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Two new grassland associations from the Madonie Mountains (Sicily) disclose critical classification issues in endemic-rich oromediterranean plant communities of the classes *Molinio-Arrhenatheretea* and *Rumici-Astragaletea siculi*

Zwei neue Grasland-Assoziationen aus den Madonie-Bergen (Sizilien) offenbaren kritische Klassifizierungsprobleme in endemischen, oromediterranen Pflanzengemeinschaften der Klassen *Molinio-Arrhenatheretea* und *Rumici-Astragaletea siculi*

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Abstract

This study deals with the phytosociological classification of the grassland plant communities of the Madonie Mountains (Sicily, Italy). We combined data from 185 vegetation plots obtained from scientific literature, with 42 plots sampled, in summit areas above 1900 m a.s.l. Only vascular plants were recorded, and soil samples were collected to analyse the main substrate parameters. Using the TWINSPAN classification, 15 clusters were identified, interpreted and classified at the association level. Four distinct vegetation units were recognized: (1) mesohygrophilous and subacidophilous meadows, (2) gorse vegetation dominated by pulvinate chamaephytes and hemicryptophytes on wind-swept ridges, (3) petrophytic vegetation on eroded soils, and (4) grasslands on slopes of carbonate rocks soils. Two newly described associations, *Androsaco breistrofferi-Potentilletum calabrae* (Cl.: *Molinio-Arrhenatheretea*, Ord.: *Cirsietalia vallis-demonis*, All.: *Plantaginion cupanii*) and *Helianthemo tomentosi-Festucetum crassifoliae* (Cl.: *Rumici-Astragaletea siculi*; Ord.: *Erysimo bonanniani-Jurinetalia bocconei*; All.: *Cerastio tomentosi-Astragalion nebrodensis*), occupy the highest elevations and exhibit unique ecological features: temperature and water potential data revealed differences between these two communities, with the former thriving in sinkholes (karst dolines) with long-lasting snow cover

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and extended water availability, while the latte withstands fluctuations in temperature and water availability on windy ridges. Significant differences in topography and soil properties occurred between the new associations. Finally, we highlighted the classification challenges existing at higher hierarchical levels within the studied communities of the *Molinio-Arrhenatheretea* and *Rumici-Astragaletea siculi*, emphasising the need to address these issues beyond the Madonie Mountains to encompass the broader Mediterranean region.

Keywords: Grassland, *Molinio-Arrhenatheretea*, oromediterranean phytosociology, *Rumici-Astragaletea siculi*, Sicily, sinkholes, ridges

Erweitere deutsche Zusammenfassung am Ende des Artikels

1. Introduction

Natural grasslands are important components of mountain ecosystems, contributing to biodiversity and a wide array of ecosystem services, such as soil protection, water regulation, carbon sequestration, livestock grazing, pollination support, aesthetic and ecotourism value (Lavorel et al. 2017, Zhao et al. 2020). However, in the Mediterranean region, mountain grasslands are confined to small, fragmented areas associated with a few mountain systems (Jiménez-Alfaro et al. 2021). Their restricted distribution, coupled with their vulnerability to climate change and the history of human-induced disturbances, underscores the urgent need for understanding and preserving these ecosystems (Winkler 2019). In Sicily, there are three mountains supporting relict natural grasslands in summit areas (Guarino & Pasta 2017): Mount Etna (3329 m a.s.l.), the Nebrodi Mountains (1847 m a.s.l.) and the Madonie Mountains (1979 m a.s.l.); these areas are subject to upper supramediterranean and lower oromediterranean bioclimate (Bazan et al. 2015). The Madonie Mountains cover approximately 984 km^2 and consist of limestones, dolomites, quartzites, shales, and metamorphic rocks. This mountain range forms the westernmost portion of the so-called "Sicilian Apennine", a tectonically complex geological realm stretching along the northern coast of Sicily. It represents a hotspot of plant biodiversity in the Mediterranean, hosting many endemic species and being a refuge area for several boreal and nemoral species that migrated southwards during the Pleistocene glacial events (Brullo et al. 2012) and remained isolated during the Holocene. The Madonie Mountains harbour a unique assemblage of grasslands, characterised by a rich vascular flora and distinctive ecological preferences (Brullo 1984). Although the first scientific studies of the Madonie vegetation date back to the 1970s and 1980s, there is still a need for a comprehensive understanding of grassland communities, including their classification and ecological characteristics. The objective of this study was to conduct a phytosociological classification of grassland communities occurring in the summit areas of the Madonie Mountains, aiming to fill gaps in scientific knowledge and pave the way for their effective conservation and management in the future.

2. Methods

2.1 Sampling design

We based our sampling on a preliminary review of the phytosociological literature of the grassland communities of the Madonie Mountains (Brullo & Grillo 1978, Pignatti et al. 1980, Raimondo 1983, Brullo 1984, Brullo et al. 2005), proving that only a few plots were previously sampled in the summit areas, i.e. above 1900 m a.s.l. Based on elevation and locality information available in the original relevé table, we used QGIS to outline the undersampled summit areas and planned the location of the sampling sites to optimise the sampling effort and avoid spatial autocorrelation, by adopting the rule that sampling plots should have been located at least 100 m apart one from another (Fig. 1). Moreover, two permanent plots (PPs) were established in each of the two main landforms on the summit plateau: sinkholes (dolines) and wind-exposed ridges. In each of these PPs, we buried data loggers (MicroLog SP3) about 10 cm deep in July 2021 to record soil temperature and water potential at hourly intervals. In June 2022, we sampled the vegetation in 42 plots of 4 m^2, four of which coincided with the previously established permanent plots. In the centre of each plot, we recorded the geographical coordinates using a field GPS with submetric accuracy (Trimble Geo7X).

Vegetation data were collected using Braun-Blanquet (1964) approach, visually estimating the species cover of vascular plants (r, +, 1, 2, 3, 4, 5). To obtain accurate topographic data, we aligned the coordinates of each plot with a 2-m resolution DEM (http://www.sitr.regione.sicilia.it/geoportale/) and used QGIS to extract elevation (m a.s.l.), slope (°), and aspect (° from N). In addition to the topographic data, soil samples from each plot were collected and analysed in the lab to measure pH, Electrical Conductivity (EC), Total Organic Carbon (TOC), Total Nitrogen (TN), Cation Exchange Capacity (CEC) and Phosphorus measured using the Olsen method (POlsen, for more details see Appendix S1 in Marcenò et al. 2022).

2.2 Data set and classification

We combined data from 185 relevés obtained from scientific literature (Brullo & Grillo 1978, Pignatti et al. 1980, Raimondo 1983, Brullo 1984, Brullo et al. 2005), with our own 42 relevés (Supplement E1). The plots selected from the literature were only those from grassland communities sampled above 1200 m a.s.l. in the Madonie Mountains. The plots referred to the *Genistetum cupanii* community were excluded due to the dominance of dwarf shrubs, which made them structurally and physiognomically very different from the rest of the dataset. The dataset was stratified based on the classification at the subassociation level proposed by Raimondo (1983), Brullo (1984) and Brullo et al. (2005), and new plots were stratified according to sinkhole/windswept ridge. Subsequently, a heterogeneity-constrained random resampling (Lengyel et al. 2011) was performed using a square root cover transformation and the Bray-Curtis (Sörensen) distance measure, retaining a maximum of fifteen relevés from each subassociation. After this procedure, our dataset consisted of 148 relevés (Fig. 1) and 296 vascular plant species, whose taxonomy and nomenclature were harmonised according to the second edition of the Flora of Italy (Pignatti et al. 2017–2019).

To classify the communities at the association level, we run a modified TWINSPAN algorithm with pseudospecies cut levels set at 0%, 5% and 25% (Roleček et al. 2009). We terminated further divisions when the Whittaker's beta-diversity between plots in the cluster fell below the threshold of 2. Starting with 15 initial clusters, we identified the diagnostic, constant, and dominant species within each TWINSPAN cluster. Diagnostic species were defined as those with a *phi coefficient* of association > 0.3, indicating a strong association of the species with a given cluster (Tichý & Chytrý 2006). In our calculations, we virtually equalised the number of plots per cluster and disregarded species whose concentration within the group was not statistically significant at $p < 0.01$, determined using Fisher's exact test (Tichý & Chytrý 2006). Constant species were defined as those with a percentage frequency > 40%, while dominant species were defined as those occurring in at least 10% of the relevés with cover values >10%.

As TWINSPAN is a divisive (top-down) classification method, we progressively grouped and reduced the number of clusters by comparing their diagnostic and constant species with the information reported in phytosociological literature.

To further examine the relationship among the grassland communities, we performed a Non-Metric Multidimensional Scaling (NMDS) to visualise the similarities between the relevés based on species composition. All the analyses were performed using the programs JUICE 7.1 (Tichý 2002) and Canoco 5 (ter Braak & Šmilauer 2012).

To check how closely the numerical classification matched the original syntaxonomic framework, a confusion matrix was created between the TWINSPAN clusters and the classification proposed in the original description of the phytosociological associations addressed in this study.

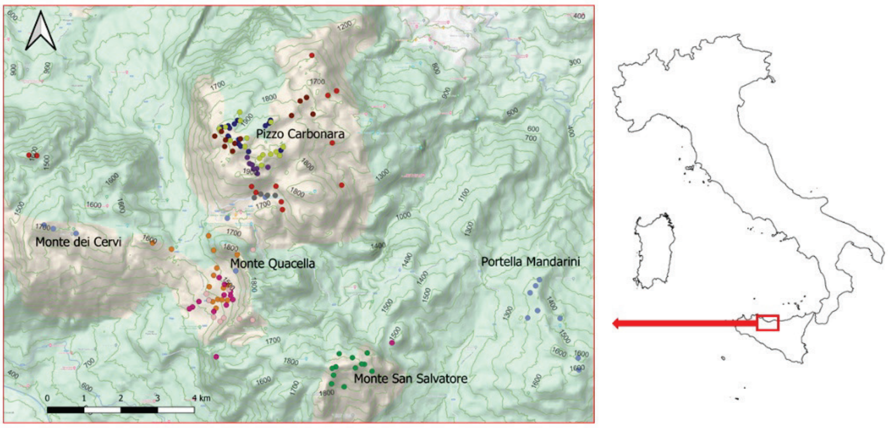

Fig. 1. Madonie Mountains (Italy, Sicily): study area and location of the relevés analysed in this paper. Colours refer to the associations listed in Figure 3.

Abb. 1. Madonie-Gebirge (Italien, Sizilien): Untersuchungsgebiet und Standorte der in dieser Arbeit analysierten Vegetationsflächen. Die Farben beziehen sich auf die in Abbildung 3 aufgeführten Assoziationen.

2.3 Syntaxonomic nomenclature

The nomenclature of the associations was revised according to the International Code of Phytosociological Nomenclature (ICPN4; Theurillat et al. 2021). The names of the taxa provided in the original descriptions were reviewed and, when necessary, the syntaxon names were mutated to reflect the current use of taxon names (*nomina mutata*; Art. 45 ICPN4). This revision takes into consideration the taxonomic concepts and nomenclature found in recent authoritative floras and checklists such as Pignatti et al. (2017–2019) and the Euro+Med (2006+). To ensure the long-term stability of the nomenclature, preference was given to taxonomic concepts that are widely accepted in current floras. As recommended by ICPN4, we designate with the authority "Marcenò" the syntaxa described by Cosimo Marcenò and with "C. Marcenò" those described by Corrado Marcenò.

2.4 Ecological preferences

Variables related to topography and soil chemistry were used for comparative ecological characterization of the newly described phytosociological associations, and two-year records of soil temperature and water potential were used to compare the microclimatic conditions experienced by these two associations. The nonparametric Mann-Whitney *U*-test was used to determine which environmental variables exhibited significant differences between the two associations. The analyses were performed in the SPSS software.

3. Results

3.1 Classification and syntaxonomic interpretation

The TWINSPAN classification process ended in a partition with 15 clusters, part of which was relatively coherent with the syntaxa recognized in the literature. Out of these clusters, ten matched closely with already described communities, three (clusters 1–2 and 8) were ascribed to two new phytosociological associations, and two (clusters 6 and 9) were outliers representing disturbed or transitional plant communities.

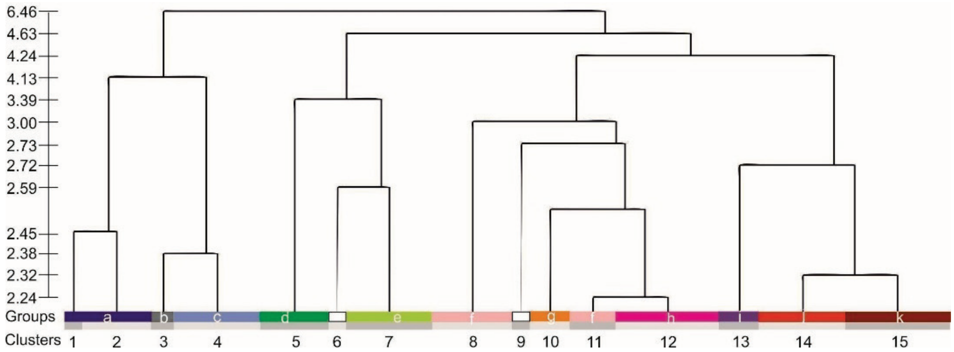

Fig. 2. Cluster dendrogram of the modified TWINSPAN classification of 148 resampled relevés into 15 clusters. Each cluster was classified at the association level based on its species composition. Colours and letters mark the groups classified within the associations listed in Figure 3. Y axis shows Whittaker's beta diversity as a cluster heterogeneity measure.

Abb. 2. Cluster-Dendrogramm der modifizierten TWINSPAN-Klassifikation von 148 neu abgetasteten Aufnahmen in 15 Cluster. Jeder Cluster wurde auf der Ebene der Assoziationen auf der Grundlage seiner Artenzusammensetzung klassifiziert. Die Farben und Buchstaben markieren die Cluster, die innerhalb der in Abbildung 3 aufgeführten Assoziationen klassifiziert wurden. Die Y-Achse zeigt Whittakers Beta-Diversität als Maß für die Heterogenität der Cluster.

The initial division obtained through TWINSPAN revealed four physiognomically distinct vegetation types (Fig. 2). The first one was represented by mesohygrophilous and subacidophilous meadows and pastures, predominantly located in flat areas and terrain depressions (groups a–c). The second was the vegetation of small pulvinate chamaephytes and caespitose hemicryptophytes occurring on windswept ridges with cryoturbated soil, both on quartzitic/quartzarenitic substrata and limestone (groups d–e). The third and the fourth were petrophytic stands, characterised by herbaceous and dwarf-shrub species thriving on eroded soils derived from weathered dolomite and shale (groups f–h) or pure limestone (groups i–k).

The first vegetation type (mesohygrophilous and subacidophilous grasslands) corresponded to the alliance *Plantaginion cupanii*, in which a further TWINSPAN division identified three associations. Clusters 1–2 (within group a) represented a newly described association, *Androsaco breistrofferi-Potentilletum calabrae*, sampled at elevations higher than the two following ones, on the flat bottom of sinkholes, on decarbonated soils derived from limestones. The other two clusters belonged to already known associations: *Cynosuro cristati-Plantaginetum cupanii* (group b), occurring on colluvial loamy soils in flat depressions surrounded by limestones, and *Armerio nebrodensis-Plantaginetum cupanii* (group c), found on colluvial soils derived from the quartzitic rock outcrops of the so-called Numidian flysch and on decarbonated marls.

The second vegetation type (windswept ridges) was also divided into three TWINSPAN groups. The first corresponded to the already known association *Plantagini humilis-Armerietum nebrodensis* (cluster 5, group d), patchy vegetation dominated by small pulvinate chamaephytes and caespitose hemicryptophytes, colonising the summit areas of the siliceous peaks of the Madonie, namely Mt. San Salvatore. Clusters 6–7 corresponded to the vegetation colonising the summit areas of the limestone peaks of the Madonie, namely Pizzo Carbonara and the surrounding smaller peaks, all of which are influenced by both karstic and cryoturbation processes. While cluster 7 is described here as a new association, named

Helianthemo tomentosi-Festucetum crassifoliae (group e), cluster 6 consisted of three relevés with a high abundance of annual plants and was interpreted as an outlier representing disturbed patches.

