (IT); BC = *Bromo erecti-Chrysopogonetum grylli*, from Ćemovsko polje, near Podgorica, Montenegro (ME); CA = *Charybido pancratii-Asphodeletum ramosi* from Gargano (IT); CF = *Carlino siculae-Feruletum communis* from Trapani (CF1) and Palermo (CF2) (IT); NA = *Narcisso tazettae-Asphodeletum microcarpi*, from Istria (HR); TA = *Thapsio garganicae-Asphodeletum ramosii*, from the island of Pianosa, Tuscany (IT).

Slika 1: Preučevano območje. Asociacije in združbe s prevladujočo vrsto *Asphodelus ramosus* v Italiji in na Zahodnem Balkanu (glej tudi Tabelo S2): AA = *Alkanno tinctoriae-Asphodeletum ramosi* iz Gargana (IT); Ac1 = združba z *Asphodelus ramosus* z območja ob reki Bojani (AL); Ac2 = združba z *Asphodelus ramosus* z območja Caltagirone, Sicilija (IT); AF = *Asphodelino luteae-Feruletum communis* iz Gargana (IT); Asp = *Gelasio columnae--Asphodeletum ramosi,* nova asociacija s platoja Murge (IT); BC = *Bromo erecti-Chrysopogonetum grylli* s Ćemovskega polja pri Podgorici, Črna Gora (ME); CA = *Charybido pancratii-Asphodeletum ramosi* iz Gargana (IT); CF = *Carlino siculae-Feruletum communis* pri mestih Trapani (CF1) in Palermo (CF2) (IT); NA = *Narcisso tazettae-Asphodeletum microcarpi* iz Istre (HR); TA = *Thapsio garganicae-Asphodeletum ramosii*, z otoka Pianosa, Toskana (IT).

been published (e.g. Brullo et al., 2009; Quintanar et al., 2009; Quintanar & Castroviejo, 2013) but a more detailed taxonomic revision on this issue for the study area (Italy and Western Balkans) is still awaited. Since *Koeleria splendens* plays an important role in the syntaxonomy of dry grassland vegetation of the area – e.g., it has been used as the name-giving taxon of the Balkan syntaxa *Koelerietalia splendentis* and *Chrysopogono grylli-Koelerion splendentis* – it has been used in its wide meaning, including both the Italian and Western Balkans populations (e.g. Pignatti, 1982).

Syntaxonomic nomenclature follows the EuroVeg-Checklist (EVC, Mucina et al., 2016; EuroVeg.EU 2022), except where indicated.

Results

The dendrogram based on quantitative data (Figure 2b) was pruned at the sixth partitioning level so as to obtain seven main clusters of relevés, clearly representative of the six associations already described for the area, and an additional main cluster ("Asp" in Figure 2, rels. 3–28 in Table 1) formed by the relevés with dominant *Asphodelus ramosus*. Two new relevés (rels. 1–2 in Table 1), however, were included in a subcluster of the main cluster AcS ("tr" in Figure 2). The two main clusters Asp and AcS merge together at the fifth partitioning level (Figure 2b).

The second partitioning level separates on one side the associations *Stipo austroitalicae-Hyparrhenietum hirtae* (StH) and *Centaureo apulae-Andropogonetum distahyum* (CeA), described for the lower elevations of the Murgia Tarantina and already ascribed to the class *Lygeo sparti-Stipetea tenacissimae* (Terzi et al., 2010). On the other side of the dendrogram there are the associations *Convolvulo-Stipetum austroitalicae* (CoS), *Irido-Scorzoneretum columnae* (IrS) and *Cytiso-Stipetum austroitalicae* (CyS).

The main clusters are also fairly well characterized in the dendrogram based on presence/absence data (Figure 2a), with few exceptions. The main clusters StH and CoS, indeed, are no longer distinguishable and are mixed into the same group (StH+CoS in Figure 2a; see also Terzi et al., 2010). The subcluster "tr" merges with Asp (relevés dominated by *Asphodelus ramosus*) and can thus be considered intermediate between the main clusters AcS and Asp.

The main clusters obtained from the classification based on quantitative data (i.e. Figure 2b) are considered and discussed below.

The relevés where *Asphodelus ramosus* dominated form a clearly identifiable cluster (Asp) that in both dendrograms merges with AcS (Figure 2a/b). Their most frequent taxa are *Asphodelus ramosus* subsp. *ramosus*, *Carlina corymbosa*, *Eryngium campestre* and *Helianthemum salicifolium*. *Asphodelus ramosus* is clearly the dominant species, followed by *Stipa austroitalica* subsp. *austroitalica*, and *Dactylis glomerata* subsp. *hispanica*. On the other hand, the species with the greatest cover in AcS, is *Stipa austroitalica*, followed by *Festuca circummediterranea*, and *Bromopsis erecta* (the latter sporadically present in Asp).

The NMS of associations from the Murge hills (Figure 3) resulted in a three-axis solution with a final stress of 12.2. The coefficient of determination for the correlations between ordination distances and distances in the original space, indicates that the NMS explains 87.7 percent of the variation. More in detail, axis 1 explains most of the variation (49.7%), followed by axis 2 (23.3%) and axis 3 (14.7%, not shown). In the ordination diagram (Figure 3), two groups of relevés are clearly distinguishable. The first includes relevés of the associations of the *Lygeo sparti-Stipetea tenacissimae* class, i.e. StH and CeA. The second group, on the right side of the diagram, includes

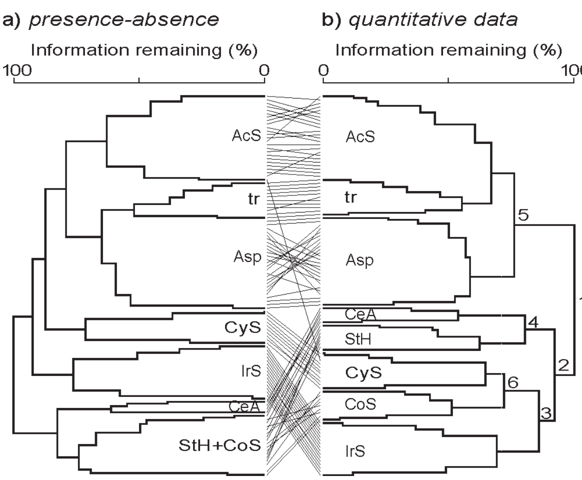

Figure 2: Hierarchical clustering (Flexible Beta method, β = -0.25; Bray-Curtis dissimilarity) of relevés of dry grassland associations from the Murge hills. 2a) clustering based on presence/absence data, 2b) clustering based on quantitative data. Main clusters: AcS = *Acino suaveolentis-Stipetum austroitalicae*; Asp = *Gelasio columnae-Asphodeletum ramosi*; tr = transition between AcS and Asp; CyS = *Cytiso spinescentis-Stipetum austroitalicae*; IrS = *Irido pseudopumilae-Scorzoneretum columnae*; CoS = *Convolvulo elegantissimi-Stipetum austroitalicae*; CeA = *Centaureo apulae-Andropogonetum distachyi*; StH = *Stipo austroitalicae-Hyparrhenietum hirtae*.

Slika 2: Hierarhična klasifikacija (metoda Flexible Beta, β = -0.25; Bray-Curtisova mera različnosti) popisov asociacij suhih travišč z gričevja Murge. 2a) klastri na osnovi prisotnosti/odsotnosti, 2b) klastri na osnovi kvantitativnih podatkov. Glavni klastri: AcS = *Acino suaveolentis-Stipetum austroitalicae*; Asp = *Gelasio columnae-Asphodeletum ramosi*; tr = prehod med AcS in Asp; CyS = *Cytiso spinescentis-Stipetum austroitalicae*; IrS = *Irido pseudopumilae-Scorzoneretum columnae*; CoS = *Convolvulo elegantissimi-Stipetum austroitalicae*; CeA = *Centaureo apulae-Andropogonetum distachyi*; StH = *Stipo austroitalicae-Hyparrhenietum hirtae*.

the AcS, IrS and Cys, already classified within the order *Scorzoneretalia villosae* (*Festuco-Brometea* class), together with the new relevés of the cluster Asp. The relevés of the association CoS are in an intermediate position between the previous two groups. The Asp cluster partially overlaps with both AcS, on one side, and IrS, on the other. The relevés of the Asp cluster were indeed sampled in the same distribution areas of those two associations, with which they share several species (see also Table S3).

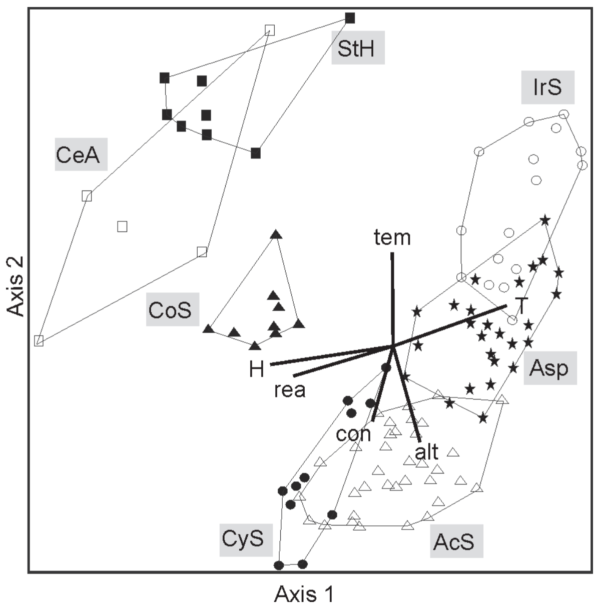

Figure 3: Non-metric multidimensional scaling of relevés of dry grassland associations from the Murge hills. AcS = *Acino suaveolentis-Stipetum austroitalicae* (empty triangles); Asp = *Gelasio columnae-Asphodeletum ramosi* (filled stars); CeA = *Centaureo apulae-Andropogonetum distachyi* (empty squares); CoS = *Convolvulo elegantissimi-Stipetum austroitalicae* (filled triangles); CyS = *Cytiso spinescentis-Stipetum austroitalicae* (filled circles); IrS = *Irido pseudopumilae-Scorzoneretum columnae* (empty circles); StH = *Stipo austroitalicae-Hyparrhenietum hirtae* (filled squares); H = Hemicryptophytes; T = Therophytes; tem = temperature; con = continentality; rea = soil reaction; alt = altitude.

Slika 3: Nemetrično večrazsežnostno lestvičenje popisov asociacij suhih travišč z gričevja Murge. AcS = *Acino suaveolentis-Stipetum austroitalicae* (prazni trikotniki); Asp = *Gelasio columnae-Asphodeletum ramosi* (polne zvezde); CeA = *Centaureo apulae-Andropogonetum distachyi* (prazni kvadrati); CoS = *Convolvulo elegantissimi-Stipetum austroitalicae* (polni trikotniki); CyS = *Cytiso spinescentis-Stipetum austroitalicae* (polni krogi); IrS = *Irido pseudopumilae-Scorzoneretum columnae* (prazni krogi); StH = *Stipo austroitalicae-Hyparrhenietum hirtae* (polni kvadrati); H = hemikriptofiti; T = terofiti; tem = temperatura; con = kontinentalnost; rea = reakcija tal; alt = višina.

Axis 1 is positively correlated with the percentages of therophytes and negatively with hemicryptophytes and soil reaction. A high percentage of annual species is found in the Asp and IrS clusters. Axis 2 is negatively correlated with altitude and continentality and positively correlated with temperature. Therefore, Acs, and CyS are characterized by a higher continentality, while StH, which was recorded at the lowest altitudes (along with CeA and CoS), has a higher temperature (Figure 3).

Life-forms and EIVs significantly differ among the seven clusters (Table S4). Focused comparisons between Asp and the other associations showed that it significantly differs from AcS for soil reaction, nutrients, therophytes, hemicryptophytes, and from IrS for nutrients, geophytes, hemicryptophytes, and phanerophytes. Generally, Asp differs from the other associations mainly for nutrients, and soil reactions, as far as EIVs are concerned, and for hemicryptophytes and therophytes, as far as life-forms are concerned (Table S4). Temperature discriminates Asp from CeA and CyS, humidity discriminates Asp from CeA and StH, and continentality differentiates Asp from CoS and CeA (Table S4).

The IndSp associated with the Asp cluster (Table S3) belong mainly to the *Stipo-Trachynietea distachyae* (e.g. *Trifolium angustifolium*, *Vulpia ciliata*) and anthropogenic classes, such as *Artemisietea vulgaris* (e.g. *Verbascum macrurum*, *Onopordum illyricum*). The highest IndVal were recorded for *Trifolium angustifolium* and *Linum tryginum*. Other IndSp are associated with groups resulting from the combination of Asp with other clusters, especially IrS, AcS and Cys (Table S3). As for the character species of the *Charybdido pancratii-Asphodeletea ramosi* indicated by Biondi et al. (2016), most of them turned out to be IndSp of combinations of main clusters. For instance, *Squilla pancration* is associated with CeA+CoS+StH, *Ferula communis* with AcS+Asp+CoS+StH, *Thapsia garganica* subsp. *garganica* with AcS+Asp+CyS+IrS, and *Asphodelus ramosus* and *Asphodeline lutea* with AcS+Asp+CyS+StH (Table S3).

Some common grasses of the Murge Plateau, such as *Festuca circummediterranea* and *Bromopsis erecta*, are associated with main clusters combinations excluding Asp, where those taxa have been recorded rarely (Table S3).

The NMS of relevés of plant communities dominated by *Asphodelus ramosus* from Italy and western Balkans resulted in a three axes solution with a final stress of 13.27. Most of the variance is explained by axis 1 (41.7 %) whereas decreasing values were obtained for axis 2 (20.4 %) and axis 3 (11.9 %, not shown).

Plant communities from Sicily, Gargano and Tuscany (Italy), mostly included in the *Charybdido pancratii-Asphodeletea ramosi* by Biondi et al. (2016), are on the right side of the ordination diagram (Figure 4). On the left side, the Balkan plant communities (Figure 4: NA, BC and Ac1) are separated from Asp (upper side), which therefore turns out to be floristically different from the other associations previously described.

Eurosiberian (Es) and East European (Ee) taxa are more represented in the Balkans (Figure 4). Axis 1 is positively correlated with steno-Mediterranean taxa whereas axis 2 is positively correlated with Euri-Mediterranean taxa (less represented in the *Charybdido pancratii-Asphodeletum ramosi*, CF in Figure 4).