The third vegetation type was further divided into five clusters, based on vegetation structure and substrate characteristics. All of the corresponding vegetation units colonise substrate derived from the weathering of dolomite and shale outcrops, but cluster 8 (group f), was referred to *Lino punctati-Seslerietum siculae senecionetosum candidi*, a patchy, pioneer vegetation colonising steep scree slopes; cluster 9 was interpreted as an outlier; cluster 10 (group g) was referred to *Astragaletum nebrodensis*, the patchy cushion-like vegetation growing on mid-slope, eroded soils, quite rich in skeleton; cluster 11 (group f) corresponded to *Lino punctati-Seslerietum siculae typicum* and cluster 12 (group h) to *Carthamo pinnati-Thymetum spinulosi*, both thriving on gently sloping sites, on substrata rich in dolomite gravel or silt and clay, respectively.

The fourth vegetation type included grasslands colonising limestone slopes. Cluster 13 (group i) corresponded to *Siculosciadetum nebrodensis*, dense vegetation colonising the slopes of the sinkholes, cluster 14 (group j) to *Cachryetum ferulaceae* and cluster 15 (group k) to *Sideritido siculae-Artemisietum albae*, both associations dominated by chamaephytes and caespitose hemicryptophytes ubiquitous on the slopes of Carbonara massif.

The NMDS ordination (Fig. 3) was consistent with the TWINSPAN results, supporting the division between the identified groups and demonstrating clear dissimilarities in species composition, except for the overlaps in the left part of the NMDS, denoting poor floristic differentiation between the *Carthamo pinnati-Thymetum spinulosi* and the *Lino punctati-Seslerietum siculae*. Axis 1 ordinates the structural and compositional variation from the mesohygrophilous communities of meadows and pastures (groups a–c) to the communities of pulvinate chamaephytes and caespitose hemicryptophytes (groups d–k). Axis 2, instead, reflects the gradient from the most acidophilous communities (groups b–d) to the basiphilous ones (groups e–k). The *Androsaco breistrofferi-Potentilletum calabrae* (group a) occupies a transitional position in the ordination because it colonizes the flat bottom of sinkholes on leached soils derived from limestone.

The species with the largest fit value revealed two floristic pools, one related to the mesohygrophilous and subacidophilous meadow and pasture communities of the Madonie Mountains (right arrows) and one to the basiphilous and more xerophilous vegetation (left arrows). The results also emphasise the uniqueness of the *Androsaco breistrofferi-Potentilletum calabrae*, which is structurally and floristically very different from the other vegetation units. The vegetation of stony windswept ridges is characterised by the occurrence of *Plantago humilis* on quartz sandstones and that of *Cerastium tomentosum* on carbonate rocks.

3.2 Ecological characteristics of the newly described associations

The two associations newly described here occupy the summit areas of the Madonie Mountains (Fig. 1). The temperature and water potential data recorded over two years revealed striking differences between the *Androsaco breistrofferi-Potentilletum calabrae* (Fig. 3, M4) and the *Helianthemo tomentosi-Festucetum crassifoliae* (Fig. 3, M1). The *Androsaco breistrofferi-Potentilletum calabrae* association occupies the bottoms of sinkholes, where temperatures remain close to 0 °C throughout the winter due to the seasonally persistent snow cover, and benefits from an extended period of water availability.

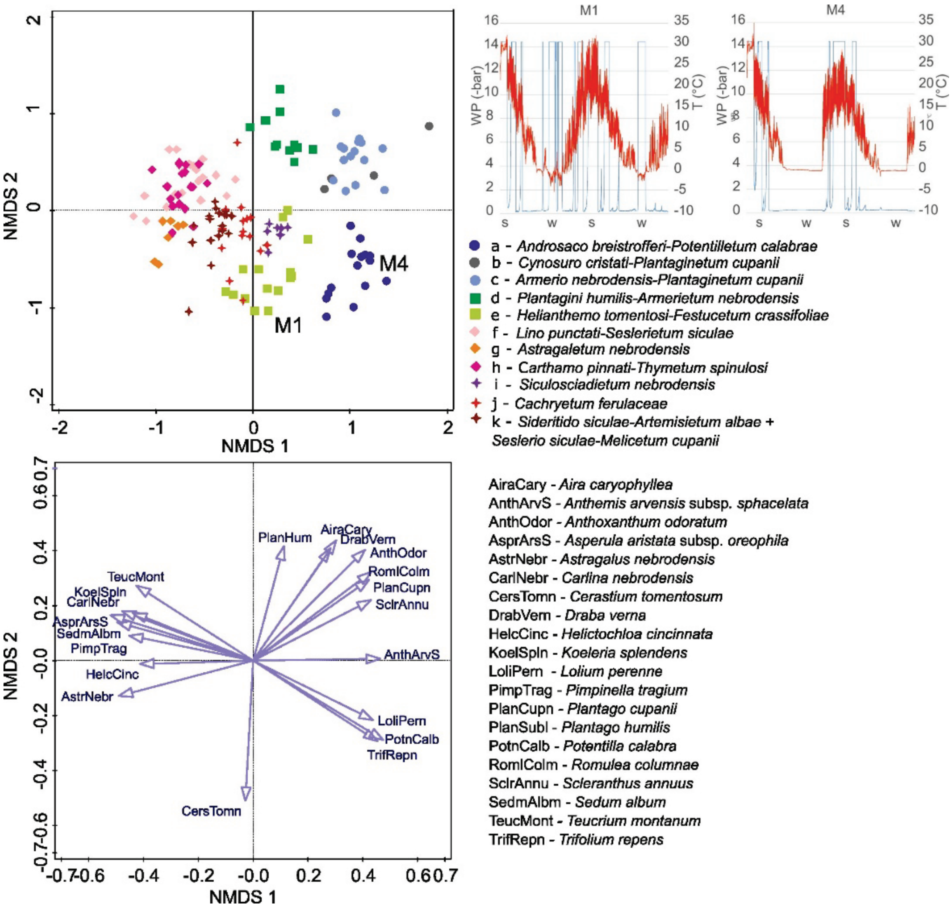

Fig. 3. NMDS ordination plot showing the 11 groups classified at the association level and 20 species with the highest fit value. M1 (windy ridge) and M4 (sinkhole) mark the permanent plots where data loggers were buried. The accompanying graphs show the temperature (red) and water potential (blue) over a period of two years, recorded in the permanent plots. On the X axis, s is summer and w is winter.

Abb. 3. NMDS-Ordinationsdiagramm mit den 11 auf Assoziationsebene klassifizierten Gruppen und den 20 Arten mit dem höchsten Anpassungswert. M1 (windiger Bergrücken) und M4 (Senke) markieren die Dauerbeobachtungsflächen, auf denen Datenlogger eingegraben wurden. Die zugehörigen Grafiken zeigen die Temperatur (rot) und den Wasserpotential (blau) über einen Zeitraum von zwei Jahren, die in den Dauerbeobachtungsflächen aufgezeichnet wurden, wobei auf der X-Achse s für Sommer und w für Winter steht.

In contrast, the *Helianthemo tomentosi-Festucetum crassifoliae* thrives on windy ridges, withstanding significant temperature fluctuations during winter, including several frosty days. This association also experiences a more pronounced variation in water availability than the previous association. Additionally, the Mann-Whitney *U*-test revealed significant differences in topography and soil characteristics between the two associations. The *Androsaco breistrofferi-Potentilletum calabrae* occupies flatter areas than *Helianthemo tomentosi-Festucetum crassifoliae*, with soils showing lower values of pH, electrical conductivity, total organic carbon, total nitrogen, and cation exchange capacity. However, the soil phosphorus concentration was found to be higher in the *Androsaco breistrofferi-Potentilletum calabrae* than in the *Helianthemo tomentosi-Festucetum crassifoliae* (Supplement E2).

3.3 Analytical description of the new associations

***Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. *ass. nova* (Fig. 2, Group a)**

Name-giving taxa: *Androsace elongata* L. subsp. *breistrofferi* (Charpin & Greuter) Molero & J.M. Monts. and *Potentilla calabra* Ten.

Typus: relevé 41, Supplement S1 (*holotypus*).

Diagnostic species of the association and higher syntaxa: *Androsace elongata* subsp. *breistrofferi*, *Anthemis arvensis* subsp. *sphacelata*, *Astragalus depressus*, *Capsella rubella*, *Herniaria nebrodensis*, *Lepidium nebrodense*, *Microthlaspi perfoliatum*, *Potentilla calabra*, *Scleranthus annuus*, *Trifolium repens*, *Veronica praecox*, *Viola parvula.*

Constant species: *Cerastium tomentosum*, *Festuca circummediterranea*, *Galium lucidum* subsp. *bernardii*, *Lolium perenne*, *Poa bulbosa*.

Dominant species: *Lolium perenne*, *Galium lucidum* subsp. *bernardii*, *Potentilla calabra*.

Ecology and distribution: This association occurs at the base of sinkholes scattered across the summit areas of Pizzo Carbonara, above 1850 m a.s.l., forming a dense, green carpet of hemicryptophytes dominated by *Lolium perenne*, *Galium lucidum* subsp. *bernardii*, and *Potentilla calabra* (Fig. 4).

Due to the high elevation, the species richness of this community is lower than the one recorded for other associations within the same alliance. However, it stands out for the presence of very rare species, including *Androsace elongata* subsp. *breistrofferi*, *Siculosciadium nebrodense*, and *Viola parvula*. The soils analysed have a pH of around 6, which supports the inclusion of this association within the *Plantaginion cupanii*, an alliance developing on leached or acidic, compacted soils. For further details on soil chemistry, see Supplement E1.

***Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. *ass. nova* (Fig. 2, group e)**

Name-giving taxa: *Helianthemum nummularium* subsp. *tomentosum* and *Festuca laevigata* subsp. *crassifolia*.

Typus: relevé 12, Supplement S2 (*holotypus*).

Diagnostic species of the association and higher syntaxa: *Anisantha tectorum*, *Bromus hordeaceus*, *Buglossoides incrassata* subsp. *splitgerberi*, *Cerastium tauricum*, *Crepis vesicaria* subsp. *taraxacifolia*, *Cynosurus echinatus*, *Draba praecox*, *Festuca laevigata* subsp. *crassifolia*, *Geranium molle*, *Helianthemum nummularium* subsp. *tomentosum*, *Hornungia petraea*, *Medicago lupulina* subsp. *cupaniana*, *Muscari neglectum*, *Myosotis incrassata*, *Petrorhagia prolifera*, *Saxifraga adscendens* subsp. *parnassica*, *Scandix pecten-veneris* subsp. *brachycarpa*, *Sedum amplexicaule*, *Senecio vulgaris*, *Sideritis sicula*, *Silene conica*, *Veronica praecox*, *V. verna*, *Xeranthemum inapertum*.

Constant species: *Arenaria serpyllifolia*, *Cerastium tomentosum*, *Erysimum bonannianum*, *Euphorbia myrsinites*, *Helianthemum cinereum*, *Poa bulbosa*.

Dominant species: *Cerastium tomentosum*, *Festuca laevigata* subsp. *crassifolia*.

Fig. 4. *Androsaco breistrofferi-Potentilletum calabrae* (left) and *Helianthemo tomentosi-Festucetum crassifoliae* (right) (Photos: V. Ilardi, 2022).

Abb. 4. *Androsaco breistrofferi-Potentilletum calabrae* (links) und *Helianthemo tomentosi-Festucetum crassifoliae* (rechts) (Fotos: V. Ilardi, 2022).

Ecology and distribution: The association thrives on the windswept ridges of the highest summits of Pizzo Carbonara above 1900 m a.s.l. *Cerastium tomentosum* and *Festuca laevigata* subsp. *crassifolia* are the dominant species. They are accompanied by chamaephytes such as *Helianthemum nummularium* subsp. *tomentosum* and *Asperula canescens*, as well as perennial graminoids such as *Poa bivonae* and several annual species (Fig. 4).

This community occurs on carbonatic outcrops and tolerates harsh environmental conditions, especially during winter, with several frosty days and significant fluctuations in water availability.

3.4 Syntaxonomic framework

The new association *Androsaco breistrofferi-Potentilletum calabrae* has been included in the *Plantaginion cupanii*, due to the high frequency of diagnostic species of this alliance, such as *Anthemis arvensis* subsp. *sphacelata*, *Potentilla calabra*, *Scleranthus annuus*, and *Trifolium pratense* subsp. *semipurpureum.* As for the *Helianthemo tomentosi-Festucetum crassifoliae*, the TWINSPAN analysis grouped it together with the *Plantagini humilis-Armerietum nebrodensis*, due to the high frequency of some annual species commonly occurring on windswept ridges of the Madonie Mountains both on acidic and alkaline substrata (Fig. 2). However, the NMDS clearly separates these two associations along the second axis (Fig. 3). Therefore, we deem appropriate to frame the *Helianthemo tomentosi-Festucetum crassifoliae* into the *Cerastio tomentosi-Astragalion nebrodensis*, based on the high frequency of basiphilous perennial plants typical of this alliance, such as *Cerastium tomentosum*, *Euphorbia myrsinites*, *Galium lucidum* subsp. *bernardii*, *Helianthemum cinereum*, and *Sideritis sicula*.

The syntaxonomic framework of all the associations considered in this paper is reported below. In parentheses, relevant bibliographic references sharing the same conceptual and syntaxonomic delimitation adopted here are reported after the term "*sensu*". A short description of all the phytosociological associations, including the list of their diagnostic, constant and dominant species is provided in Supplement E3. The synoptic table of all associations treated in this study is reported in the Supplement S3.

Cl.: *Molinio-Arrhenatheretea* Tx. 1937 (*sensu* Brullo & Grillo 1978, Biondi et al. 2014)
- Ord.: *Cirsietalia vallis-demonis* Brullo & Grillo 1978 (*sensu* Brullo & Grillo 1978, Biondi et al. 2014)
  - All.: *Plantaginion cupanii* Brullo & Grillo 1978 (*sensu* Brullo & Grillo 1978, Biondi et al. 2014)
    - Ass.: *Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. 2024 (group a)
    - Ass.: *Cynosuro cristati-Plantaginetum cupanii* Raimondo 1983 (group b)
    - Ass.: *Armerio nebrodensis-Plantaginetum cupanii* Brullo & Marcenò in Brullo 1984 (group c)

Cl.: *Rumici-Astragaletea siculi* Pignatti et Nimis in E. Pignatti et al. 1980 (*sensu* Brullo 1984, Brullo et al. 2005)
- Ord.: *Erysimo bonanniani-Jurinetalia bocconei* Brullo 1984 (*sensu* Brullo 1984, Brullo et al. 2005)
  - All.: *Armerion nebrodensis* Brullo 1984 (*sensu* Brullo 1984, Brullo et al. 2005)
    - Ass.: *Plantagini humilis-Armerietum nebrodensis* Pignatti & Nimis in E. Pignatti et al. 1980 (group d)
  - All.: *Cerastio tomentosi-Astragalion nebrodensis* Pignatti & Nimis ex S. Brullo 1984 (*sensu* Brullo 1984, Brullo et al. 2005)
    - Ass.: *Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. 2024 (group e)
    - Ass.: *Lino punctati-Seslerietum siculae* Nimis in E. Pignatti et al. 1980 *mut.* Brullo et al. 2005* (group f)
    - Ass.: *Astragaletum nebrodensis* Nimis in E. Pignatti et al. 1980 (group g)

Ass.: *Carthamo pinnati-Thymetum spinulosi* Brullo & Marcenò in Brullo 1984 *mut.* C. Marcenò et al. *nom. mut. nov.*** (group h)

Ass.: *Siculosciadietum nebrodensis* Brullo & Giusso 2005 *mut.* C. Marcenò et al. *nom. mut. nov.**** (group i)

Ass.: *Cachryetum ferulaceae* Raimondo 1983 (group j)

Ass.: *Sideritido siculae-Artemisietum albae* (Raimondo 1983) Brullo & Giusso 2005 (group k)

Ass.: *Seslerio siculae-Melicetum cupanii* Brullo & Giusso 2005 (group k)

*According to the ICPN, the change of the association name proposed by Brullo et al. (2005) is considered a mutation rather than a correction. This is because knowledge of the species *Sesleria nitida* subsp. *sicula* Brullo & Giusso 2006 only came about after the description of this alliance.

****Basionym**: *Carduncello-Thymetum spinulosi* Brullo & Marcenò in Brullo 1984, p. 383; name-giving taxon of the original association name: *Carduncellus pinnatus* (Desf.) DC. 1838; authoritative taxonomic treatments adopting the name *Carthamus pinnatus* Desf., 1799: Euro+Med (2006+), Pignatti et al. (2017–2019), WFO (2023).

*****Basionym**: *Peucedanetum nebrodensis* Brullo & Giusso in Brullo et al. 2005, p. 118; name-giving taxon of the original association name: *Peucedanum nebrodense* (Guss.) Nyman 1838; authoritative taxonomic treatments adopting the name *Siculosciadium nebrodense* (Guss.) C. Brullo, Brullo, S.R., Downie & Giusso, 2013: Pignatti et al. (2017–2019), WFO (2023).