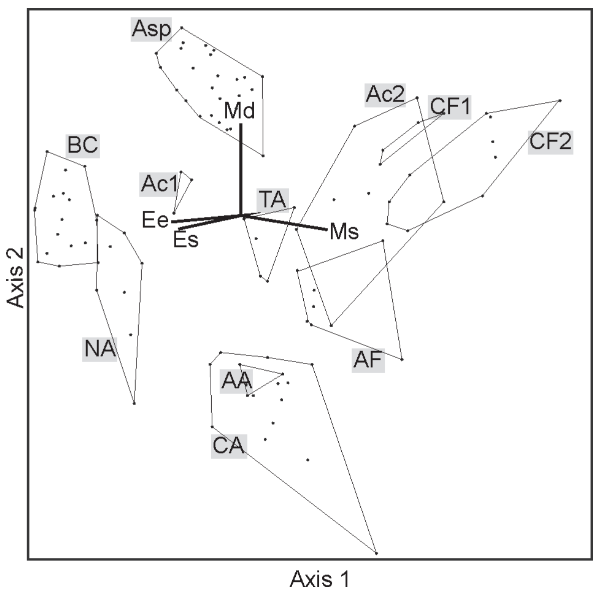

Figure 4: Non-metric multidimensional scaling of *Asphodelus ramosus*-dominated associations/plant communities from Italy and Western Balkans (see also Table S2). AA = *Alkanno tinctoriae-Asphodeletum ramosi*, from Gargano (IT); Ac1 = *Asphodelus ramosus* community, from the Buna River area (AL); Ac2 = *Asphodelus ramosus* community from Caltagirone, Sicily (IT); AF = *Asphodelino luteae-Feruletum communis*, from Gargano (IT); Asp = *Gelasio columnae-Asphodeletum ramosi,* the new association from the Murge Plateau (IT); BC = *Bromo erecti-Chrysopogonetum grylli*, from Ćemovsko polje, near Podgorica, Montenegro (ME); CA = *Charybido pancratii-Asphodeletum ramosi* from Gargano (IT); CF = *Carlino siculae-Feruletum communis* from Sicily (IT); NA = *Narcisso tazettae-Asphodeletum microcarpi*, from Istria (HR); TA = *Thapsio garganicae-Asphodeletum ramosi*, from the island of Pianosa, Toscana (IT). Chorotypes: Ms = steno-Mediterranean, Md = euri-Mediterranean, Ee = East European, Es = Eurosiberian.

Slika 4: Nemetrično večrazsežnostno lestvičenje popisov asociacij/združb s prevladujočo vrsto *Asphodelus ramosus* v Italiji in na Zahodnem Balkanu (glej tudi Tabelo S2). AA = *Alkanno tinctoriae-Asphodeletum ramosi*, iz Gargana (IT); Ac1 = *Asphodelus ramosus* community, from the Buna River area (AL); Ac2 = *Asphodelus ramosus* community from Caltagirone, Sicily (IT); AF = *Asphodelino luteae-Feruletum communis*, from Gargano (IT); Asp = *Gelasio columnae-Asphodeletum ramosi,* the new association from the Murge Plateau (IT); BC = *Bromo erecti-Chrysopogonetum grylli*, from Ćemovsko polje, near Podgorica, Montenegro (ME); CA = *Charybido pancratii-Asphodeletum ramosi* from Gargano (IT); CF = *Carlino siculae-Feruletum communis* from Sicily (IT); NA = *Narcisso tazettae-Asphodeletum microcarpi*, from Istria (HR); TA = *Thapsio garganicae-Asphodeletum ramosi*, from the island of Pianosa, Toscana (IT). Horotipi: Ms = stenomediteranski, Md = evrimediteranski, Ee = vzhodnoevropski, Es = evrosibirski.

Discussion

The *Asphodelus ramosus*-dominated plant community of the Murge Plateau was found to be floristically and ecologically different from the other grassland associations in the area. Therefore, the new association *Gelasio columnae-Asphodeletum ramosi* ass. nov. (holotypus rel. 16, Table 1) is described (Figure 5). Its distribution area overlaps the one of the associations *Acino-Stipetum austroitalicae* and (partially) *Irido-Scorzoneretum villosae*, from which it differs in the ecological indicators concerning edaphic conditions, such as nutrients and soil reaction. On the other hand, the ecological indicators related to climatic conditions, such as temperature, humidity, and continentality, discriminate the *Gelasio columnae-Asphodeletum ramosi* from the associations of the order *Cymbopogono-Brachypodietalia ramosi* present in the data set. From the floristic point of view, although several taxa were found to be IndSp of the new association (e.g. *Trifolium angustifolium, Linum tryginum*), the *Gelasio columnae-Asphodeletum ramosi* can be identified in the field by the dominance of *Asphodelus ramosus* (recorded with low frequency and cover in the IrS), and the absence of species common in the AcS (e.g. *Festuca circummediterranea*, *Bromopsis erecta*, *Dianthus sylvestris* subsp. *longicaulis*). The presence of taxa typical of the *Hippocrepido glaucae-Stipion austroitalicae* (e.g. *Gelasia villosa* subsp. *columnae*, *Stipa austroitalica* subsp. *austroitalica*, *Thymus spinulosus*, *Carduus nutans* subsp. *perspinosus*) distinguishes this association from others dominated by *Asphodelus ramosus* from other areas. The structure of the new association is influenced by the high proportion of therophytes (interposed among perennials), mainly of the classes *Stipo-Trachynietea distachyae*, *Helianthemetea guttati* and *Chenopodietea*, and by the lower proportion of hemicryptophytes.

The presence of some ruderal taxa typical of the vegetation types subjected to zoo-anthropogenic disturbance (e.g. *Verbascum macrurum*, *Salvia verbenaca*, *Onopordum illyricum*) indicates that *Gelasio columnae-Asphodeletum ramosi* represents a stage in the regression series caused by overgrazing, possibly combined with frequent fires. Overgrazing often leads to an increase in the cover of *Asphodelus ramosus* along with other unpalatable plants and thistles, such as *Thapsia garganica*, *Asphodeline lutea*, *Ferula communis*, *Eryngium campestre*, and *Carlina corymbosa* (e.g., Camarda et al., 2016), as observed in the *Gelasio columnae-Asphodeletum ramosi*.