4. Discussion

The associations examined in this article belong to three alliances: *Plantaginion cupanii*, *Cerastio-Astragalion nebrodensis* and *Armerion nebrodensis*, all of which are restricted to northern Sicily. However, their syntaxonomical framework has been a subject of diverse interpretations among researchers, resulting in complex and divergent classifications.

As far as the associations are concerned, those referred to groups f–h (i.e. *Lino punctati-Seslerietum siculae*, *Astragaletum nebrodensis* and *Carthamo pinnati-Thymetum spinulosi*) were described in the outcrop area of the Mufara and Quacella geological formations, consisting of flaky claystones, marls and calcilutites (Carbone & Grasso 2012, and references therein). The action of weathering on such heterogeneous materials creates deep gullies, from which numerous cones and debris flows branch off. In addition, detachments of massive rock masses are not uncommon. These deposits of different grain size and geological texture are colonised by the same species pool, but the vegetation physiognomy and the dominant species are driven by a terrain whose nature and morphology is changing at a distance of a few metres. Therefore, the syntaxa referred to clusters 8–12 tend to blur into one another, giving rise to facies and physiognomies that have been variously interpreted from a phytosociological point of view, but always within a substantial uniformity of the species pool. The confusion matrix between the taxonomic interpretation of previous authors (summarised by Brullo et al. 2005) and the TWINSPAN analysis presented here reveals the spurious consistency and uncertain boundaries between the syntaxa in question (Supplement E4).

Terzi et al. (2022) suggested that the association *Cerastio tomentosi-Cachryetum ferulaceae* Brullo & Marcenò 1984 [recte: *Cachryetum ferulaceae* (group j)], along with the alliance *Cerastio tomentosi-Astragalion nebrodensis* and the order *Erysimo bonanniani-*

Jurineetalia bocconei, should be considered invalid based on article 5a of the ICPN. Their statement is based on the fact that the original diagnosis of the association contains two *Cerastium* species (*C. tomentosum* and *C. semidecandrum*), and it was not clear which one was the name-giving taxon. However, all the three aforementioned syntaxa should be considered valid due to the occurrence of *Cerastium tomentosum* as the only representative of the genus *Cerastium* in the holotype (Table 15, relevé 6) chosen by Brullo (1984).

In the original description of *Cachryetum ferulaceae*, three subassociations were recognized: *typicum*, *artemisietosum albae* and *vicietosum glaucae* (Raimondo 1983). Later on, Brullo et al. (2005) proposed to move the last two subassociations into the newly established association *Sideritido siculae-Artemisietum albae* (group k), in order to separate the relatively more mesophilous vegetation dominated by *Cachrys ferulacea*, preferring north-facing or gently sloping sites, from the more xerophilous vegetation of steeper slopes (*artemisietosum*), screes and karstic ridges (*vicietosum glaucae*). Brullo et al. (2005) also described another association, named *Seslerio siculae-Melicetum cupanii*, occurring on steeper and rockier slopes than the *Sideritido siculae-Artemisietum albae*. However, in our analyses, the relevés of the latter two associations were found to be nested within cluster 15. Therefore, *Seslerio siculae-Melicetum cupanii* should rather be considered a *facies*, characterised by the abundant occurrence of *Melica cupanii*, of *Sideritido siculae-Artemisietum albae*. This conclusion is supported by the confusion matrix, which, while demonstrating a clear separation of *Siculosciadietum nebrodensis*, reveals a blurred distinction between *Cachryetum ferulaceae* and *Sideritido siculae-Artemisietum albae*, and between the latter and *Seslerio siculae-Melicetum cupani* (Supplement E4).

At higher hierarchical levels of the syntaxonomic system, the classification also poses some critical issues. Regarding the *Plantaginion cupanii*, Brullo & Grillo (1978) initially placed it within the order *Cirsietalia vallis-demonis*, which was framed into the class *Molinio-Arrhenatheretea*. This classification scheme was followed by Biondi et al. (2014), who considered *Plantaginion cupanii* to occur both in Sicily and Calabria, even though it is not clear which Calabrian associations should be included within this alliance. However, the EuroVegChecklist (Mucina et al. 2016) considers *Cirsietalia vallis-demonis* a synonym of *Nardetalia strictae*, with the alliance *Cirsio vallis-demoni-Nardion* representing Calabrian supramediterranean mesic seasonal perennial pastures on siliceous substrates. Furthermore, Mucina et al. (2016) moved the *Plantaginion cupanii* alliance to the order *Poetalia bulbosae* and the class *Poetea bulbosae*, defining it as "Siculo-Calabrian supramediterranean mesic seasonal perennial pastures on calcareous substrates". Despite a few associations ascribed to *Plantaginion cupanii* consist of trampled and overgrazed hemicryptophytic acidophilous communities, dominated by rosulate and pulvinate species, thus justifying the EuroVegChecklist's decision to some extent, the diagnosis is wrong because it reports "supramediterranean … on calcareous substrates", whereas the associations ascribed to *Plantaginion cupanii* include supra- and oro-mediterranean grasslands only occurring on decarbonated or acidic, compacted soils. We believe that placing the *Plantaginion cupanii* within the class *Poetea bulbose* may not adequately recognize the biogeographical importance of the new association *Androsaco breistrofferi-Potentilletum calabrae* and all of the associations already described within the *Plantaginion cupanii* that are not structurally similar to the typical *Poetea bulbosae* vegetation, i.e. that do not consist of trampled and overgrazed stands dominated by dwarf rosulate or pulvinate species. Our findings suggest that these grassland communities are patches of temperate vegetation that became relict in the Mediterranean region, but the placement of the order *Cirsietalia vallis-demonis* also deserves further discussion. In our opinion, the best solution is to consider both the *Cirsietalia vallis-demonis* and the *Plantaginion cupanii* as a part of the class *Molinio-Arrhenatheretea*, as originally proposed by Brullo & Grillo (1978) and followed by Biondi et al. (2014), Guarino & Pasta (2017) and Guarino & Pignatti (2019). An alternative proposal could be to include the order *Cirsietalia vallis-demonis* within the *Nardetea strictae*, and to consider the communities of *Plantaginion cupanii* as the southernmost and most impoverished representatives of this class. However, *Nardus stricta* is the only species of *Nardetea strictae* stretching up to southern Calabria and, considering the extremely limited occurrence of chionophilous swards in southern Italy, it would be somewhat questionable to add a further alliance to the *Ranunculo-Nardion strictae* Bonin 1972.

The situation regarding the *Cerastio tomentosi-Astragalion nebrodensis* is even more complex. Pignatti et al. (1980) initially placed the calcareous oromediterranean communities of Sicily within the order *Erinaceetalia anthyllidis* and the class *Ononido-Rosmarinetea*. However, Brullo (1984) described the class *Cerastio-Carlinetea nebrodensis* and the order *Erysimo bonanniani-Jurinetalia bocconei* for the Madonie Mountains, emphasising the floristic differences between the Sicilian and other oromediterranean areas in the Mediterranean Basin. Subsequently, Brullo et al. (2005) modified the hierarchical classification by including all the Sicilian and Calabrian oromediterranean communities within the class *Rumici-Astragaletea siculi*. The Prodromus of Italian Vegetation (Biondi et al. 2014) considers *Rumici-Astragaletea siculi* as a synonym of *Cisto-Lavanduletea stoechadis* and includes *Erysimo bonanniani-Jurinetalia bocconei* in the class *Rosmarinetea officinalis*. However, the EuroVegChecklist (Mucina et al. 2016) places the order *Erysimo bonanniani-Jurinetalia bocconei* within *Festuco hystricis-Ononidetea striatae*, a class that encompasses submediterranean, submontane-montane, and oromediterranean dry grasslands and related dwarf scrub on calcareous substrates in the Iberian Peninsula, Western Alps, and Apennines.

More recently, Terzi et al. (2022) introduced a new class called *Helianthemo cani-Seslerietea nitidae*, considering the *Festuco hystricis-Ononidetea striatae* as an invalid name, extending the distribution of the new class to the Balkan Peninsula. Within this class, they included the order *Erysimo bonanniani-Jurineetalia bocconei* and the Sicilian alliance *Cerastio tomentosi-Astragalion nebrodensis*.

Owing to the rich number of local endemics, as well as to the remarkable regional floristic affinities between the acidophilous and basiphilous assemblages of the oromediterranean vegetation of Sicilian (and Calabrian) high mountains, it is questionable to separate the studied vegetation in two different classes. Furthermore, the number of local endemics in the carbonate part of the Madonie Mountains is higher than in any other high-mountain ecosystem of Sicily. Therefore, the option of framing the Sicilian basiphilous oromediterranean vegetation into an Iberian class and to keep the Calabrian-Sicilian silicicolous oromediterranean vegetation in a separate class is not well supported both from the biogeographic and phylogenetic viewpoint. Nearly all oromediterranean endemics of Mount Etna have their closest relatives in the Madonie Mountains, which are clearly derived from a recent allopatric speciation. Some species indifferent to soil conditions occur in both the Madonie, Etna and beyond (e.g. *Bellardiochloa variegata* s.l., *Carlina nebrodensis*, *Centaurea parlatoris*, *Cerastium tomentosum*, *Galium aetnicum*, *Herniaria nebrodensis*, *Petrorhagia saxifraga* subsp. *gasparrinii* and *Saponaria sicula*). Instead, none of the character species of the original description of *Festuco hystricis-Ononidetea striatae* occurs neither in the Sicilian nor in the Calabrian high mountains (Guarino & Pasta 2017).

5. Conclusions

Our comprehensive study on the grassland communities of the Madonie Mountains filled a knowledge gap about the vegetation at the highest elevations of this massif. We extended the classification of plant communities to the oromediterranean grasslands of the sinkholes and ridges surrounding Pizzo Carbonara, identifying two new associations and highlighting some critical issues regarding the previously described associations. To determine the most suitable phytosociological framework for these grassland communities, further research and comprehensive analyses along with summit areas of Sicilian and nearby mountains are necessary. Resolving the classification issues at the higher hierarchical levels will contribute to a better understanding of the ecological and biogeographical significance of these unique grassland communities not only in the Madonie Mountains, but also in the whole Mediterranean region. In any case, this requires future testing and the comparison of a large amount of data from vegetation surveys concerning the mountain grasslands and related dwarf scrub communities on both acidic and calcareous substrates and located in different geographic areas (Iberian, Italian and Balkan peninsulas).

Erweiterte deutsche Zusammenfassung

Einleitung – Natürliches und semi-natürliches Grasland trägt zur biologischen Vielfalt in Bergökosystemen bei und erbringt wichtige Ökosystemleistungen wie Bodenschutz, Wasserregulierung, Kohlenstoffbindung und vieles mehr. Im Mittelmeerraum sind diese Bergwiesen und -weiden auf kleine, fragmentierte Regionen beschränkt, die mit bestimmten Gebirgen verbunden sind. Ihre Anfälligkeit gegenüber dem Klimawandel und menschlichen Eingriffen betont die Notwendigkeit von Schutzmaßnahmen. In Sizilien gibt es in drei Gebirgen – dem Ätna, den Nebrodi-Bergen und den Madonie-Bergen – noch natürliche und semi-natürliche Graslandschaften. Das Hauptziel dieser Studie bestand darin, eine phytosoziologische Klassifizierung der Grasländer in den Gipfelbereichen der Madonie-Berge vorzunehmen, um Lücken im wissenschaftlichen Kenntnisstand zu schließen und den Weg für ihre effektive Erhaltung und Bewirtschaftung in der Zukunft zu ebnen.

Methoden – Das Stichprobendesign basierte auf der phytosoziologischen Literatur und konzentrierte sich auf Grasländer oberhalb von 1900 m ü. NN in den Madonie-Bergen (Sizilien, Italien). Die Auswahl der Untersuchungsflächen wurde mit QGIS optimiert, wobei ein Mindestabstand von 100 m zwischen den Probeflächen eingehalten wurde. 42 Untersuchungsflächen (je 4 m²) wurden im Juni 2022 nach dem Braun-Blanquet-Verfahren in den Gipfelgebieten beprobt. Es wurden geografische Koordinaten, topografische Daten und Bodenproben für die Analyse von pH-Wert, elektrischer Leitfähigkeit, organischem Gesamtkohlenstoff, Gesamtstickstoff, Kationenaustauschkapazität und verfügbarem Phosphor gesammelt. Dauerbeobachtungsflächen wurden in Senken und auf windexponierten Bergrücken angelegt und Datenlogger zur Aufzeichnung der Bodentemperatur und des Wasserpotenzials für die Langzeitüberwachung installiert. Die Daten von 185 Untersuchungsflächen aus der wissenschaftlichen Literatur wurden mit unseren eigenen 42 Untersuchungsflächen kombiniert. Der kombinierte Datensatz wurde auf der Grundlage der von Raimondo (1983), Brullo (1984) und Brullo et al. (2005) vorgeschlagenen Klassifizierung auf der Ebene der Subassoziationen stratifiziert und durch den Mittelwert der heterogenitätsbedingten Zufallsstichprobe reduziert, um maximal fünfzehn Vegetationsaufnahmen aus jeder Subassoziation für die weitere Analyse zu nutzen. Der endgültige Datensatz besteht aus 148 Vegetationsaufnahmen (Abb. 1) und beinhaltet 296 Gefäßpflanzenarten, deren Taxonomie und Nomenklatur gemäß der zweiten Ausgabe der Flora von Italien (Pignatti et al. 2017–2019) harmonisiert wurden. Um die Vegetationsaufnahmen auf Assoziationsebene zu klassifizieren, führten wir einen modifizierten TWINSPAN-Algorithmus mit Pseudospezies-Cut-Levels von 0 %, 5 % und 25 % durch. Da es sich bei TWINSPAN um eine teilende (top-down) Klassifizierungsmethode handelt, haben wir die Anzahl der Cluster schrittweise gruppiert und reduziert, indem wir ihre diagnostischen und konstanten Arten mit den in der phytosoziologischen Literatur angegebenen Informationen verglichen. Um die Beziehung zwischen den verschiedenen Grasländern weiter zu untersuchen, führten wir eine nichtmetrische multidimensionale Skalierung (NMDS) durch, um die Ähnlichkeiten zwischen den Vegetationsaufnahmen auf der Grundlage der Artenzusammensetzung zu visualisieren. Alle Analysen wurden mit den Programmen JUICE 7.1 (Tichý 2002) und Canoco 5 (ter Braak & Šmilauer 2012) durchgeführt. Um zu prüfen, inwieweit die numerische Klassifizierung mit dem ursprünglichen syntaxonomischen Rahmen übereinstimmt, wurde eine Konfusionsmatrix zwischen den TWINSPAN-Clustern und der in der ursprünglichen Beschreibung der in dieser Arbeit behandelten phytosoziologischen Assoziationen vorgeschlagenen Klassifizierung erstellt.