The presence of ruderal taxa has also been observed in other plant communities dominated by *Asphodelus ramosus*, such as the *Carlino siculae-Feruletum communis*, described in Sicily and originally classified in the order *Carthametalia lanatii* and in the class *Artemisietea vul-*

Figure 5: *Gelasio columnae-Asphodeletum ramosi* from the Murge Plateau, south-eastern Italy (Photo: M. Terzi, 13th May 2021).
Slika 5: *Gelasio columnae-Asphodeletum ramosi* na planoti Murge, jugovzhodna Italija (foto: M. Terzi, 13.5.2021).

garis [syn. *Onopordetea acanthi*] (Gianguzzi et al., 1996; Gianguzzi & La Mantia, 2008). That association occurs on calcareous substrates (as the *Gelasio columnae-Asphodeletum ramosi*), in severely degraded vegetation due to overgrazing, with vegetation cover ranging from 50% to 85% (Gianguzzi & La Mantia, 2008). Also the *Thapsio garganicae-Asphodeletum ramosi* – another *Asphodelus ramosus*-dominated association from Pianosa Island (Tuscany, Italy) – was originally classified in the *Artemisietea vulgaris*, in the order *Brachypodio ramosi-Dactylidetalia hispanicae* (Foggi et al., 2008); the authors avoided classifying this association in the *Lygeo sparti-Stipetea tenacissimae* because the diagnostic taxa of this class are poorly represented in the vegetation of Pianosa Island. However, the *Brachypodio ramosi-Dactylidetalia hispanicae* is currently considered a syntaxonomic synonym of the *Cymbopogono-Brachypodietalia ramosi* which, in turn, is framed in the class *Lygeo sparti-Stipetea tenacissimae* (Mucina et al., 2016). Several taxa present in this association, e.g., *Asphodelus ramosus*, *Carlina corymbosa, Dactylis glomerata* subsp. *hispanica, Pallenis spinosa* subsp. *spinosa*, *Thapsia garganica, Ferula communis*, *Squilla pancration*, have been considered typical of this class (e.g. Brullo et al., 2010; FloraVeg.EU, 2022).

The co-occurrences of xerophilous perennial taxa of the class *Lygeo sparti-Stipetea tenacissimae* together with others of nitrophilous-ruderal vegetation was also observed in another plant community dominated by *Asphodelus ramosus* from Sicily (Poli-Marchese & Grillo, 2003). As a consequence, this community and some others from southern Italy and Malta, containing *Asphodelus ramosus* (as subordinated species), have been classified in this class and in the order *Cymbopogono-Brachypodietalia ramosi* [syn. *Hyparrhenietalia hirtae*] (Brullo et al., 2001, 2010, 2020; Poli-Marchese & Grillo, 2003). A plant community dominated by *Asphodelus ramosus* from Murge was also considered to belong to this class (Perrino et al., 2014). In this case, the authors showed a dendrogram in which the relevés of this community merged with those of the *Acino suaveolentis-Stipetum austroitalicae*, indicating some floristic similarities.

The results of this work are in line with those mentioned above, where the *Gelasio columnae-Asphodeletum ramosi* includes numerous ruderal species (cf. Table 1, e.g. species from *Chenopodietea*, *Artemisietea vulgaris*) along with others from the *Lygeo sparti-Stipetea tenacissimae*, frequently associated with *Asphodelus ramosus* even in associations from other geographic contexts. In addition, the

Gelasio columnae-Asphodeletum ramosi also includes some important diagnostic taxa of the *Hippocrepido glaucae-Stipion austroitalicae*.

This alliance is currently framed in the order *Scorzoneretalia villosae* (but see also Terzi et al., 2022b), which was originally described in the Western Balkans to represent the grassland vegetation at the interface between the Central European class *Festuco-Brometea* and the Mediterranean *Lygeo sparti-Stipetea tenacissimae* [syn. *Thero-Brachypodietea*] (Terzi, 2011, 2015). Indeed, the most xerothermic Balkan alliance of this order, the *Chrysopogono grylli-Koelerion splendentis*, has been arranged in both classes (Horvatić, 1973; Royer, 1991). This alliance includes associations with *Asphodelus ramosus*, also as the dominant species, which have been described along the Adriatic side of the Balkans, from Istria (Šegulja, 1970) to Montenegro and Albania (Fanelli et al., 2015; Stanišić-Vujačić et al., 2022). In Italy, the most xerothermic alliance of the *Scorzoneretalia villosae*, in contact with the *Cymbopogono-Brachypodietalia ramosi*, is represented by the *Hippocrepido glaucae-Stipion austroitalicae*. As cited above, the *Gelasio columnae-Asphodeletum ramosi* includes species of both these orders. The results of this work, however, show that this association is floristically more similar to the other associations of the *Scorzoneretalia villosae* than to those in the data set belonging to the *Lygeo sparti-Stipetea tenacissimae* (Figures 2–4).

Another interesting approach to the syntaxonomy of *Asphodelus*-dominated plant communities was proposed by Biondi et al. (2016) who described the class *Charybido pancratii-Asphodeletea ramosi,* and the order *Asphodeletalia ramosi* to include “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” (Biondi et al., 2016: 13). Diagnostic species of the class and subordinate units include *Asphodelus ramosus* and other taxa usually associated with it, such as *Thapsia garganica, Squilla pancration, Asphodeline lutea, Ferula communis,* and *Carlina corymbosa*.

Although those taxa are often found together, also in the Murge Plateau, the *Gelasio columnae-Asphodeletum ramosi* and some other *Asphodelus ramosus*-dominant associations (e.g. the *Carlino siculae-Feruletum communis*) do not represent abandoned or underused grasslands as much as they represent plant communities under zoo-anthropogenic disturbances.

In the drier areas of the Mediterranean Basin, *Asphodelus ramosus* often becomes dominant as a result of fire and overgrazing, as in the North African ermes which are the most degraded stage of the regressive vegetation series (Le Hoeurou, 1973). The ermes are defined as low herbaceous vegetation, with a marked seasonal rate of development, such that the vegetation is generally open except during the wet season, when it may completely cover the ground (Ionesco & Sauvage, 1962). Unpalatable plants (e.g., *Asphodelus ramosus, Squilla pancration*) and thistles, along with many ephemeral species occupying the spaces between the perennials, are quite common. Although the floristic compositions of *Asphodelus ramosus*-dominated plant communities from North Africa and other geographic contexts are different from those from Italy, there are some structural similarities. The syntaxonomic concept of the *Charybido pancratii-Asphodeletea ramosi* (and subordinated units), including associations from Italy and Western Balkans, was reviewed by Stanišić-Vujačić et al. (2022). These authors found important floristic differences between the *Asphodelus* associations from Italy and those from the Western Balkans, which they ascribed to *Scorzoneretalia villosae* and *Asphodeletalia ramosi*, respectively. That conclusion is partially confirmed by the results of this paper, given that the Balkan associations were found to be separated from those from Italy (Figure 4), and characterized by a higher percentage of East European and Eurisiberian taxa and a lower percentage of steno-Mediterranean taxa.

The proposal to update the standard phytosociological classification of European vegetation with the inclusion of the new class *Charybdido pancratii-Asphodeletea ramosi* and its subordinate units was rejected because the floristic delimitation of the new class towards other neighbouring ones (e.g. *Lygeo sparti-Stipetea tenacissimae*) had not been adequately addressed (Biurrun & Willner, 2020). According to Brullo et al. (2020), a new class would not be justified in areas with arid Mediterranean climate because numerous taxa of the *Lygeo sparti-Stipetea tenacissimae*, and in particular some caespitose grasses (e.g. *Hyparrhenia hirta*), co-occur together with the diagnostic taxa indicated by Biondi et al. (2016) for the new syntaxonomic units. Actually, in the case of the *Gelasio columnae-Asphodeletum ramosi* no such caespitose grasses were recorded. In addition, along the Murge Plateau, many of the diagnostic taxa of the *Charybdido pancratii-Asphodeletea ramosi* were found to be associated with combinations of associations of both the *Scorzoneretalia villosae* (i.e. *Hippocrepido glaucae-Stipion austroitalicae*) and *Cymbopogono-Brachypodietalia ramosi* (Table S3). As quoted above, without a large-scale revision for the *Charybdido pancratii-Asphodeletea ramosi* to delimit it to neighbouring classes, this new syntaxonomic concept cannot be integrated into the standard phytosociological classification of European vegetation (i.e. EVC, Biurrun & Willner, 2020). Therefore, although the concept of a high-rank syntaxonomic unit for communities dominated by *Asphodelus ramosus* seems rather interesting, there is the need for a more comprehensive syntaxonomic revision (possibly including vegetation data from the entire distribution area of this species).

The *Gelasio columnae-Asphodeletum ramosi* represents an intermediate vegetation type between the *Hippocrepido glaucae-Stipion austroitalicae* (*Scorzoneretalia villosae*) and the *Cymbopogono-Brachypodietalia ramosi* and there are reasons to classify it in both the orders. Although *Asphodelus ramosus* is currently considered a species belonging to the class *Lygeo sparti-Stipetea tenacissimae*, the results of this paper indicate that the new association is more similar to the associations of the *Hippocrepido glaucae-Stipion austroitalicae* rather than to those of that class present in the data set. The occurrence of taxa such as *Stipa austroitalica*, *Gelasia villosa* subsp. *columnae*, *Thymus spinulosus*, *Euphorbia nicaeensis* subsp. *nicaeensis*, *Carduus nutans* subsp. *perspinosus* together with the dominant *Asphodelus ramosus*, indicates that the new association still belongs to the *Hippocrepido glaucae-Stipion austroitalicae*. The *Gelasio columnae-Asphodeletum ramosi* is therefore classified in this alliance, which, in turn, is ascribed by the EVC (Mucina et al., 2016) to the *Scorzoneretalia villosae* order and the *Festuco-Brometea* class. It is worth mentioning that Terzi et al. (2022b) proposed to move the xerophytic alliances of this order to another class, the *Helianthemo cani-Seslerietea nitidae* (see Terzi et al. 2022a). However, a large-scale numerical analysis to support this interpretation is still missing, and the scheme below refers to the hierarchical syntaxonomic relationships of the EVC. In any case, given the above, the following classification scheme is tentative.

Class: *Festuco-Brometea* Br.-Bl. et Tx. ex Soó 1947
Order: *Scorzoneretalia villosae* Kovačević 1959
Alliance: *Hippocrepido glaucae-Stipion austroitalicae* Forte et Terzi in Forte, Perrino et Terzi 2005
Association: *Gelasio columnae-Asphodeletum ramosi* ass. nov.

Other syntaxa quoted in the text

Acino suaveolentis-Stipetum austroitalicae Forte et Terzi in Forte, Perrino et Terzi 2005; *Artemisietea vulgaris* Lohmeyer et al. in Tx. ex von Rochow 1951; *Asphodeletalia ramosi* Biondi in Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, Del Viscio et Casavecchia 2016; *Brachypodio ramosi-Dactylidetalia hispanicae* Biondi et al. 2001; *Carlino siculae-Feruletum communis* Gianguzzi, Ilardi et Raimondo 1993; *Carthametalia lanati* S. Brullo in S. Brullo et Marcenò 1985; *Centaureo apulae-Andropogonetum distachyi* Biondi et Guerra 2008; *Charybdido pancratii-Asphodeletea ramosi* Biondi in Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, Del Viscio et Casavecchia 2016; *Charybido pancratii-Asphodeletum ramosi* Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, Del Viscio et Casavecchia 2016; *Chenopodietea* Br.-Bl. in Br.-Bl. et al. 1952; *Chrysopogono grylli-Koelerion splendentis* Horvatić 1973; *Convolvulo elegantissimi-Stipetum austroitalicae* Biondi et Guerra, 2008; *Cymbopogono-Brachypodietalia ramosi* Horvatić 1963; *Cytiso spinescentis-Stipetum austroitalicae* Terzi et Forte in Forte, Perrino et Terzi 2005; *Helianthemetea guttati* Rivas Goday et Rivas-Mart. 1963; *Helianthemo cani-Seslerietea nitidae* Terzi, Di Pietro et Theurillat 2022; *Hyparrhenietalia hirtae* Rivas-Mart. 1978; *Irido pseudopumilae-Scorzoneretum columnae* Di Pietro, Misano et Terzi in Terzi, D'Amico et Di Pietro 2010; *Koelerietalia splendentis* Horvatić 1973; *Lygeo sparti-Stipetea tenacissimae* Rivas-Mart. 1978; *Ononido-Rosmarinetea* Br.-Bl. in A. Bolòs y Vayreda 1950; *Onopordetea acanthii* Br.-Bl. 1967; *Scorzonero villosae-Chrysopogonetalia grylli* Horvatić et Horvat in Horvatić 1963; *Stipo austroitalicae-Hyparrhenietum hirtae* Biondi et Guerra 2008; *Stipo-Trachynietea distachyae* S. Brullo in S. Brullo et al. 2001; *Thapsio garganicae-Asphodeletum ramosi* Foggi, Cartei et Pignotti 2008; *Thero-Brachypodietea ramosi* Br.-Bl. ex A. Bolòs y Vayreda et O. de Bolòs 1950.

Acknowledgements

This research has been carried out with the support of the Alta Murgia National Park Authority (Italy). I thank Romeo Di Pietro and Francesca Casella for helpful discussions on a preliminary draft of this paper, and Antun Alegro and an anonymous reviewer for their comments and suggestions.

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Supplementary materials

Table S1: Sources of phytosociological data for the dry grassland associations of the Murge hill.

Table S2: Sources of phytosociological data for the *Asphodelus ramosus*-dominated associations/plant communities.

Table S3: Indicator Species for the main clusters and their combinations in larger groups.

Table S4: Kruskal-Wallis test for Ecological Indicator Values and life-forms spectra and post hoc pairwise comparisons against the *Gelasio columnae-Asphodeletum ramosi*.

Table S5: Dates, geographical coordinates, altitudes and sporadic species of relevés in Table 1.

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Table 1: *Gelasio columnae-Asphodeletum ramosi* ass. nov., * holotypus rel. 16; rels 1–2: transition towards the *Acino suaveolentis-Stipetum austroitalicae*.
Tabela 1: *Gelasio columnae-Asphodeletum ramosi* ass. nov., * holotypus rel. 16; rels 1–2: prehod k asociaciji *Acino suaveolentis-Stipetum austroitalicae*.