Ergebnisse – Der TWINSPAN-Klassifizierungsprozess führte zu einer Partition mit 15 Clustern (Abb. 2), von denen ein Teil mit den anerkannten Syntaxa der Literatur übereinstimmte. Von diesen Clustern stimmten zehn eng mit bereits beschriebenen Syntaxa überein, drei (Cluster 1–2 und 8) wurden zwei neuen phytosoziologischen Assoziationen zugeschrieben, und zwei (Cluster 6 und 9) repräsentierten gestörte oder Übergangsassoziationen. Die ursprüngliche Einteilung durch TWINSPAN ergab vier physiognomisch unterschiedliche Vegetationstypen: Der erste wurde durch mesohygrophile und subacidophile Wiesen und Weiden repräsentiert, die vorwiegend in flachen Gebieten und Geländemulden zu finden sind (Gruppen a–c). Die zweite Gruppe besteht aus kleinen polsterförmigen Chamaephyten und caespitosen Hemikryptophyten, die auf windgepeitschten Bergrücken mit kryoturbiertem Boden sowohl auf quarzitischen/quarzarenitischen Substraten als auch auf Kalkstein vorkommen (Gruppen d–e). Die dritte und vierte Gruppe ist eine petrophytische Vegetation, die durch krautige und zwergstrauchige Arten gekennzeichnet ist, die auf erodierten Böden aus verwittertem Dolomit und Schiefer (Gruppen f–h) oder reinem Kalkstein (Gruppen i–k) gedeihen. Die beiden neu beschriebenen Assoziationen, *Androsaco breistrofferi-Potentilletum calabrae* und *Helianthemo tomentosi-Festucetum crassifoliae*, sind in den Gipfelbereichen der Madonie-Berge zu finden. Erstere ist in Dolinen zu finden und profitiert von der anhaltenden Schneedecke, während letztere auf windigen Bergrücken gedeiht und Temperaturschwankungen toleriert. Zwischen den beiden Assoziationen wurden signifikante Unterschiede in der Topografie und den Bodeneigenschaften festgestellt, wobei das *Androsaco breistrofferi-Potentilletum calabrae* flachere Gebiete mit niedrigerem pH-Wert und Nährstoffen, aber höherer Phosphorkonzentration besiedelt. Die NMDS-Ordination bestätigte die TWINSPAN-Ergebnisse und zeigte deutliche Unterschiede in der Artenzusammensetzung, wobei Achse 1 die Variation von mesohygrophilen zu polsterförmigen Chamaephyten darstellt und Achse 2 acidophile mit basiphilen Gemeinschaften auftrennt (Abb. 3). Syntaxonomie der neuen Assoziationen: Das *Androsaco breistrofferi-Potentilletum calabrae* wird aufgrund gemeinsamer Charakterarten mit hoher Stetigkeit dem *Plantaginion cupanii* zugeordnet; das *Helianthemo tomentosi-Festucetum crassifoliae*, das ursprünglich mit dem *Plantagini humilis-Armerietum nebrodensis* gruppiert wurde, wird auf der Grundlage der NMDS-Ordination zum *Cerastio tomentosi-Astragalion nebrodensis* umklassifiziert, wobei unterschiedliche Merkmale und Artstetigkeiten hervorgehoben werden. Der syntaxonomische Rahmen für alle Assoziationen wird mit relevanten bibliographischen Referenzen für eine konsistente Abgrenzung bereitgestellt. Detaillierte Beschreibungen der einzelnen Assoziationen, einschließlich diagnostischer, konstanter und dominanter Arten, sind in Anhang E3 zu finden.

Diskussion – Diese Studie hat sich mit der Syntaxonomie von Grasländern der Verbände *Plantaginion cupanii*, *Cerastio-Astragalion nebrodensis*, und *Armerion nebrodensis* in Nordsizilien befasst (Brullo, 1984). Deren pflanzensoziologische Einordnung wurde in der Literatur unterschiedlich interpretiert, daraus resultierten verschiedenen Klassifizierungen (Brullo & Grillo 1978, Biondi et al. 2014, Mucina et al. 2016). Die eingesetzte TWINSPAN-Klassifikation und die NMDS-Ordination zur Charakterisierung und Klassifizierung von 42 Vegetationsaufnahmen der Madonie-Berge zeigen sowohl bekannte als auch neue Assoziationen. Die ökologischen Merkmale der neuen Assoziationen wurden detailliert beschrieben und ihre einzigartigen Anpassungen an spezifische Umweltbedingungen hervorgehoben. Diese Daten bieten wertvolle Einblicke in die biologische Vielfalt der Region und können auch für Schutz- und Managementzwecke genutzt werden. Zum Beispiel legen unsere Ergebnisse nahe, dass die neu beschriebenen Graslandgemeinschaften Relikte temperater Vegetation in der Mittelmeerregion darstellen. Zu den wichtigsten Ergebnissen gehört die Identifizierung verschiedener Vegetationstypen auf der Grundlage von Gelände- und Substratmerkmalen. So finden sich beispielsweise die Assoziationen *Lino punctati-Seslerietum siculae*, *Astragaletum nebrodensi*s und *Carthamo pinnati-Thymetum spinulosi* in Gebieten, die von geologischen Störungen betroffen sind und in denen die Vegetation aufgrund der veränderten Geländemorphologie zu einer Vermischung neigt.

Unsere kritische Neubewertung legt nahe, die Assoziation *Seslerio siculae-Melicetum cupanii* als eine Variante von *Sideritido siculae-Artemisietum albae* neu zu klassifizieren. Darüber hinaus stellen die Autoren die Einordnung von *Plantaginion cupanii* in die Klasse *Poetea bulbosae* von Mucina et al. (2016) in Frage und schlagen stattdessen seine ursprüngliche Einordnung in *Molinio-Arrhenatheretea* vor (Brullo & Grillo 1978, Biondi et al. 2014, Guarino & Pasta 2017, Guarino & Pignatti 2019). Die Studie stellt auch die von Mucina et al. (2016) vorgeschlagene Einteilung der sizilianischen oromediterranen Vegetation in verschiedene Klassen für acidophile und basiphile Gemeinschaften in Frage. Aufgrund der Fülle lokaler endemischer Arten sowie der bemerkenswerten regionalen floristischen Affinitäten zwischen den acidophilen und basiphilen Einheiten der oromediterranen Vegetation des sizilianischen (und kalabrischen) Hochgebirges ist es fragwürdig, die untersuchte Vegetation in zwei verschiedene Klassen einzuteilen. Die Arbeit erfordert einen biogeographisch und phylogenetisch fundierteren Ansatz zur Klassifizierung dieser komplexen Ökosysteme.

Schlussfolgerung – diese Studie füllt eine Wissenslücke über die Vegetation in den höchsten Lagen der Madonie-Berge, erweitert die Klassifikation der oromediterranen Grasländer und identifiziert zwei neue Assoziationen. Außerdem werden syntaxonomische Probleme mit bereits beschriebenen Assoziationen aufgezeigt. Weitere Forschungen und Vergleiche mit Grasländern aus anderen Mittelmeerregionen sind erforderlich, um die Probleme bei der Klassifikation zu lösen und das Verständnis für die ökologische und biogeografische Bedeutung dieser einzigartigen Gemeinschaften zu verbessern.

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Author contribution statement

CM, ASG, and RG conceived the idea. CM, ASG, MC, GG, VI, and RG carried out fieldwork and species identification. Sara P conducted the soil analysis. CM led the data analyses and wrote the first draft of the manuscript. All authors contributed and revised drafts, and agreed on the manuscript before being submitted for publication.

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Supplements

Supplement S1. *Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. *ass. nova*.

Beilage S1. *Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. *ass. nova*.

Supplement S2. *Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. *ass. nova*.

Beilage S2. *Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. *ass. nova*.

Supplement S3. Synoptic table of the percentage frequencies of the diagnostic species in the associations mentioned throughout the text.

Beilage S3. Übersichtstabelle über die prozentualen Häufigkeiten der diagnostischen Arten in den im Text erwähnten Verbänden.

Additional supporting information may be found in the online version of this article.

Zusätzliche unterstützende Information ist in der Online-Version dieses Artikels zu finden.

Supplement E1. Full dataset table.

Anhang E1. Tabelle des vollständigen Datensatzes.

Supplement E2. Mann-Whitney *U*-tests of the differences between the two newly described associations.

Anhang E2. Mann-Whitney *U*-Tests der Unterschiede zwischen den beiden neu beschriebenen Assoziationen.

Supplement E3. Short description of the phytosociological associations and nomenclatural considerations.

Anhang E3. Kurze Beschreibung der pflanzensoziologischen Assoziationen und nemenklatorischen Überlegungen.

Supplement E4. Confusion matrix between the classified associations.

Anhang E4. Konfusionsmatrix zwischen den klassifizierten Assoziationen.

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Supplement S1. *Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. *ass. nova*. The holotypus is marked by (*). Relevé area for all plot is 4 m^2.

Beilage S1. *Androsaco breistrofferi-Potentilletum calabrae* C. Marcenò et al. *ass. nova*. Der Holotypus ist mit einem (*) gekennzeichnet. Relevante Fläche für alle Parzellen ist 4 m^2

Relevé number	11	25	21	37	7	31	23	14	38	40	41*	30	35	36	27
Altitude (m)	1899	1922	1929	1889	1908	1919	1928	1944	1900	1935	1936	1921	1897	1911	1904
Aspect (°)	207	62	186	64	265	307	114	231	63	216	262	188	42	315	248
Slope (°)	14	4	8	1	20	2	3	6	4	12	4	7	2	3	2
N° species	23	25	17	21	18	19	11	16	16	16	17	18	14	18	15
Total vegetation cover (%)	80	60	70	70	90	90	90	95	75	80	90	95	95	95	90
Diagnostic species of the association															
Capsella rubella	r	1	.	.	r	r	r	r	+	r	r	r	r	r	1
Lepidium nebrodense	.	.	.	.	.	r	.	.	.	.	.	+	r	r	2
Viola parvula	.	.	r	.	.	.	r	.	.	.	r	.	r	r	.
Microthlaspi perfoliatum	.	r	.	.	r	.	.	.	.	.	r	r	.	r	.
Androsace elongata subsp. *breistrofferi*	.	r	.	r	.	.	.	.	.	.	+	.	.	.	r
Blitum bonus-henricus	.	.	.	2	.	.	.	.	.	r	r	.	.	.	.
Diagnostic species of high rank syntaxa															
Potentilla calabra	2	3	.	2	2	3	3	2	+	r	3	3	4	4	3
Anthemis arvensis subsp. *sphacelata*	2	2	2	1	2	r	2	2	1	.	.	r	r	r	r
Trifolium repens	3	+	2	2	2	3	3	.	3	3	2	1	.	3	+
Lolium perenne	4	3	2	4	5	4	4	5	3	.	.	.	.	.	.
Scleranthus annuus	2	.	.	r	r	.	.	r	r	.	.	2	.	.	r
Trifolium pratense subsp. *semipurpureum*	.	.	.	.	.	+	.	r	.	+	.	.	+	.	.
Other species															
Cerastium tomentosum	.	.	.	+	1	r	1	2	r	2	2	3	.	2	2
Festuca circummediterranea	.	2	2	2	2	.	2	.	+	r	.	.	2	2	2
Galium lucidum subsp. *bernardii*	r	1	.	.	.	r	.	r	.	3	3	2	2	2	2
Herniaria nebrodensis	.	.	.	2	r	2	.	.	r	1	2	3	2	+	4
Veronica praecox	r	.	.	r	r	.	.	r	.	r	r	r	r	r	r
Euphorbia myrsinites	1	.	.	+	r	r	r	.	2	.	.	r	.	r	.
Poa bulbosa	+	.	2	2	.	.	.	+	.	2	+	r	r	.	.
Polycarpon polycarpoides	.	2	2	.	r	.	.	3	2	.	r	2	.	.	.
Astragalus depressus	.	r	.	.	r	+	.	.	r	.	.	.	r	.	r
Bellis perennis	.	2	+	r	2	.	.	r	.	r	.	.	.	.	.
Draba praecox	r	r	r	r	.	.	.	.	.	.	.	r	r	.	.
Cynosurus echinatus	.	.	r	.	.	r	.	r	.	.	.	.	.	r	r
Filago discolor	r	.	.	.	.	r	.	.	.	.	r	r	.	.	r
Hypochaeris laevigata	.	.	.	r	.	.	.	.	1	.	.	+	.	r	.
Viola nebrodensis	.	r	.	.	r	.	.	.	.	r	r	.	.	.	.
Acinos alpinus	r	r	+	.	.	.	.	.	.	.	.	.	.	.	.
Alyssum simplex	r	r	.	.	.	.	.	r	.	.	.	.	.	.	.
Arenaria serpyllifolia	r	.	r	r	.	.	.	.	.	.	.	.	.	r	.
Cerastium tauricum	.	r	.	.	.	r	.	.	.	.	r	.	.	.	.
Crepis vesicaria subsp. *taraxacifolia*	.	r	r	.	.	.	.	r	.	.	.	.	.	.	.
Erysimum bonannianum	.	r	r	.	.	.	.	.	r	.	.	.	.	.	.
Filago arvensis	.	r	r	r	.	.	.	.	.	.	.	.	.	.	.
Noccaea rivalis	.	r	.	.	.	r	.	.	.	r	.	.	.	.	.
Petrorhagia saxifraga subsp. *gasparrini*	r	.	.	.	.	.	.	.	r	.	.	r	.	.	.
Aethionema saxatile	r	.	.	.	.	.	.	r	.	.	.	.	.	.	.
Centaurea parlatoris	1	.	.	.	r	.	.	.	.	.	.	.	.	.	.
Crepis leontodontoides	.	.	.	.	.	r	.	.	.	.	.	.	.	r	.
Dactylis glomerata	1	.	.	.	.	.	.	.	.	.	.	.	.	2	.
Medicago lupulina subsp. *cupaniana*	1	.	.	.	.	.	.	.	2	.	.	.	.	.	.
Minuartia mediterranea	.	r	.	.	.	.	r	.	.	.	.	.	.	.	.
Myosotis incrassata	.	r	r	.	.	.	.	.	.	.	.	.	.	.	.
Veronica verna	.	.	.	.	.	r	r	.	.	.	.	.	.	.	.

Records with a single occurrence. **Other species:** *Achillea ligustica* (11, r); *Cachrys ferulacea* (11, r); *Cerastium semidecandrum* (35, r); *Festuca rubra* subsp. *microphylla* (31, 2); *Gagea* cfr. *foliosa* (41, r); *Geranium molle* (37, r); *Helianthemum cinereum* (11, 2); *Minuartia verna* (37, r); *Petrorhagia prolifera* (21, r); *Phleum hirsutum* subsp. *ambiguum* (37, r); *Poa bivonae* (25, r); *Scandix pecten-veneris* subsp. *brachycarpa* (25, r); *Scilla bifolia* (40, r); *Siculosciadium nebrodense* (40, 2); *Sinapis pubescens* (7, r).

Supplement S2. *Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. *ass. nova*. The holotypus is marked by (*). Relevé area for all plot is 4 m^2. All vegetation plots were sampled in June 2022.

Beilage S2. *Helianthemo tomentosi-Festucetum crassifoliae* C. Marcenò et al. *ass. nova*. Der Holotypus ist mit (*) gekennzeichnet. Relevante Fläche für alle Parzellen ist 4 m^2. Alle Vegetationsaufnahmen wurden im Juni 2022 angefertigt.

Relevé number	28	5	2	42	9	34	8	6	15	12*	22	39	26	4	33
Altitude (m)	1930	1928	1930	1957	1920	1908	1911	1962	1960	1965	1934	1932	1928	1921	1900
Aspect (°)	354	7,5	264	306	141	162	97,1	33,9	39,7	62,4	350	9,1	86,9	164	10,2
Slope (°)	11,8	10,6	17,8	13,5	19,9	8,6	14,4	13	6	6,1	13,4	10,9	8,5	17,3	16,5
N° species	17	27	38	32	26	31	26	27	35	28	35	29	31	43	35
Total vegetation cover (%)	60	55	40	80	45	45	37	70	61	48	60	50	50	60	75
Diagnostic species of the association															
Festuca laevigata subsp. *crassifolia*	.	3	2	3	.	.	2	2	3	3	3	.	.	2	.
Scandix pecten-veneris subsp. *brachycarpa*	r	r	r	1	r	r	r	.	r	r	r	r	r	r	r
Silene conica	r	r	r	+	.	r	.	r	r	r	r	r	r	r	r
Crepis vesicaria subsp. taraxacifolia	.	r	2	r	r	r	r	.	+	r	r	r	.	r	r
Xeranthemum inapertum	.	2	r	r	r	r	.	.	r	r	r	r	r	r	r
Medicago lupulina subsp. *cupaniana*	2	r	r	.	.	r	r	.	r	r	r	2	+	r	1
Cachrys ferulacea	r	r	r	.	+	r	+	r	r	.	r	.	.	r	.
Cerastium tauricum	r	r	r	r	.	.	.	.	.	r	.	r	r	r	r
Myosotis incrassata	.	r	r	r	.	.	.	r	r	.	r	r	r	.	r
Helianthemum nummularium subsp. *tomentosum*	.	1	.	.	+	r	r	2	1	2	.	2	.	1	.
Phleum hirsutum subsp. *ambiguum*	.	.	.	.	1	r	+	.	1	.	r	.	r	+	r
Saxifraga adscendens subsp. *parnassica*	.	.	r	.	.	.	.	.	r	r	.	.	.	.	r
Buglossoides incrassata subsp. *splitgerberi*	.	.	r	+	.	r	.	.	.	.	.	.	.	.	r
Diagnostic species of high rank sintaxa															
Helianthemum cinereum	1	+	.	.	r	r	+	1	r	r	.	r	r	r	.
Euphorbia myrsinites	.	2	r	r	.	2	.	.	.	r	r	r	r	r	r
Galium lucidum subsp. *bernardii*	2	1	.	.	.	.	+	.	2	.	.	2	+	1	r
Cerastium tomentosum	.	.	+	.	3	+	+	r	2	.	.	.	3	3	.
Sideritis sicula	.	.	r	.	.	2	1	.	.	r	.	.	.	r	2
Poa bivonae	+	.	2	r	.	.	.	+	.	.	r	r	.	.	.
Herniaria nebrodensis	2	.	.	.	.	.	.	r	.	r	.	r	.	r	r
Alyssum nebrodense	.	.	.	.	r	r	.	.	r	+	.	.	.	.	r
Astragalus nebrodensis	.	.	.	.	r	r	.	.	.	.	.	.	.	1	2
Other species															
Sedum amplexicaule	r	+	r	r	r	r	.	r	r	r	r	r	r	r	r
Cynosurus echinatus	r	r	r	+	r	r	.	.	r	.	2	r	r	r	r
Bromus hordeaceus	r	r	r	r	.	.	r	+	r	r	r	.	r	r	r
Poa bulbosa	2	2	2	4	.	r	.	2	r	.	+	2	+	1	r
Anisantha tectorum	.	1	r	2	r	.	.	2	r	r	1	r	r	r	r
Draba praecox	r	r	r	r	.	.	.	r	r	.	r	r	r	r	r
Arenaria serpyllifolia	.	r	r	r	r	.	.	r	.	.	r	r	+	r	r
Veronica praecox	.	.	r	r	r	r	.	.	r	r	r	r	r	.	r
Petrorhagia prolifera	.	.	r	r	.	r	.	r	r	.	r	r	.	r	.
Carduus nutans subsp. *macrocephalus*	.	r	r	r	.	.	.	.	.	r	r	r	r	r	.
Erysimum bonannianum	.	.	.	r	.	r	r	.	.	.	r	+	r	r	r
Sedum album	.	.	.	.	.	r	+	r	r	r	r	.	r	r	.
Geranium molle	.	.	r	r	r	.	.	.	.	.	r	r	r	.	r
Veronica verna	.	r	.	r	.	.	r	r	.	.	.	.	r	r	.
Ranunculus millefoliatus	.	r	.	r	.	r	.	.	r	r	r	.	.	.	.
Trifolium striatum	.	r	.	1	.	r	.	.	.	.	r	.	r	.	r
Valeriana tuberosa	.	+	r	.	.	.	.	+	r	r	r	.	.	.	.
Festuca circummediterranea	3	.	2	.	2	2	.	.	.	.	.	.	2	.	4
Allium cupanii	.	.	.	r	.	r	.	.	.	.	r	r	.	.	r
Senecio vulgaris	.	.	.	.	.	.	.	.	.	.	r	r	r	.	r
Alyssum simplex	r	.	.	.	.	.	.	.	.	.	.	.	r	r	r
Galium verticillatum	.	.	r	.	r	.	r	.	.	.	.	.	.	r	.
Silene sicula	.	.	.	.	.	r	+	.	+	.	.	r	.	.	.
Minuartia verna	+	.	.	.	.	.	.	2	.	+	.	.	.	r	.
Anthemis arvensis subsp. *sphacelata*	.	r	r	.	.	.	.	.	.	.	.	.	.	r	r
Pimpinella tragium	.	.	.	.	.	.	.	2	1	1	.	.	.	.	r
Hornungia petraea	.	.	r	.	.	.	r	r	.	.	.	.	.	.	.
Buglossoides arvensis	.	.	r	.	.	.	.	.	.	r	r	.	.	.	.
Clypeola jonthlaspi	.	.	.	.	.	.	.	r	.	r	.	r	.	.	.
Papaver dubium	.	.	r	r	.	.	r	.	.	.	.	.	.	.	.
Acinos alpinus	.	.	r	.	.	.	+	.	r	.	.	.	.	.	.
Saxifraga granulata	.	.	.	r	.	.	.	.	.	r	r	.	.	.	.
Trifolium arvense	.	.	.	.	.	.	.	.	.	.	r	.	.	r	.
Capsella rubella	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.
Muscari neglectum	.	.	.	r	.	.	.	.	.	.	.	.	r	.	.
Geranium pyrenaicum	.	.	r	.	.	.	r	.	.	.	.	.	.	.	.
Allium flavum	.	.	.	.	.	.	.	r	.	.	.	.	.	r	.
Minuartia mediterranea	.	.	.	.	.	.	.	.	r	r	.	.	.	.	.
Lamium amplexicaule	.	.	.	.	r	.	.	.	.	.	.	.	.	r	.
Draba turgida	.	.	.	.	.	.	.	r	r	.	.	.	.	.	.
Lathyrus sphaericus	.	.	.	.	r	.	.	.	.	.	.	.	r	.	.
Polycarpon polycarpoides	.	.	r	.	.	.	.	.	r	.	.	.	.	.	.
Centaurea parlatoris	.	.	.	.	.	.	.	.	.	.	r	.	.	1	.
Trifolium scabrum	.	.	.	.	.	.	.	.	r	.	.	.	.	r	.
Aethionema saxatile	.	r	.	.	r	.	.	.	.	.	.	.	.	.	.
Teucrium chamaedrys	.	.	.	.	+	2	.	.	.	.	.	.	.	.	.
Noccaea rivalis	.	.	.	.	.	.	.	.	r	.	.	.	.	.	r
Arabidopsis thaliana	.	.	.	.	.	.	r	.	.	.	.	.	.	r	.

Records with a single occurrence. **Diagnostic species of high rank sintaxa:** *Viola nebrodensis* (8, r); *Filago discolor* (2, r). **Other species:** *Cerastium semidecandrum* (34, r); *Sedum acre* (6, r); *Galium verum* (4, r); *Alyssum siculum* (34, r); *Vicia glauca* (8, r); *Trifolium stellatum* (42, r); *Filago arvensis* (9, r); *Rosa sicula* (22, r); *Sinapis pubescens* (4, r); *Cuscuta* sp. (9, r); *Astragalus depressus* (42, r); *Dactylis glomerata* (8, 1); *Lactuca viminea* (9, r); *Micromeria juliana* (4, r); *Hypochaeris laevigata* (33, r); *Petrorhagia saxifraga* subsp. *gasparrini* (39, 3); *Helictochloa cincinnata* (15, 2); *Valerianella discoidea* (2, r); *Sedum hispanicum* (22, r); *Ranunculus bulbosus* (6, r); *Triticum vagans* (4, r); *Vicia lathyroides* (9, r); *Anthemis cretica* (8, r); *Arenaria leptoclados* (34, r).

Supplement S3. Synoptic table of the percentage frequencies of the diagnostic species in the associations mentioned throughout the text. Only the species with frequency within individual alliances of at least 20% are reported. Grey shading indicates diagnostic species with higher fidelity (light grey: *phi* >0.30; dark grey: *phi* >0.70). Clusters refer to the associations listed in figure 3. Character and Differential Species (CDS) of the higher rank syntaxa, taken from the literature, are marked with the following codes: 1. *Molinio-Arrhenatheretea;* 1.1. *Cirsietalia vallis-demonis;* 1.1.1. *Plantaginion cupanii;* 2. *Rumici Astragaletea siculi;* 2.1. *Erysimo-Jurinetalia bocconei;* 2.1.1. *Armerion nebrodensis;* 2.1.2 *Cerastio-Astragalion nebrodensis.*

Beilage S3. Übersichtstabelle über die prozentualen Häufigkeiten der diagnostischen Arten in den im Text erwähnten Verbänden. Es werden nur die Arten aufgeführt, deren Häufigkeit in den einzelnen Verbänden mindestens 20 % beträgt. Graue Schattierungen kennzeichnen diagnostische Arten mit höherer Treue (hellgrau: *phi* >0,30; dunkelgrau: *phi* >0,70). Die Cluster beziehen sich auf die in Abbildung 3 aufgeführten Assoziationen. Charakter- und Differenzialarten der höherrangigen Syntaxa, die der konsultierten Literatur entnommen wurden, sind mit den folgenden Codes gekennzeichnet: 1. *Molinio-Arrhenatheretea;* 1.1. *Cirsietalia vallis-demonis;* 1.1.1. *Plantaginion cupanii* ; 2. *Rumici Astragaletea siculi;* 2.1. *Erysimo-Jurinetalia bocconei;* 2.1.1. *Armerion nebrodensis;* 2.1.2 *Cerastio-Astragalion nebrodensis.*

CDS	Clusters	a	b	c	d	e	f	g	f	h	i	j	k
	Number of plots	15	4	15	12	15	14	7	8	18	7	15	18
	Androsaco breistrofferi-Potentilletum calabrae												
	Microthlaspi perfoliatum	33	.	.	.	.	.	.	.	.	.	.	.
	Viola parvula	33	.	.	.	.	.	.	.	.	.	.	.
	Androsace elongata subsp. *breistrofferi*	27	.	.	.	.	.	.	.	.	.	.	.
	Cynosuro cristati-Plantaginetum cupanii												
	Colchicum bivonae	.	75	.	.	.	.	.	.	.	.	.	.
	Trifolium phleoides	.	75	13	.	.	.	.	.	.	.	.	.
1.	*Prunella vulgaris*	.	75	20	.	.	.	.	.	.	.	.	.
	Petrorhagia illyrica	.	75	.	.	.	.	.	.	.	14	.	17
	Carlina sicula	.	50	.	.	.	.	.	.	.	.	.	.
1.1.	*Hypochaeris radicata*	.	50	.	.	.	.	.	.	.	.	.	.
	Aira cupaniana	.	50	.	.	.	.	.	.	.	.	.	.
	Erodium acaule	.	50	13	.	.	.	.	.	.	.	.	.
	Trifolium glomeratum	.	50	13	.	.	.	.	.	.	.	.	.
	Trifolium micranthum	.	50	20	.	.	.	.	.	.	.	.	.
	Triticum vagans	.	50	.	.	7	.	.	.	.	.	20	.
	Galium verum	.	50	13	.	7	.	.	.	.	14	.	.
	Juncus bufonius	.	25	.	.	.	.	.	.	.	.	.	.
	Gagea foliosa	.	25	.	.	.	.	.	.	.	.	.	.
	Taraxacum species	.	25	.	.	.	.	.	.	.	.	.	.
	Carex leporina	.	25	.	.	.	.	.	.	.	.	.	.
	Ranunculus marginatus	.	25	.	.	.	.	.	.	.	.	.	.
	Corydalis solida subsp. *densiflora*	.	25	.	.	.	.	.	.	.	.	.	.
	Agrostis stolonifera	.	25	.	.	.	.	.	.	.	.	.	.
	Scilla bifolia	7	25	.	.	.	.	.	.	.	.	.	.
	Sinapis pubescens	7	50	.	.	7	21	.	.	.	.	33	.
	Sagina apetala	.	25	20	.	.	.	.	.	.	.	.	.
	Centaurea solstitialis subsp. *schouwii*	.	25	.	.	.	21	.	.	.	.	.	.
	Armerio nebrodensis-Plantaginetum cupanii												
	Trifolium campestre	.	.	87	8	.	.	.	.	.	.	13	.
	Trifolium arvense	.	.	60	17	13	.	.	.	.	.	.	.
	Sedum acre	.	.	40	.	7	.	.	.	.	.	.	.
	Veronica arvensis	.	25	47	8	.	.	.	.	.	.	.	.
1.1.1.	*Crepis vesicaria* subsp. *bivonana*	.	.	27	.	.	7	.	.	.	.	.	.
1.1.1.	*Trifolium bivonae*	.	25	33	.	.	.	.	.	.	.	.	.
	Moenchia erecta	.	25	40	17	.	.	.	.	.	.	.	.
1.	*Bellis perennis*	40	50	60	8	.	.	14	.	17	.	13	.
	Hypochaeris cretensis	.	.	27	.	.	7	14	.	.	.	7	.
	Plantagini humilis-Armerietum nebrodensis												
	Plantago subulata	.	.	.	100	.	.	.	.	.	.	.	.
	Saxifraga granulata	.	.	.	83	20	7	.	.	17	.	.	.
	Bellardiochloa variegata subsp. *nebrodensis*	.	.	.	42	.	.	.	.	.	.	.	.
2.	*Rumex acetosella* subsp. *multifidus*	.	.	.	42	.	.	.	.	.	.	.	.
	Minuartia recurva subsp. *condensata*	.	.	.	42	.	.	.	.	.	.	.	.
	Juniperus communis subsp. *hemisphaerica*	.	.	.	33	.	.	.	.	.	.	.	.
2.1.1.	*Genista cupanii*	.	.	.	33	.	.	.	.	.	.	.	.
	Jasione montana	.	.	.	25	.	.	.	.	.	.	.	.
	Scleranthus annuus	47	50	53	75	.	.	.	.	.	.	.	.
	Hornungia petraea	.	.	.	33	20	.	.	.	.	.	.	.
	Minuartia verna	7	.	.	75	27	29	.	25	61	43	.	33
	Helianthemo tomentosi-Festucetum crassifoliae												
	Scandix pecten-veneris subsp. *brachycarpa*	7	.	.	.	93	.	.	.	.	.	.	.
	Crepis vesicaria subsp. *taraxacifolia*	20	.	.	.	80	.	.	.	.	.	.	.
	Festuca laevigata subsp. *crassifolia*	.	.	.	.	60	.	.	.	.	.	.	.
	Xeranthemum inapertum	.	.	.	8	80	.	.	.	.	.	33	11
	Cerastium tauricum	20	.	.	.	60	.	.	.	.	.	.	.
	Sideritis sicula	.	.	.	.	40	.	.	.	.	.	.	.
	Silene conica	.	.	.	50	87	7	.	.	.	.	47	.
	Petrorhagia prolifera	7	.	13	8	53	.	.	.	.	.	.	.
	Veronica verna	13	.	.	.	40	.	.	.	.	.	.	.
	Geranium molle	7	.	.	.	47	.	.	.	.	.	20	.
	Buglossoides incrassata subsp. *splitgerberi*	.	.	.	.	27	.	.	.	.	.	.	.
	Saxifraga adscendens subsp. *parnassica*	.	.	.	.	27	.	.	.	.	.	.	.
	Senecio vulgaris	.	.	.	.	27	.	.	.	.	.	.	.
	Cynosurus echinatus	33	.	27	42	80	.	.	.	.	.	47	.
	Poa bivonae	7	.	.	.	40	.	.	.	.	.	.	17
	Myosotis incrassata	13	25	20	17	60	.	.	.	.	.	.	.
	Arenaria serpyllifolia	20	.	27	42	67	.	.	.	.	.	40	.
1.1.1.	*Medicago lupulina* subsp. *cupaniana*	13	50	.	.	80	.	14	.	6	57	60	28
	Alyssum simplex	20	.	.	.	27	.	.	.	.	.	.	.
	Lino punctati-Seslerietum siculae senecionetosum candidi												
	Thymus spinulosus	.	.	.	.	.	79	.	.	.	.	.	.
	Asphodelus ramosus	.	.	.	.	.	50	.	.	.	.	.	.
	Carthamus pinnatus	.	.	.	.	.	50	.	.	.	.	.	.
	Scutellaria columnae subsp. *columnae*	.	.	.	.	.	57	.	.	11	.	.	.
	Catapodium rigidum	.	.	.	.	.	43	.	.	.	.	7	.
	Jacobaea candida	.	.	.	.	.	50	.	13	.	.	13	.
	Sanguisorba minor	.	.	.	.	.	29	.	.	.	.	.	.
	Stipa sicula	.	.	.	.	.	36	.	.	11	.	.	.
	Eryngium campestre	.	50	13	.	.	71	43	.	6	.	.	.
	Saxifraga adscendens	.	.	.	.	.	29	.	.	6	.	.	.
	Orobanche species	.	.	.	.	.	29	.	.	17	.	.	.
	Rumex scutatus	.	.	.	.	.	21	.	.	6	.	.	.
	Scorzonera villosa subsp. *columnae*	.	.	.	8	.	36	29	.	.	.	7	.
2.	*Carlina nebrodensis*	.	.	.	33	.	79	29	38	72	.	47	44
	Astragaletum nebrodensis												
	Hyoseris radiata	.	.	.	.	.	29	100	25	17	.	47	17
	Achillea ligustica	7	.	.	.	.	36	71	.	.	.	40	22
2.	*Phleum ambiguum*	7	.	27	33	53	57	100	13	44	.	87	72
	Thymus striatus	.	.	.	.	.	.	29	25	.	.	.	.
2.1.2.	*Astragalus nebrodensis*	.	.	.	.	27	71	100	63	94	57	87	94
	Lino punctati-Seslerietum siculae typicum												
	Dianthus siculus	.	.	.	.	.	14	14	88	22	.	.	.
	Cuscuta epithymum	.	.	.	.	.	.	.	38	.	.	.	.
	Draba turgida	.	.	.	.	13	.	.	38	.	.	.	.
	Crupina crupinastrum	.	.	.	.	.	.	.	25	.	.	.	.
	Euphorbia rigida	.	.	.	.	.	.	29	50	39	.	27	.
	Carthamo pinnati-Thymetum spinulosi												
	Laserpitium siler subsp. *siculum*	.	.	.	.	.	7	14	25	78	.	.	.
	Edraianthus graminifolius subsp. *siculus*	.	.	.	.	.	.	.	.	33	.	.	.
	Sorbus graeca	.	.	.	.	.	.	.	.	28	.	.	.
	Juniperus communis subsp. *hemisphaerica*	.	.	.	.	.	7	14	13	44	.	.	.
	Iberis violacea	.	.	.	.	.	.	.	.	22	.	.	.
	Orchis quadripunctata subsp. *brancifortii*	.	.	.	.	.	7	.	.	28	.	.	.
	Hypochaeris laevigata	27	.	20	8	7	71	71	25	83	14	.	11