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*	17	18	19	20	21	22	23	24	25	26	27	28	life-form	chorotype
aspect (°)	0	340	0	0	0	0	0	0	2	0	0	10	250	148	10	270	290	180	120	260	140	210	260	240	310	270	250	250		
slope (°)	0	3	0	0	0	0	0	0	2	0	0	3	2	15	3	3	3	2	2	20	3	3	2	2	4	5	5	5		
vegetation cover (%)	95	100	80	80	80	75	75	75	85	80	90	75	75	90	80	85	70	100	100	100	95	80	50	80	80	85	85	85		
plot size (m^2)	30	30	30	40	30	30	30	30	25	30	25	25	25	30	25	25	25	50	50	50	70	40	50	50	50	50	30	30		
Gelasio columnae-Asphodeletum ramosi																														
Asphodelus ramosus subsp. *ramosus*	4	4	4	4	4	3	3	3	3	3	4	3	3	4	4	4	4	4	5	4	3	3	3	3	3	3	3	3	G	Steno-Medit
Gelasia villosa subsp. *columnae*	+	1	.	3	1	+	.	2	2	.	2	2	1	.	2	2	2	+	1	+	+	2	+	+	+	+	2	1	H	Endemic
Hippocrepido glaucae-Stipion austroitalicae																														
Stipa austroitalica subsp. *austroitalica*	2	2	3	2	+	.	.	3	2	+	+	.	2	+	+	+	+	+	1	3	+	3	2	+	3	3	2	1	H	Endemic
Thymus spinulosus	2	2	+	2	2	2	3	.	+	2	2	.	.	.	.	+	+	1	+	1	+	2	.	2	2	2	2	1	Ch	Endemic
Carduus nutans subsp. *perspinosus*	.	.	+	+	+	+	+	.	.	+	+	.	+	+	.	+	.	+	+	+	.	.	+	+	+	+	+	.	H	Endemic
Crepis neglecta subsp. *corymbosa*	+	.	.	.	+	.	+	+	+	+	+	+	+	.	1	1	1	.	.	+	+	.	+	.	+	.	+	+	T	Endemic
Euphorbia nicaeensis subsp. *nicaeensis*	+	+	.	+	+	+	+	.	+	2	.	+	1	+	+	+	+	.	.	.	.	.	+	.	+	+	.	+	G	Steno-Medit
Erysimum crassistylum	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	+	+	.	.	+	.	.	+	.	.	H	Euri-Medit
Potentilla detommasii	+	+	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	H	SE-European
Iris pseudopumila	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	G	Endemic
Hippocrepis glauca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	H	European
Scorzoneretalia villosae* and *Festuco-Brometea																														
Eryngium campestre	+	+	+	+	2	+	+	+	+	+	+	+	2	+	+	+	2	+	2	+	+	+	+	1	+	+	2	+	H	Euri-Medit
Asphodeline lutea^	+	+	.	.	2	2	+	.	+	+	.	.	+	1	.	+	.	+	+	.	1	.	+	1	+	+	+	+	G	Euri-Medit
Convolvulus cantabrica	.	.	.	+	+	2	.	+	.	.	+	+	+	+	1	+	+	.	.	1	.	+	.	+	1	+	.	.	H	Euri-Medit
Galium corrudifolium	2	+	.	+	+	+	.	.	+	+	.	.	.	+	.	+	.	+	+	1	.	.	.	2	+	2	.	1	H	Steno-Medit
Centaurea deusta	.	+	.	.	+	+	+	+	2	+	.	.	.	.	.	.	.	.	.	.	+	1	+	1	+	+	.	2	H	Endemic
Eryngium amethystinum	+	.	+	+	.	+	+	.	+	+	.	+	.	.	.	+	.	.	+	.	.	+	.	1	+	.	.	1	H	Euri-Medit
Koeleria splendens	.	+	+	+	+	+	+	.	2	2	.	.	+	.	.	.	.	.	.	.	.	+	.	.	2	2	.	3	H	Montane
Phlomis herba-venti subsp. *herba-venti*	+	+	.	+	.	+	.	+	+	.	+	.	.	.	.	+	.	+	1	.	.	.	.	+	.	+	+	.	H	Steno-Medit
Ornithogalum gussonei	+	.	.	.	+	.	+	.	+	+	.	+	+	.	+	.	1	.	.	.	.	.	.	.	.	.	+	.	G	Steno-Medit
Sanguisorba minor	.	+	.	.	+	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	2	+	.	+	1	.	+	H	Paleotemperate
Tragopogon porrifolius	.	+	+	.	.	.	.	.	.	.	.	.	.	+	+	.	.	r	+	+	+	.	.	+	.	.	.	+	H	Euri-Medit
Teucrium chamaedrys subsp. *chamaedrys*	2	1	.	.	.	.	1	+	+	2	.	.	.	2	.	1	.	.	.	+	.	.	.	.	.	.	.	2	Ch	Euri-Medit
Anthyllis vulneraria	.	.	.	+	.	.	+	.	2	+	.	.	+	.	.	.	+	.	.	.	.	.	.	.	2	+	.	1	H	Euri-Medit
Seseli tortuosum	+	.	.	.	.	.	.	.	2	.	+	.	1	.	.	.	+	.	.	.	.	.	+	+	+	2	.	.	H	Steno-Medit
Phleum ambiguum	+	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.	+	2	3	.	.	H	Endemic
Bupleurum baldense	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	T	Steno-Medit

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*	17	18	19	20	21	22	23	24	25	26	27	28	l.f.	chorotype
Asperula aristata subsp. *scabra*	.	.	+	.	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	H	Montane
Arabis hirsuta	.	.	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	H	European
Echium vulgare	.	.	.	.	.	.	+	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	H	European
Bromopsis erecta	2	3	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2	.	.	H	Paleotemperate
Hypericum perforatum	+	+	.	.	.	+	.	.	2	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	H	Paleotemperate
Leopoldia comosa	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	G	Euri-Medit
Medicago falcata	.	+	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	H	Eurasian
Centaurium erythraea	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	H	Paleotemperate
Cuscuta epithymum	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	T	Eurasian
Ophrys bertolonii	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	Steno-Medit
Trigonella gladiata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	T	Steno-Medit
Potentilla pedata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	H	Euri-Medit
Satureja montana	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	Ch	Montane
Carex flacca	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	H	European
Silene otites	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	H	Eurasian
Stipa capillata	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	H	Eurasian
Festuca circummediterranea	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	H	Euri-Medit
Lygeo sparti-Stipetea tenacissimae																														
Carlina corymbosa^	.	.	2	+	2	2	2	2	+	+	1	2	+	+	2	2	2	+	+	+	+	+	2	+	+	+	2	+	H	Steno-Medit
Dactylis glomerata	1	.	1	2	+	2	2	+	+	+	2	2	+	+	2	+	3	2	2	1	2	.	2	2	2	+	+	2	H	Steno-Medit
Pallenis spinosa subsp. *spinosa*	+	.	+	+	+	+	+	+	.	+	+	+	.	+	+	+	.	.	.	+	+	1	+	+	+	+	.	.	H	Euri-Medit
Thapsia garganica subsp. *garganica*^	+	+	.	+	2	+	1	+	+	.	+	+	1	2	+	+	+	+	.	.	.	.	+	+	.	.	2	.	H	Steno-Medit
Sixalix atropurpurea subsp. *maritima*	.	.	+	.	1	+	+	.	+	+	.	r	+	+	.	.	.	r	.	.	+	+	2	+	+	+	+	+	H	Steno-Medit
Reichardia picroides	+	+	+	+	+	.	.	+	+	.	.	+	+	.	+	.	+	.	+	+	+	+	+	.	.	+	+	.	H	Steno-Medit
Ferula communis^	+	+	+	+	+	+	+	+	+	+	.	.	.	.	+	.	.	.	.	.	.	+	+	.	+	+	.	+	H	Euri-Medit
Convolvulus althaeoides subsp. *tenuissimus*	.	.	.	.	.	+	.	+	2	+	.	+	+	+	.	.	.	+	1	+	+	.	1	.	+	.	+	+	H	Steno-Medit
Micromeria graeca s.l.	.	.	.	.	.	+	+	.	+	1	.	.	.	.	.	.	.	.	.	.	+	.	+	.	2	2	.	.	Ch	Steno-Medit
Squilla pancration^	.	.	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	1	.	+	.	.	.	+	.	.	G	Steno-Medit
Stipo-Trachynietea distachyae																														
Hypochaeris achyrophorus	+	+	+	+	+	.	+	1	+	+	+	+	+	+	+	+	+	2	2	+	+	+	+	+	+	.	1	1	T	Steno-Medit
Sherardia arvensis	+	.	+	1	1	+	1	+	+	.	+	+	+	1	+	+	+	1	2	+	+	+	+	+	.	+	1	+	T	Euri-Medit
Linum strictum + *L. corymbulosum*	+	.	+	+	+	+	+	1	+	+	+	+	+	+	+	1	+	+	.	.	+	.	+	2	+	1	+	1	T	Steno-Medit
Vulpia ciliata	.	.	1	+	1	+	+	1	1	1	.	+	1	.	2	+	+	+	+	.	+	+	+	+	1	+	.	+	T	Euri-Medit
Trifolium scabrum	.	.	+	.	+	+	+	1	+	+	+	.	+	.	1	+	+	+	+	+	+	1	+	1	+	.	+	+	T	Euri-Medit
Trifolium stellatum	+	.	.	+	.	+	+	1	+	+	+	2	2	.	2	1	2	+	+	+	+	+	.	1	+	+	+	.	T	Euri-Medit
Trifolium angustifolium	+	.	.	+	1	2	.	+	+	+	+	1	+	+	.	1	+	+	1	+	+	.	1	.	+	.	+	+	T	Euri-Medit
Tordylium apulum	1	+	+	1	+	+	+	+	+	.	2	1	1	+	+	1	+	1	1	+	+	.	.	.	.	.	1	.	T	Steno-Medit