Continued on back page
Fortsetzung auf der Rückseite

CDS	Clusters	a	b	c	d	e	f	g	f	h	i	j	k
	Number of plots	15	4	15	12	15	14	7	8	18	7	15	18
	Siculosciadetum nebrodensis												
	Siculosciadium nebrodense	7	.	.	.	.	.	.	.	.	100	.	.
	Sedum hispanicum	.	.	.	8	7	.	.	.	.	100	.	.
	Malva moschata	.	.	.	.	.	.	.	.	.	86	.	.
	Reichardia picroides	.	.	.	.	.	29	.	.	.	100	.	.
1.1.	*Trifolium pratense* subsp. *semipurpureum*	27	25	27	.	.	.	.	.	.	100	.	11
1.1.	*Rumex nebroides*	.	.	.	.	.	.	.	.	.	57	.	17
	Aethionema saxatile	13	.	.	8	13	21	.	.	28	86	.	.
2.1.	*Allium cupanii*	.	.	.	25	33	7	14	.	11	86	.	33
2.	*Herniaria nebrodensis*	67	50	20	67	40	.	.	.	.	86	.	.
	Anthyllis vulneraria subsp. *maura*	.	.	.	.	.	64	43	63	72	86	20	39
2.	*Centaurea parlatoris*	13	.	7	17	13	86	86	63	83	100	33	89
	Cachryetum ferulaceae												
	Alyssum siculum	.	.	.	.	7	14	.	.	6	.	60	.
	Verbascum siculum	.	.	.	.	.	.	.	.	.	.	33	.
	Stachys germanica	.	.	.	.	.	.	.	.	.	.	33	6
	Galium verticillatum	.	.	.	.	27	.	.	.	.	.	47	.
	Scandix pecten-veneris	.	.	.	.	.	.	.	.	.	.	27	.
	Scorzoneroides cichoriacea	.	.	.	.	.	.	.	.	.	.	27	.
	Berberis aetnensis	.	.	.	.	.	.	.	.	.	.	27	6
	Filago arvensis	20	.	20	25	7	.	.	.	.	.	53	.
	Trifolium stellatum	7	.	7	.	7	.	.	.	.	.	33	.
	Vicia glauca	.	.	.	.	7	.	.	.	.	.	27	11
2.	*Rosa sicula*	.	.	.	.	7	7	29	.	11	.	47	22
	Filago discolor	33	.	13	.	7	.	.	.	.	.	40	.
1.1.1.	*Arrhenatherum elatius* subsp. *nebrodense*	.	.	.	.	.	21	14	.	6	.	47	39
2.1.2.	*Knautia calycina*	.	.	.	.	.	14	14	.	33	.	47	28
	Siderito siculae-Artemisietum albae												
2.1.2.	*Anthyllis vulneraria* subsp. *busambarensis*	.	.	.	.	.	.	.	.	.	.	.	39
	Lactuca viminea	.	.	.	.	7	43	.	.	.	.	33	72
	Helianthemum oelandicum subsp. *nebrodense*	.	.	.	.	.	.	.	.	11	.	.	33
	Verbascum rotundifolium	.	.	.	.	.	.	.	.	.	.	.	22
	Sternbergia colchiciflora	.	.	.	.	.	.	.	.	.	.	.	22
	Allium sphaerocephalon subsp. *arvense*	.	.	.	.	.	36	.	.	44	.	33	67
	Allium flavum	.	.	.	.	13	.	.	.	6	.	.	33
	Asphodeline lutea	.	.	.	.	.	7	.	.	.	.	27	39
2.1.2.	*Viola nebrodensis*	27	.	.	.	7	.	.	.	.	.	33	50
	Matthiola fruticulosa	.	.	.	.	.	.	.	.	17	.	.	28
2.	*Valeriana tuberosa*	.	.	.	67	40	.	14	25	11	71	33	83
2.	*Arabis collina* subsp. *rosea*	.	.	.	50	.	29	43	.	67	29	13	78
	Diagnostic species for more than one association												
1.	*Dactylis glomerata*	13	50	40	.	7	36	43	.	6	100	73	100
2.1.	*Cachrys ferulacea*	7	.	20	.	67	29	43	13	22	100	80	100
2.1.	*Acinos alpinus* var. *nebrodensis*	20	.	13	50	20	29	14	.	50	43	93	83
1.1.1.	*Anthemis arvensis* subsp. *sphacelata*	87	75	100	.	27	7	29	38	.	57	20	.
2.1.	*Erysimum bonannianum*	20	.	.	25	53	36	43	.	17	100	87	78
	Poa bulbosa	53	75	33	.	80	.	.	25	11	.	27	50
	Sedum amplexicaule	.	50	.	92	93	29	57	.	22	.	47	50
2.	*Silene sicula*	.	.	.	42	27	43	86	.	61	29	67	94
2.	*Bunium petraeum*	.	.	20	33	.	71	14	.	44	100	13	89
	Cerastium semidecandrum	7	75	93	33	7	43	.	.	.	.	33	.
	Micromeria juliana	.	.	.	.	7	64	14	63	33	.	27	11
2.1.2.	*Inula montana*	.	.	.	8	.	43	29	75	33	.	47	83
2.1.2.	*Alyssum nebrodense*	.	.	.	.	33	64	57	13	61	.	80	89
2.1.2.	*Helictochloa cincinnata*	.	.	.	.	7	93	86	38	67	.	20	89
2.1.2.	*Asperula aristata* subsp. *oreophila*	.	.	.	17	.	93	71	88	89	.	40	67
2.1.2.	*Euphorbia myrsinites*	53	.	.	.	67	93	.	.	28	100	60	94
2.1.	*Helianthemum croceum*	.	.	.	.	.	57	57	100	72	.	7	6
2.1.2.	*Pimpinella tragium*	.	.	.	.	27	71	14	100	83	.	.	33
2.1.	*Lomelosia crenata* var. *hirsuta*	.	.	.	8	.	36	57	75	83	.	7	.
2.1.2.	*Sesleria nitida* subsp. *sicula*	.	.	.	.	.	36	57	88	100	.	27	61
2.	*Koeleria splendens*	.	.	.	17	.	86	57	88	100	.	.	39
1.	*Bromus hordeaceus*	.	75	33	.	80	14	.	.	.	.	53	.
	Crepis vesicaria subsp. *vesicaria*	.	75	.	.	.	.	.	.	11	100	47	56
	Carduus nutans subsp. *macrocephalus*	.	50	20	.	53	.	.	.	6	.	33	.
	Anisantha tectorum	.	50	13	.	80	.	.	.	.	.	27	6
	Anthemis cupaniana	.	.	.	100	.	.	29	.	78	.	20	28
	Draba verna	40	25	27	83	73	.	.	.	.	.	.	.
	Helianthemum nummularium subsp. *tomentosum*	.	.	.	.	60	7	.	.	17	.	7	94
	Astragalus depressus	40	.	.	.	7	.	.	.	.	29	40	.
1.	*Lolium perenne*	60	100	73	.	.	.	.	.	.	.	13	.
1.1.	*Trifolium striatum*	.	75	67	8	40	.	.	.	.	.	.	.
2.1.	*Dianthus arrostii*	.	.	.	58	.	29	.	.	56	.	40	.
	Linaria simplex	.	.	.	.	.	36	.	.	11	.	40	6
	Linum punctatum	.	.	.	.	.	14	14	50	50	.	.	.
	Trifolium repens	87	100	33	.	.	.	.	.	.	86	.	.
	Onosma echioides subsp. *canescens*	.	.	.	.	.	64	14	63	72	.	.	.
	Sideritis italica	.	.	.	.	.	71	.	.	28	.	73	100
	Capsella rubella	87	50	.	.	13	.	.	.	.	.	.	.
1.1.	*Potentilla calabra*	93	50	80	.	.	.	.	.	.	.	.	.
1.1.1.	*Plantago cupanii*	.	100	100	25	.	.	.	.	.	.	.	.
1.	*Anthoxanthum odoratum*	.	75	67	33	.	.	.	.	.	.	.	.
1.1.	*Ornithogalum montanum*	.	50	40	.	.	.	.	.	.	.	7	.
	Ranunculus millefoliatus	.	.	40	17	40	.	.	.	.	.	.	.
	Teucrium montanum	.	.	.	.	.	43	.	75	67	.	.	.
	Arenaria grandiflora	.	.	.	.	.	36	.	63	56	.	.	.
	Veronica praecox	67	.	.	.	67	.	.	.	.	.	.	.
	Lepidium nebrodense	33	50	.	.	.	.	.	.	.	.	.	.
	Vulpia sicula	.	100	80	.	.	.	.	.	.	.	.	.
1.	*Cynosurus cristatus*	.	75	60	.	.	.	.	.	.	.	.	.
	Romulea columnae	.	75	60	.	.	.	.	.	.	.	.	.
	Leontodon tuberosus	.	75	93	.	.	.	.	.	.	.	.	.
	Plantago lagopus	.	50	33	.	.	.	.	.	.	.	.	.
	Ranunculus paludosus	.	50	47	.	.	.	.	.	.	.	.	.
2.1.1.	*Armeria nebrodensis*	.	.	73	100	.	.	.	.	.	.	.	.
	Aira caryophyllea	.	.	47	50	.	.	.	.	.	.	.	.
2.	*Saponaria sicula*	.	.	.	.	.	36	.	.	28	.	.	.
	Festuca ovina	.	.	.	.	.	.	57	88	.	.	.	.
	Artemisia alba	.	.	.	.	.	.	.	.	.	.	73	61
	Melica cupanii	.	.	.	.	.	.	.	.	.	.	40	39
	Other species												
2.	*Cerastium tomentosum*	73	50	.	17	53	36	100	75	72	100	93	100
2.	*Petrorhagia saxifraga* subsp. *gasparrinii*	20	.	87	67	7	64	57	50	50	100	87	89
2.1.	*Galium lucidum* subsp. *bernardii*	67	.	.	17	53	50	100	88	89	86	53	89
	Festuca circummediterranea	67	75	87	83	40	86	43	25	89	100	93	94
2.1.2.	*Helianthemum cinereum*	7	.	.	.	73	79	86	75	61	57	87	11
2.1.	*Polycarpon polycarpoides*	47	50	33	75	13	50	.	25	39	86	80	61
2.1.	*Pilosella leucopsilon*	.	75	40	58	.	64	29	50	72	.	7	.
	Sedum album	.	.	.	25	53	64	57	13	67	.	33	72
2.1.	*Jurinea bocconei*	.	.	.	33	.	36	.	50	33	.	13	17
	Silene vulgaris	.	.	.	.	.	.	43	38	11	.	47	22
	Teucrium chamaedrys	.	.	.	.	13	43	.	25	22	.	27	33
2.	*Tragopogon crocifolius* subsp. *nebrodensis*	.	.	.	.	.	14	.	.	6	29	7	17
	Cuscuta sp.	.	.	.	.	7	29	.	.	17	.	20	.
1.1.1.	*Tolpis virgata* subsp. *sexaristata*	.	.	27	17	.	21	.	.	6	.	.	.
	Rumex bucephalophorus	.	.	.	8	.	21	.	.	.	.	20	.

Supplement E1. Full dataset table.

Anhang E1. Tabelle des vollständigen Datensatzes

Relevé number	Relevé area (m2)	Cover total (%)	References
1	4	70	Marcenò et al. 2024
2	4	40	Marcenò et al. 2024
3	4	60	Marcenò et al. 2024
4	4	60	Marcenò et al. 2024
5	4	55	Marcenò et al. 2024
6	4	70	Marcenò et al. 2024
7	4	90	Marcenò et al. 2024
8	4	37	Marcenò et al. 2024
9	4	45	Marcenò et al. 2024
10	4	50	Marcenò et al. 2024
11	4	80	Marcenò et al. 2024
12	4	48	Marcenò et al. 2024
13	4	85	Marcenò et al. 2024
14	4	95	Marcenò et al. 2024
15	4	61	Marcenò et al. 2024
16	4	50	Marcenò et al. 2024
17	4	80	Marcenò et al. 2024
18	4	70	Marcenò et al. 2024
19	4	55	Marcenò et al. 2024
20	4	65	Marcenò et al. 2024
21	4	70	Marcenò et al. 2024
22	4	60	Marcenò et al. 2024
23	4	90	Marcenò et al. 2024
24	4	70	Marcenò et al. 2024
25	4	60	Marcenò et al. 2024
26	4	50	Marcenò et al. 2024
27	4	90	Marcenò et al. 2024
28	4	60	Marcenò et al. 2024
29	4	82	Marcenò et al. 2024
30	4	95	Marcenò et al. 2024
31	4	90	Marcenò et al. 2024
32	4	20	Marcenò et al. 2024
33	4	75	Marcenò et al. 2024
34	4	45	Marcenò et al. 2024
35	4	95	Marcenò et al. 2024
36	4	95	Marcenò et al. 2024
37	4	70	Marcenò et al. 2024
38	4	75	Marcenò et al. 2024
39	4	50	Marcenò et al. 2024
40	4	80	Marcenò et al. 2024
41	4	90	Marcenò et al. 2024
42	4	80	Marcenò et al. 2024
567	50	60	Brullo et al. 2005
568	50	60	Brullo et al. 2005
569	20	90	Brullo et al. 2005
570	20	100	Brullo et al. 2005
571	25	90	Pignatti et al. 1980
572	30	40	Pignatti et al. 1980
573	30	50	Pignatti et al. 1980
574	5	40	Pignatti et al. 1980
575	4	60	Pignatti et al. 1980
576	25	30	Pignatti et al. 1980
577	100	30	Brullo 1984
578	60	60	Brullo 1984
579	30	80	Brullo 1984
580	70	40	Brullo 1984
581	100	30	Brullo 1984
582	30	50	Brullo 1984
583	10	40	Brullo 1984
584	20	40	Brullo 1984
585	150	60	Brullo 1984
586	100	30	Brullo 1984
587	100	30	Brullo 1984
588	150	35	Brullo 1984
589	120	30	Brullo 1984
590	100	60	Brullo 1984
591	100	30	Brullo 1984
592	100	80	Brullo 1984
593	20	70	Brullo 1984
594	30	80	Brullo 1984
595	50	60	Brullo 1984
596	40	30	Brullo 1984
597	20	55	Brullo 1984
598	60	55	Brullo 1984
599	60	50	Brullo 1984
600	50	40	Brullo 1984
601	50	40	Brullo 1984
602	50	45	Brullo 1984
603	50	45	Brullo 1984
604	50	90	Brullo et al. 2005
605	50	80	Brullo et al. 2005
606	100	70	Brullo et al. 2005
607	50	90	Brullo et al. 2005
608	20	90	Brullo 1984
609	5	65	Brullo 1984
610	15	90	Brullo 1984
611	50	60	Brullo 1984
612	100	50	Brullo 1984
613	50	70	Brullo 1984
614	50	90	Brullo 1984
615	100	90	Brullo 1984
616	100	90	Brullo 1984
617	30	90	Brullo 1984
618	12	60	Pignatti et al. 1980
619	16	80	Pignatti et al. 1980
620	16	80	Pignatti et al. 1980
621	20	80	Pignatti et al. 1980
622	25	95	Pignatti et al. 1980
623	16	50	Pignatti et al. 1980
624	16	95	Pignatti et al. 1980
625	25	50	Pignatti et al. 1980
626	15	15	Pignatti et al. 1980
627	15	20	Pignatti et al. 1980
634	50	50	Brullo 1984
635	100	40	Brullo 1984
636	60	40	Brullo 1984
649	50	90	Brullo 1984
650	150	90	Brullo 1984
652	100	90	Brullo 1984
654	100	80	Brullo 1984
655	50	70	Brullo 1984
656	50	50	Brullo 1984
657	30	70	Brullo 1984
658	30	70	Brullo 1984