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*	17	18	19	20	21	22	23	24	25	26	27	28	l.f.	chorotype
Trifolium campestre	+	+	.	+	1	1	.	2	+	+	.	+	.	1	.	+	.	1	+	+	+	+	+	+	1	1	.	1	T	Paleotemperate
Trachynia distachya	.	2	.	.	2	1	1	.	2	+	2	.	.	.	+	1	+	+	+	1	.	.	2	.	2	+	.	.	T	Steno-Medit
Medicago minima	+	.	.	.	.	+	+	2	.	.	1	.	1	.	2	+	+	+	+	+	+	1	.	.	+	.	1	.	T	Euri-Medit
Catapodium rigidum	+	.	+	.	+	+	+	.	.	.	.	.	.	1	+	.	+	+	1	+	.	+	+	+	+	.	.	+	T	Euri-Medit
Euphorbia exigua	+	.	+	.	.	.	+	.	+	+	.	+	.	.	+	+	+	.	+	+	.	+	+	+	+	.	.	.	T	Euri-Medit
Tordylium officinale	.	.	1	.	+	.	.	.	2	+	.	+	+	.	.	.	.	+	.	.	.	+	+	+	+	+	.	1	T	Euri-Medit
Sideritis romana subsp. *romana*	.	.	+	.	.	.	+	.	+	.	.	+	+	.	+	.	+	.	.	+	+	+	+	+	1	.	.	.	T	Steno-Medit
Crepis rubra	+	.	.	.	+	.	.	+	+	+	.	+	+	.	.	.	+	2	.	.	.	.	+	+	+	.	.	+	T	Steno-Medit
Hedypnois rhagadioloides	+	.	.	.	.	+	.	.	+	+	+	+	.	.	.	.	+	1	+	+	.	+	+	.	.	.	.	.	T	Steno-Medit
Lagurus ovatus	.	.	1	.	.	.	1	+	+	1	.	.	+	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	T	Euri-Medit
Valerianella eriocarpa	+	.	.	.	.	+	.	.	.	+	+	+	.	.	.	+	1	.	.	.	.	.	.	.	.	.	+	.	T	Steno-Medit
Polygala monspeliaca	+	.	.	.	.	.	+	+	+	.	.	.	+	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	T	Steno-Medit
Medicago rigidula	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	+	+	.	+	.	.	.	.	+	.	.	+	.	T	Euri-Medit
Ononis reclinata subsp. *reclinata*	.	.	1	.	.	.	.	+	.	.	.	+	1	.	+	.	+	.	.	.	.	+	.	.	.	.	.	.	T	Euri-Medit
Hippocrepis biflora	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	+	.	.	+	.	T	Euri-Medit
Ajuga iva	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	r	+	.	.	T	Steno-Medit
Filago germanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	1	.	.	.	.	+	+	.	.	.	T	Paleotemperate
Medicago disciformis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+	+	.	.	.	.	.	.	.	.	T	Steno-Medit
Petrorhagia dubia	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	+	.	+	.	.	.	T	Steno-Medit
Silene nocturna	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	T	Steno-Medit
Hippocrepis ciliata	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	T	Steno-Medit
Xeranthemum inapertum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	1	.	.	+	T	European
Medicago orbicularis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	.	T	Euri-Medit
Coronilla scorpioides	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	T	Euri-Medit
Crepis neglecta subsp. *neglecta*	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	T	Euri-Medit
Artemisietea vulgaris																														
Daucus carota	+	+	+	.	+	+	+	+	+	+	+	+	.	+	+	+	.	.	.	.	+	+	2	+	2	+	+	+	H	Paleotemperate
Salvia verbenaca	+	+	.	.	.	.	.	.	.	.	+	+	.	+	.	.	+	+	2	+	+	.	+	+	.	.	+	.	H	European
Verbascum macrurum	.	.	+	+	.	+	+	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	+	.	.	r	.	.	H	Montane
Onopordum illyricum	.	.	.	.	+	+	.	.	.	.	+	+	+	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	H	Steno-Medit
Salvia argentea	.	.	.	+	+	+	.	.	+	+	.	.	.	.	.	.	.	+	+	.	.	.	.	r	.	.	.	.	H	Steno-Medit
Carthamus lanatus subsp. *lanatus*	.	.	.	.	.	+	.	.	.	.	2	+	+	.	.	.	.	+	1	.	.	.	+	.	.	.	.	.	T	Euri-Medit
Silene vulgaris	.	.	.	+	.	.	+	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	T	Paleotemperate
Echium asperrimum	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	H	Steno-Medit
Verbascum pulverulentum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	r	.	.	.	.	.	H	European
Chenopodietea																														
Avena barbata s.l.	1	.	1	+	+	+	+	.	+	1	+	+	1	1	+	+	+	2	3	1	2	1	2	1	1	2	+	1	T	Euri-Medit

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*	17	18	19	20	21	22	23	24	25	26	27	28	l.f.	chorotype
Dasypyrum villosum	2	1	.	1	1	.	1	+	+	.	+	1	+	2	1	1	1	4	4	2	1	1	+	2	+	2	+	+	T	Euri-Medit
Crepis vesicaria	+	+	+	+	+	+	.	+	+	+	+	+	+	.	2	2	2	+	+	+	+	.	+	.	+	+	+	+	T	Atlantic
Bromus cf. *scoparius*	+	.	+	.	+	+	+	+	+	1	+	+	1	.	+	+	+	+	+	+	1	+	1	+	+	.	.	+	T	Steno-Medit
Bellardia trixago	+	.	1	+	+	+	+	.	+	.	1	+	+	+	+	+	1	.	.	.	+	+	+	+	1	1	.	+	T	Euri-Medit
Aegilops geniculata	+	+	.	2	+	1	+	2	+	.	2	2	.	.	1	1	1	2	2	1	.	+	1	.	+	.	+	.	T	Steno-Medit
Anagallis arvensis	+	.	+	+	.	.	.	.	.	+	+	+	1	.	+	+	1	+	+	+	.	.	+	.	.	.	+	.	T	Euri-Medit
Urospermum dalechampii	.	.	+	+	+	.	.	+	+	+	+	+	+	.	2	.	+	.	.	.	+	.	+	.	.	.	+	.	H	Euri-Medit
Anisantha madritensis	+	1	+	.	.	.	.	.	1	+	.	+	+	.	+	.	.	1	1	.	3	.	.	.	1	.	.	.	T	Euri-Medit
Hirschfeldia incana	+	.	.	.	.	.	+	.	.	.	+	+	+	.	.	.	.	+	1	+	.	.	+	r	.	.	.	.	T	Euri-Medit
Althaea hirsuta	+	+	.	+	.	+	.	.	.	+	.	.	.	.	.	.	.	1	1	+	.	.	+	+	.	.	.	.	T	Euri-Medit
Plantago lagopus	.	.	.	.	.	.	+	.	+	1	.	.	.	.	.	+	.	1	+	.	.	1	1	.	.	.	.	.	T	Steno-Medit
Scorpiurus muricatus	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	+	.	T	Euri-Medit
Alyssum simplex	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	+	.	.	.	+	T	Euri-Medit
Nigella damascena	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	+	+	.	.	.	.	.	.	.	T	Euri-Medit
Malope malacoides	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	2	.	T	Steno-Medit
Scandix pecten-veneris	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	r	+	+	.	.	.	.	.	.	.	.	T	Euri-Medit
Astragalus hamosus	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	r	.	.	.	.	.	.	.	+	.	T	Euri-Medit
Galium parisiense	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	+	.	T	Euri-Medit
Urospermum picroides	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	T	Euri-Medit
Taeniatherum caput-medusae	+	+	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	T	Steno-Medit
Lolium rigidum	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	T	Widespread
Geropogon hybridus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	T	Steno-Medit
Knautia integrifolia subsp. *integrifolia*	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	T	Euri-Medit
Galactites tomentosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	.	.	.	.	.	.	.	.	H	Steno-Medit
Lathyrus cicera	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	.	.	.	.	T	Euri-Medit
Vicia bithynica	.	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	T	Euri-Medit
Helianthemetea guttati																														
Helianthemum salicifolium	+	.	1	+	1	1	1	2	1	1	1	1	1	+	+	1	1	+	+	+	1	+	1	+	1	1	+	+	T	Euri-Medit
Cynosurus echinatus	1	+	.	+	1	+	1	1	1	+	.	+	.	1	+	+	.	+	1	+	+	.	1	+	2	2	+	+	T	Euri-Medit
Briza maxima	1	1	.	.	+	+	.	1	+	1	+	+	+	2	+	+	1	+	+	+	+	+	1	1	.	.	+	1	T	Widespread
Linum tryginum	.	.	+	+	.	.	+	+	1	+	1	+	+	+	.	1	1	.	+	.	+	.	1	+	1	+	.	.	T	Euri-Medit
Crupina crupinastrum	.	+	.	.	.	.	.	+	+	.	.	.	+	.	.	.	+	+	.	.	+	+	+	.	+	+	.	.	T	Steno-Medit
Onobrychis caput-galli	.	.	.	.	.	.	+	+	.	.	+	+	.	.	1	+	+	.	.	+	+	.	.	.	.	.	.	.	T	Steno-Medit
Asterolinon linum-stellatum	+	.	+	.	.	+	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	T	Steno-Medit
Aira elegantissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	+	.	.	+	T	Euri-Medit
Trifolium cherleri	.	.	+	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	T	Euri-Medit
Aira cupaniana	+	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	T	Steno-Medit

relevé number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16*	17	18	19	20	21	22	23	24	25	26	27	28	l.f.	chorotype
Other taxa																														
Poa bulbosa subsp. *bulbosa*	+	.	+	+	.	+	+	+	+	+	+	+	1	.	2	2	2	+	+	.	.	+	+	+	+	+	+	.	H	Paleotemperate
Teucrium capitatum subsp. *capitatum*	.	.	.	+	2	+	+	2	+	2	.	.	.	.	+	+	+	+	.	.	.	+	+	.	+	+	.	1	Ch	Steno-Medit
Elaeoselinum asclepium	2	2	.	+	.	.	.	.	+	2	.	.	.	.	.	.	.	+	+	+	.	.	+	+	.	+	.	.	H	Steno-Medit
Petrorhagia saxifraga subsp. *gasparrinii*	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	+	.	+	.	+	1	+	1	.	.	H	Euri-Medit
Linum bienne	.	+	.	.	.	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	+	+	+	.	H	Atlantic
Petrorhagia prolifera	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	+	.	+	.	+	T	Euri-Medit
Plantago serraria	.	.	.	+	+	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	1	.	H	Steno-Medit
Onobrychis aequidentata	.	.	.	.	+	.	+	+	.	.	.	+	.	.	+	.	2	.	.	.	.	.	.	.	.	.	.	.	T	Steno-Medit
Rumex thyrsoides	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	.	.	+	+	.	+	.	.	.	.	r	.	.	H	Euri-Medit
Cachrys libanotis	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	+	+	.	.	H	Euri-Medit
Cachrys pungens	+	.	.	.	2	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+	H	Euri-Medit
Pyrus spinosa	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	+	.	.	r	.	.	P	Steno-Medit
Alkanna tinctoria	.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	.	.	.	+	.	.	H	Steno-Medit
Stachys cretica subsp. *salviifolia*	.	+	.	.	.	+	.	+	.	.	.	.	.	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	H	Steno-Medit
Euphorbia apios	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	G	Euri-Medit
Biscutella didyma	+	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	T	Euri-Medit
Serapias vomeracea	+	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	G	Euri-Medit
Asparagus acutifolius^	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	P	Steno-Medit
Crataegus monogyna	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	P	Paleotemperate
Euphorbia myrsinites	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	Ch	European
Allium cf. *apulum*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	G	Endemic
Astragalus sesameus	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	T	Steno-Medit
Clinopodium nepeta subsp. *glandulosum*	.	.	.	.	.	.	.	+	.	.	.	.	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	T	Montane
Euphorbia peplus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	.	.	.	.	.	T	Eurosiberian
Anthoxanthum odoratum	+	.	.	.	.	.	.	.	.	1	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	H	Eurasian
Sonchus asper	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	T	Eurasian
Sporadic taxa	7	4	5	1	1	1	5	3	4	3	2	3	4	4	1	0	1	5	5	13	4	7	3	3	2	2	2	5		

* = holotypus of the *Gelasio columnae-Asphodeletum ramosi* ass. nov.
^ = diagnostic taxa of the class *Charybdido pancratii-Asphodeletea ramosi* according to Biondi et al. (2016)