Species	1	2	3
Capsella rubella	2	0	0
Potentilla calabra	0.1	0	0
Androsace elongata s. breistrofferi	0	0	0
Viola parvula	0	0	0
Colchicum bivonae	0	0	0
Prunella vulgaris	0	0	0
Petrorhagia illyrica	0	0	0
Aira cupaniana	0	0	0
Carlina sicula	0	0	0
Trifolium phleoides	0	0	0
Triticum vagans	0	0	0
Erodium acaule	0	0	0
Trifolium glomeratum	0	0	0
Trifolium micranthum	0	0	0
Hypochaeris radicata	0	0	0
Lepidium nebrodense	0	0	0
Romulea columnae	0	0	0
Trifolium repens	4	0	0
Lolium perenne	30	0	0
Cynosurus cristatus	0	0	0
Galium verum	0	0	0
Trifolium campestre	0	0	0
Sedum acre	0	0	0
Saxifraga granulata	0	0	0
Bellardiochloa variegata s. nebrodensis	0	0	0
Rumex acetosella s. multifidus	0	0	0
Minuartia recurva s. condensata	0	0	0
Draba verna	0	0	0
Geranium rotundifolium	0	0	0
Trifolium stellatum	0	0	0
Alyssum siculum	0	0	0
Lamium amplexicaule	0	0	0
Veronica arvensis	0	0	0
Scandix pecten-veneris	0	0	0
Xeranthemum inapertum	0	0	1
Vicia sativa	0	0	0
Filago discolor	0	0	0
Scandix pecten-veneris s. brachycarpa	0	0.5	0.1
Festuca laevigata s. crassifolia	0	15	15
Crepis vesicaria s. taraxacifolia	0	4	0.3
Cerastium tauricum	0	0	0.1
Veronica praecox	0	0.1	1
Silene conica	0	1	0.2
Buglossoides incrassata s. splitgerberi	0	0.1	0
Genista cupanii	0	0	0
Pyrus spinosa	0	0	0
Crataegus laciniata	0	0	0
Avenella flexuosa	0	0	0
Tolpis virgata	0	0	0
Sherardia arvensis	0	0	0
Cistus salviifolius	0	0	0
Logfia gallica	0	0	0
Scutellaria columnae s. columnae	0	0	0
Onosma echioides s. canescens	0	0	0
Catapodium rigidum	0	0	0
Jacobaea candida	0	0	0
Stipa sicula	0	0	0
Micromeria juliana	0	0	0
Teucrium montanum	0	0	0
Asphodelus ramosus	0	0	0
Pimpinella tragium	0	0	0
Saxifraga adscendens	0	0	0
Sideritis italica	0	0	0
Saponaria sicula	0	0	0
Orchis anthropophora	0	0	0
Centaurea solstitialis s. schouwii	0	0	0
Sixalix atropurpurea s. maritima	0	0	0
Secale strictum	0	0	0
Bonannia graeca	0	0	0
Pimpinella anisoides	0	0	0
Carthamus pinnatus	0	0	0
Festuca ovina	0	0	0
Thymus striatus	0	0	0
Silene vulgaris	0	0	0
Sesleria nitida s. sicula	0	0	0
Lomelosia crenata	0	0	0
Juniperus communis s. hemisphaerica	0	0	0
Laserpitium siler s. siculum	0	0	0
Siculosciadium nebrodense	0	0	0
Malva moschata	0	0	0
Sedum hispanicum	0	0	0
Reichardia picroides	0	0	0
Trifolium pratense s. semipurpureum	0	0	0
Rumex nebroides	0	0	0
Aethionema saxatile	0	0	0
Crepis vesicaria s. vesicaria	0	0	0
Allium cupanii	0	0	0
Artemisia alba	0	0	0
Melica cupanii	0	0	0
Vulpia sicula	0	0	0
Plantago cupanii	0	0	0
Leontodon tuberosus	0	0	0
Plantago subulata	0	0	0
Anthemis cupaniana	0	0	0
Armeria nebrodensis	0	0	0
Thymus spinulosus	0	0	0
Vicia glauca	0	0	0
Verbascum siculum	0	0	0
Arrhenatherum elatius s. nebrodense	0	0	0
Stachys germanica	0	0	0
Knautia calycina	0	0	0
Viola nebrodensis	0	0	0
Alyssum nebrodense	0	0	0.5
Lactuca viminea	0	0	0
Anthyllis vulneraria s. busambarensis	0	0	0
Galium verticillatum	0	0	0
Cachrys ferulacea	0	1	0
Asphodeline lutea	0	0	0
Helianthemum nummularium s. tomentosum	0	0	5
Inula montana	0	0	0
Helianthemum oelandicum s. nebrodense	0	0	0
Berberis aetnensis	0	0	0
Allium sphaerocephalon s. arvense	0	0	0
Sternbergia colchiciflora	0	0	0
Verbascum rotundifolium	0	0	0
Phleum ambiguum	0	0	3
Acinos alpinus	0	0.5	0
Silene sicula	0	0	0
Cerastium tomentosum	0	2	50
Euphorbia myrsinites	0	0.1	0
Astragalus nebrodensis	0	0	0
Dasypyrum villosum	0	0	0
Dactylis glomerata	0	0	0
Rosa sicula	0	0	0
Erysimum bonannianum	0	0	0.5
Scorzoneroides cichoriacea	0	0	0
Linaria purpurea	0	0	0
Valeriana tuberosa	0	0.5	0
Achillea ligustica	0	0	0
Allium flavum	0	0	0
Linaria simplex	0	0	0
Matthiola fruticulosa	0	0	0
Sedum album	0	0	0
Filago arvensis	0	0	0
Polycarpon polycarpoides	0	0.5	0
Medicago lupulina s. cupaniana	0.1	1	1
Carlina nebrodensis	0	0	0
Senecio squalidus s. microglossus	0	0	0
Cynoglossum nebrodense	0	0	0
Scutellaria rubicunda	0	0	0
Teucrium chamaedrys	0	0	0
Bunium petraeum	0	0	0
Festuca circummediterranea	0	4	10
Astragalus depressus	2	0	0
Helictochloa cincinnata	0	0	0
Petrorhagia saxifraga s. gasparrinii	0	0	0
Tragopogon crocifolius s. nebrodensis	0	0	0.5
Asperula aristata s. oreophila	0	0	0
Galium lucidum s. bernardii	0	0	0
Helianthemum cinereum	0	0	1
Rumex bucephalophorus	0	0	0
Arabis collina s. rosea	0	0	0
Centaurea parlatoris	0	0	0
Melica ciliata	0	0	0
Geranium molle	0	0.3	0
Dianthus arrostii	0	0	0
Hyoseris radiata	0	0	0
Geranium pyrenaicum	0	1	0
Euphorbia rigida	0	0	0
Trifolium strictum	0	0	0
Legousia speculum-veneris	0	0	0
Crepis leontodontoides	0	0	0
Poa bulbosa	2	5	10
Arenaria serpyllifolia	0	1	0.3
Poa bivonae	1	8	0
Sinapis pubescens	2	0	0
Noccaea rivalis	0	0	0
Anisantha tectorum	0	1	1
Muscari neglectum	0	0	0
Cynosurus echinatus	0	1	0.5
Cuscuta sp.	0	0	0
Carduus nutans s. macrocephalus	0	0.3	0
Bromus hordeaceus	0	1	0.3
Sedum amplexicaule	0	1	0.5
Anthyllis vulneraria s. maura	0	0	0
Cerastium glomeratum	0	0	0
Cerastium semidecandrum	0	0	0
Taraxacum species	0	0	0
Lathyrus sphaericus	0	0	0
Minuartia mediterranea	0	0	0
Jurinea bocconei	0	0	0
Trisetum flavescens s. splendens	0	0	0
Opopanax chironium	0	0	0
Emerus major	0	0	0
Teucrium flavum	0	0	0
Carlina lanata	0	0	0
Crupina crupinastrum	0	0	0
Anthemis cretica	0	0	0
Valerianella discoidea	0	0	0
Sedum caespitosum	0	0	0.5
Festuca rubra s. microphylla	0	0	0
Quercus petraea s. austrotyrrhenica	0	0	0
Malus sylvestris	0	0	0
Gagea cfr	0	0	0
Hedera helix	0	0	0
Teesdalia nudicaulis	0	0	0
Galium parisiense	0	0	0
Cuscuta epithymum	0	0	0
Arabidopsis thaliana	0	0	0
Ranunculus bulbosus	0	0	0
Asperula canescens	0	0	0
Hornungia petraea	0	0.1	0
Arenaria leptoclados	0	0	0
Sideritis sicula	0	0.5	0
Ruscus aculeatus	0	0	0
Galium rotundifolium	0	0	0
Avena barbata	0	0	0
Potentilla micrantha	0	0	0
Daphne laureola	0	0	0
Trifolium cherleri	0	0	0
Festuca myuros	0	0	0
Cyclamen repandum	0	0	0
Festuca ciliata	0	0	0
Taraxacum garbarianum	0	0	0
Odontites bocconei	0	0	0
Scleranthus perennis s. marginatus	0	0	0
Sorbus graeca	0	0	0
Clypeola jonthlaspi	0	0	0
Cerinthe minor s. auriculata	0	0	0
Papaver dubium	0	0	0
Brachypodium rupestre	0	0	0
Iberis violacea	0	0	0
Iris species	0	0	0
Cytisus infestus	0	0	0
Sagina subulata	0	0	0
Cruciata pedemontana	0	0	0
Pteridium aquilinum	0	0	0
Blitum bonus-henricus	0	0	0
Valerianella dentata	0	0	0
Quercus ilex	0	0	0
Bellis perennis	0	0	0
Convolvulus cantabrica	0	0	0
Buglossoides arvensis	0	0	0
Trifolium scabrum	0	0	0
Edraianthus graminifolius s. siculus	0	0	0
Vicia lathyroides	0	0	0
Viola alba subsp. dehnhardtii	0	0	0
Bellardia latifolia	0	0	0
Linum trigynum	0	0	0
Lolium rigidum	0	0	0
Agrostis castellana	0	0	0
Teucrium siculum	0	0	0
Senecio vulgaris	0	0	0
Saxifraga adscendens s. parnassica	0	0.2	0
Minuartia verna	0	0	0
Microthlaspi perfoliatum	0	0	0
Daphne oleoides	0	0	0
Corydalis solida subsp. densiflora	0	0	0
Gagea foliosa	0	0	0
ELIMINA	0	0	0
Agrostis stolonifera	0	0	0
Juncus bufonius	0	0	0
Carex leporina	0	0	0
Ranunculus marginatus	0	0	0
Aira elegantissima	0	0	0
Orchis quadripunctata s. brancifortii	0	0	0
Hypochaeris cretensis	0	0	0
Scilla bifolia	0	0	0
Briza maxima	0	0	0
Rumex scutatus	0	0	0
Draba turgida	0	0	0
Sagina apetala	0	0	0
Ilex aquifolium	0	0	0
Daucus carota	0	0	0
Ranunculus millefoliatus	0	0	0
Veronica verna	0	0	0
Crepis vesicaria s. bivonana	0	0	0
Sanguisorba minor	0	0	0
Juniperus communis s. hemisphaerica	0	0	0
Ornithogalum montanum	0	0	0
Alyssum simplex	0	0	0.1
Jasione montana	0	0	0
Orobanche species	0	0	0
Linum punctatum	0	0	0
Carex flacca s. erythrostachys	0	0	0
Myosotis incrassata	0	0.5	0
Moenchia erecta	0	0	0
Petrorhagia prolifera	0	0	0
Arenaria grandiflora	0	0	0
Scorzonera villosa s. columnae	0	0	0
Dianthus siculus	0	0	0
Koeleria splendens	0	0	0
Trifolium bivonae	0	0	0
Ranunculus paludosus	0	0	0
Plantago lagopus	0	0	0
Trifolium arvense	0	0	0
Helianthemum croceum	0	0	0
Trifolium striatum	0	0	0
Aira caryophyllea	0	0	0
Eryngium campestre	0	0	0
Scleranthus annuus	30	0	0
Hypochaeris laevigata	0	0	0
Anthemis arvensis s. sphacelata	3	1	0.3
Anthoxanthum odoratum	0	0	0
Herniaria nebrodensis	0	0	0
Pilosella leucopsilon	0	0	0

Continued (relevé 658-1028) on second page

Fortsetzung (Vegetationsaufnahmen 658-1058) auf der zweiten Seite

Relevé number	659	660	661	662	663	664	665	666	667	668	669	670	671	672	673
Relevé area (m2)	50	40	50	60	150	50	100	100	100	100	100	100	100	100	100
Cover total (%)	40	70	70	60	75	90	90	90	90	90	80	70	80	80	60
References	Brullo 1984	Brullo 1984	Brullo 1984	Brullo 1984	Raimondo 1983	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo et al. 2005	Brullo 1984
Capsella rubella	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potentilla calabra	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Androsace elongata s. breistrofferi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola parvula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Colchicum bivonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prunella vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrorhagia illyrica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aira cupaniana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carlina sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium phleoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Triticum vagans	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Erodium acaule	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Trifolium glomeratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium micranthum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypochaeris radicata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lepidium nebrodense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Romulea columnae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium repens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lolium perenne	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Cynosurus cristatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium verum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium campestre	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum acre	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saxifraga granulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bellardiochloa variegata s. nebrodensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex acetosella s. multifidus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minuartia recurva s. condensata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Draba verna	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Geranium rotundifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium stellatum	0	2	0	2	2	0	0	0	0	0	0	0	0	0	0
Alyssum siculum	3	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Lamium amplexicaule	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica arvensis	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0
Scandix pecten-veneris	2	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Xeranthemum inapertum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Vicia sativa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Filago discolor	2	2	3	0	2	0	0	0	0	0	0	0	0	0	0
Scandix pecten-veneris s. brachycarpa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca laevigata s. crassifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepis vesicaria s. taraxacifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerastium tauricum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Veronica praecox	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silene conica	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0
Buglossoides incrassata s. splitgerberi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Genista cupanii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pyrus spinosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crataegus laciniata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avenella flexuosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tolpis virgata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sherardia arvensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cistus salviifolius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Logfia gallica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scutellaria columnae s. columnae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Onosma echioides s. canescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Catapodium rigidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jacobaea candida	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Stipa sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Micromeria juliana	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Teucrium montanum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asphodelus ramosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pimpinella tragium	0	0	0	0	2	0	0	0	0	0	0	0	2	0	0
Saxifraga adscendens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sideritis italica	13	0	0	0	0	13	13	38	38	13	68	13	38	13	13
Saponaria sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orchis anthropophora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Centaurea solstitialis s. schouwii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sixalix atropurpurea s. maritima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Secale strictum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bonannia graeca	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Pimpinella anisoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carthamus pinnatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca ovina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thymus striatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Silene vulgaris	0	3	2	0	0	2	2	2	0	0	2	0	0	0	0
Sesleria nitida s. sicula	0	0	3	3	0	0	0	0	0	0	0	0	3	13	0
Lomelosia crenata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juniperus communis s. hemisphaerica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Laserpitium siler s. siculum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Siculosciadium nebrodense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malva moschata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum hispanicum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Reichardia picroides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium pratense s. semipurpureum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex nebroides	0	0	0	0	2	0	0	0	0	0	2	0	0	0	0
Aethionema saxatile	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepis vesicaria s. vesicaria	2	2	0	2	0	2	2	2	0	0	2	0	2	0	0
Allium cupanii	0	0	0	0	0	0	0	2	0	0	2	2	2	0	0
Artemisia alba	0	0	0	0	2	38	38	38	68	38	38	13	13	3	13
Melica cupanii	0	3	0	2	0	0	0	0	0	0	0	0	0	0	0
Vulpia sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago cupanii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Leontodon tuberosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago subulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthemis cupaniana	0	0	0	0	0	0	0	0	2	0	2	0	3	0	0
Armeria nebrodensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Thymus spinulosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vicia glauca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Verbascum siculum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Arrhenatherum elatius s. nebrodense	0	3	0	0	0	2	2	0	2	2	0	2	2	0	2
Stachys germanica	2	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Knautia calycina	0	2	2	3	2	0	0	0	0	13	2	68	13	13	2
Viola nebrodensis	0	0	0	2	0	0	0	0	0	0	0	2	2	0	0
Alyssum nebrodense	0	2	0	3	2	2	3	3	13	3	3	3	3	2	2
Lactuca viminea	0	0	0	0	2	2	2	0	2	2	2	2	2	0	3
Anthyllis vulneraria s. busambarensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium verticillatum	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0
Cachrys ferulacea	13	13	38	13	38	2	2	3	2	2	3	3	2	3	2
Asphodeline lutea	2	3	2	0	2	2	2	2	2	2	0	2	0	0	0
Helianthemum nummularium s. tomentosum	0	0	0	0	0	13	3	13	3	13	3	3	3	13	0
Inula montana	2	2	0	2	2	3	13	3	13	3	3	3	3	3	0
Helianthemum oelandicum s. nebrodense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Berberis aetnensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Allium sphaerocephalon s. arvense	0	0	0	0	0	0	0	2	0	2	0	2	2	2	0
Sternbergia colchiciflora	0	0	0	0	0	0	2	0	2	2	0	0	0	2	0
Verbascum rotundifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phleum ambiguum	13	13	3	3	3	13	13	13	13	13	38	3	13	13	13
Acinos alpinus	2	3	3	2	0	2	0	2	2	0	2	2	2	0	2
Silene sicula	3	3	3	2	2	3	3	13	3	3	3	3	3	2	2
Cerastium tomentosum	2	3	2	38	3	13	3	3	3	3	3	3	13	13	13
Euphorbia myrsinites	2	0	2	2	3	3	3	2	2	3	2	2	3	3	2
Astragalus nebrodensis	13	3	13	13	3	13	13	38	3	3	13	13	13	2	3
Dasypyrum villosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dactylis glomerata	3	13	3	3	0	13	13	3	3	2	2	2	3	2	3
Rosa sicula	0	3	2	0	2	3	0	2	0	2	0	0	0	0	0
Erysimum bonannianum	0	3	2	3	3	2	2	2	2	2	2	2	2	2	3
Scorzoneroides cichoriacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linaria purpurea	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valeriana tuberosa	2	2	2	3	2	0	2	2	0	2	2	2	2	0	0
Achillea ligustica	0	0	2	0	0	2	0	0	0	2	0	2	2	0	2
Allium flavum	0	0	0	0	0	0	0	0	0	2	2	2	2	0	0
Linaria simplex	2	0	0	0	2	0	0	0	0	0	0	0	0	0	2
Matthiola fruticulosa	0	0	0	0	0	2	2	0	2	0	0	2	2	0	0
Sedum album	0	0	0	0	0	2	2	2	2	2	2	0	2	2	2
Filago arvensis	13	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Polycarpon polycarpoides	3	2	3	3	0	2	0	2	2	0	2	2	2	2	3
Medicago lupulina s. cupaniana	0	2	0	0	3	0	0	0	0	0	0	0	0	3	3
Carlina nebrodensis	0	0	2	2	2	2	2	2	0	0	2	2	0	2	2
Senecio squalidus s. microglossus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cynoglossum nebrodense	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Scutellaria rubicunda	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teucrium chamaedrys	0	0	0	0	0	0	0	0	0	2	0	2	2	0	0
Bunium petraeum	0	0	2	2	2	2	2	3	2	2	2	2	2	2	2
Festuca circummediterranea	13	3	13	13	3	38	38	38	38	38	13	13	13	38	38
Astragalus depressus	2	3	0	2	2	0	0	0	0	0	0	0	0	0	0
Helictochloa cincinnata	0	0	0	0	0	13	2	3	13	3	3	13	3	0	0
Petrorhagia saxifraga s. gasparrinii	3	2	3	2	2	3	3	3	2	3	3	2	2	2	3
Tragopogon crocifolius s. nebrodensis	0	0	2	0	2	0	0	0	0	0	2	2	2	0	0
Asperula aristata s. oreophila	0	0	0	0	2	2	2	2	2	2	2	2	2	2	3
Galium lucidum s. bernardii	0	2	3	2	0	3	2	3	13	2	2	2	2	3	2
Helianthemum cinereum	2	0	3	2	2	0	0	0	0	0	0	0	0	0	3
Rumex bucephalophorus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Arabis collina s. rosea	0	2	2	2	0	2	2	2	2	2	2	0	0	2	0
Centaurea parlatoris	2	13	3	2	2	13	3	3	3	2	3	3	3	0	2
Melica ciliata	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0
Geranium molle	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Dianthus arrostii	0	2	3	2	0	0	0	0	0	0	0	0	0	0	0
Hyoseris radiata	0	0	0	0	0	0	0	0	0	0	0	2	2	0	2
Geranium pyrenaicum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Euphorbia rigida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium strictum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Legousia speculum-veneris	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Crepis leontodontoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Poa bulbosa	0	0	2	0	0	3	3	2	3	2	2	2	2	0	0
Arenaria serpyllifolia	2	0	2	2	0	0	0	0	0	0	0	0	0	0	0
Poa bivonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sinapis pubescens	0	2	0	2	0	0	0	0	0	0	0	0	0	0	2
Noccaea rivalis	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0
Anisantha tectorum	2	3	2	2	2	0	0	0	0	0	0	0	0	0	2
Muscari neglectum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cynosurus echinatus	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0
Cuscuta sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Carduus nutans s. macrocephalus	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Bromus hordeaceus	2	2	0	0	2	0	0	0	0	0	0	0	0	0	0
Sedum amplexicaule	2	2	3	2	2	2	2	3	2	2	2	0	2	0	2
Anthyllis vulneraria s. maura	0	0	2	0	2	0	0	3	2	3	2	3	3	3	0
Cerastium glomeratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerastium semidecandrum	2	0	2	0	0	0	0	0	0	0	0	0	0	0	2
Taraxacum species	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Lathyrus sphaericus	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Minuartia mediterranea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jurinea bocconei	0	0	0	3	0	0	0	2	0	0	2	0	2	0	0
Trisetum flavescens s. splendens	0	38	3	0	0	0	0	0	0	0	0	0	0	0	0
Opopanax chironium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Emerus major	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teucrium flavum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carlina lanata	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Crupina crupinastrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthemis cretica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valerianella discoidea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sedum caespitosum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca rubra s. microphylla	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus petraea s. austrotyrrhenica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malus sylvestris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gagea cfr	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hedera helix	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teesdalia nudicaulis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium parisiense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cuscuta epithymum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arabidopsis thaliana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus bulbosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asperula canescens	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hornungia petraea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arenaria leptoclados	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sideritis sicula	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ruscus aculeatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Galium rotundifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Avena barbata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Potentilla micrantha	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daphne laureola	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium cherleri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca myuros	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclamen repandum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Festuca ciliata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Taraxacum garbarianum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Odontites bocconei	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scleranthus perennis s. marginatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sorbus graeca	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Clypeola jonthlaspi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cerinthe minor s. auriculata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Papaver dubium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Brachypodium rupestre	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0
Iberis violacea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Iris species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cytisus infestus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sagina subulata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cruciata pedemontana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pteridium aquilinum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Blitum bonus-henricus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Valerianella dentata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Quercus ilex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bellis perennis	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Convolvulus cantabrica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Buglossoides arvensis	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium scabrum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Edraianthus graminifolius s. siculus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vicia lathyroides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Viola alba subsp. dehnhardtii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bellardia latifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linum trigynum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lolium rigidum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agrostis castellana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Teucrium siculum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Senecio vulgaris	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Saxifraga adscendens s. parnassica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minuartia verna	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Microthlaspi perfoliatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daphne oleoides	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corydalis solida subsp. densiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gagea foliosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELIMINA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Agrostis stolonifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juncus bufonius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex leporina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus marginatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aira elegantissima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orchis quadripunctata s. brancifortii	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypochaeris cretensis	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
Scilla bifolia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Briza maxima	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rumex scutatus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Draba turgida	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sagina apetala	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ilex aquifolium	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Daucus carota	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus millefoliatus	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Veronica verna	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Crepis vesicaria s. bivonana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Sanguisorba minor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Juniperus communis s. hemisphaerica	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ornithogalum montanum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Alyssum simplex	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Jasione montana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Orobanche species	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Linum punctatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carex flacca s. erythrostachys	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Myosotis incrassata	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Moenchia erecta	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Petrorhagia prolifera	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Arenaria grandiflora	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Scorzonera villosa s. columnae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dianthus siculus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Koeleria splendens	0	0	0	0	0	3	2	2	2	2	2	0	2	0	0
Trifolium bivonae	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ranunculus paludosus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Plantago lagopus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Trifolium arvense	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Helianthemum croceum	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Trifolium striatum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Aira caryophyllea	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eryngium campestre	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Scleranthus annuus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hypochaeris laevigata	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthemis arvensis s. sphacelata	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anthoxanthum odoratum	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Herniaria nebrodensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pilosella leucopsilon	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0

Supplement E2. Mann-Whitney *U* tests of the differences between the two newly described associations. The number of samples analysed was 15 in both associations. Standard deviation (SD). *P*-values: *<0.05, **<0.01, ***>0.001, *ns* = not significant. pH, Electrical Conductivity (EC), Total Organic Carbon (TOC), Total Nitrogen (TN), Cation Exchange Capacity (CEC) and Available Phosphorus (POlsen).

Anhang E2 Mann-Whitney-*U*-Tests der Unterschiede zwischen den beiden neu beschriebenen Assoziationen. Die Anzahl der analysierten Proben betrug jeweils 15 in beiden Assoziationen. Standardabweichung (SD). *P*-Werte: *<0,05, **<0,01, ***>0,001, *ns* = nicht signifikant. pH, Elektrische Leitfähigkeit (EC), Organischer Gesamt-Kohlenstoff (TOC), Gesamt-Stickstoff (TN), Kationenaustauschkapazität (CEC) und verfügbarer Phosphor (POlsen).

	Androsaco breistrofferi-Potentilletum calabrae		***Helianthemo tomentosi-Festucetum crassifoliae***			
	Mean	**SD**	**Mean**	**SD**	**Mann-Whitney *U***	***P*-value**
Altitude (m)	1916	17	1934	22	77	**
Aspect (°)	201	93	105	90	110	ns
Slope(°)	7	5.4	13	6	68	**
TPI	3	1.9	6	2	15	***
TWI	10	3.8	11	3	89	*
pH	7	0.5	8	0.2	5	***
EC	110	53	249	76	22	***
TOC	98	18	155	44	33	***
TN	6	1	12	3	23	***
CEC	53	4	73	12	23	***
POlsen	46	15	28	8	52	***

Supplement E3. Short description of the phytosociological associations and nomeclatural considerations. A short description of the phytosociological associations mentioned in the paper, excluding the newly described associations already commented on in the main text, is presented. Each description contains information about the name-giving taxa of the association and the typus of the association name, and when necessary, the original form of the syntaxonomic name and the taxa naming the corrected or mutated association name. Diagnostic species are ordered by their fidelity value. Dominant and constant species are ordered by their frequency values. Finally, for each association, a brief description of its ecology and distribution is provided. The *Siderito siculae-Artemisietum albae* and the *Seslerio siculae-Melicetum cupanii* (group k) are not included in this Appendix since TWINSPAN analysis did not support their differentiation

Anhang E3. Kurzbeschreibung der in der Arbeit erwähnten pflanzensoziologischen Assoziationen, unter Ausschluss der bereits im Haupttext kommentierten neu beschriebenen Assoziationen. Jede Beschreibung enthält Informationen zu den namensgebenden Taxa der Assoziation und zum Typus des Assoziationsnamens sowie, wenn notwendig, zur ursprünglichen Form des syntaxonomischen Namens und den Taxa, die den korrigierten oder mutierten Assoziationsnamen benennen. Diagnosetaxa sind nach ihrem Treuewert (multipliziert mit 100) geordnet. Dominante und konstante Arten sind nach ihren Häufigkeitswerten geordnet. Abschließend wird für jede Assoziation eine kurze Beschreibung ihrer Ökologie und Verbreitung bereitgestellt. Die Siderito siculae-Artemisietum albae und die Seslerio siculae-Melicetum cupanii (Gruppe k) sind in diesem Anhang nicht enthalten, da die TWINSPAN-Analyse ihre Differenzierung nicht unterstützt hat.

***Cynosuro cristati-Plantaginetum cupanii* Raimondo 1983 (group b)**

Name-giving taxa: *Cynosurus cristatus* and *Plantago cupanii*

Typus: Raimondo 1983, relevé 1, table 4 (*holotypus*).

Diagnostic species: *Colchicum bivonae* 0.8, *Trifolium phleoides* 0.7, *Prunella vulgaris* 0.7, *Vulpia sicula* 0.7, *Petrorhagia illyrica* 0.7, *Hypochaeris radicata* 0.6, *Carlina sicula* 0.6, *Aira cupaniana* 0.6, *Plantago cupanii* 0.6, *Romulea columnae 0.6, Cynosurus cristatus* 0.6, *Trifolium glomeratum* 0.6, *Erodium acaule* 0.6, *Lolium perenne* 0.5, *Triticum vagans* 0.5, *Trifolium micranthum* 0.5, *Leontodon tuberosus* 0.5, *Anthoxanthum odoratum* 0.5, *Trifolium repens* 0.5, *Plantago lagopus* 0.5, *Lepidium nebrodense* 0.5, *Galium verum* 0.5, *Trifolium striatum* 0.4, *Taraxacum species* 0.4, *Ranunculus marginatus* 0.4, *Juncus bufonius* 0.4, *Gagea foliosa* 0.4, *Corydalis solida* subsp. *densiflora* 0.4, *Carex leporina* 0.4, *Agrostis stolonifera* 0.4, *Ornithogalum montanum 0.4, Ranunculus paludosus* 0.4, *Sinapis pubescens* 0.4, *Scilla bifolia* 0.4, *Bromus hordeaceus* 0.4, *Crepis vesicaria* subsp. *vesicaria* 0.3, *Cerastium semidecandrum* 0.3, *Capsella rubella* 0.3, *Sagina apetala* 0.3, *Carduus nutans* subsp. *macrocephalus* 0.3, *Centaurea solstitialis* subsp. *schouwii* 0.3, *Poa* bulbosa 0.3, *Anisantha tectorum* 0.3

Constant species: *Pilosella leucopsilon* 0.7, *Festuca circummediterranea* 0.7, *Anthemis arvensis* subsp. *sphacelata* 0.7, *Sedum amplexicaule* 0.5, *Scleranthus annuus* 0.5, *Potentilla calabra* 0.5, *Polycarpon polycarpoides* 0.5, *Medicago lupulina* subsp. *cupaniana* 0.5, *Herniaria nebrodensis* 0.5, *Eryngium campestre* 0.5, *Dactylis glomerata* 0.5, *Cerastium tomentosum* 0.5, *Bellis perennis* 0.5

Dominant species: *Plantago cupanii* 0.5, *Vulpia sicula* 0.2, *Trifolium repens* 0.2, *Pilosella leucopsilon* 0.2, *Cynosurus cristatus* 0.2

Ecology and distribution: Mesophilic grassland colonising silica-rich soil, with low permeability and evidence of hydromorphism, accumulating in the bottom part of large karst depressions (polje). These grasslands occur at elevations between 1100 and 1750 m a.s.l., with two variants (characterised by abundant *Pilosella leucopsilon* and *Festuca circummediterranea*, respectively) and one subassociation (*bryetosum*, Raimondo 1983).

***Armerio nebrodensis-Plantaginetum cupanii* Brullo et Marcenò in Brullo 1984 (group c)**

Name-giving taxa: *Armeria nebrodensis* and *Plantago cupanii*

Typus: Brullo, 1984, relevé 5, table 20 (*holotypus*).

Diagnostic species: *Trifolium campestre* 0.8, *Leontodon tuberosus* 0.6, *Plantago cupanii* 0.6, *Trifolium arvense* 0.5, *Sedum acre* 0.5, *Vulpia sicula* 0.5, *Armeria nebrodensis* 0.5, *Cerastium semidecandrum* 0.4, *Veronica arvensis* 0.4, *Potentilla calabra* 0.4, *Romulea columnae* 0.4, *Cynosurus cristatus* 0.4, *Anthoxanthum odoratum* 0.4, *Crepis vesicaria* subsp. *bivonana* 0.4, *Sagina subulata* 0.4, *Iris* sp. 0.4, *Cruciata pedemontana* 0.4, *Bellardia latifolia* 0.4, *Ranunculus paludosus* 0.4, *Aira caryophyllea* 0.4, *Trifolium striatum* 0.4, *Anthemis arvensis* subsp. *sphacelata* 0.4, *Trifolium bivonae* 0.3, *Moenchia erecta* 0.3, *Lolium perenne* 0.3, *Ornithogalum montanum* 0.3, *Valerianella dentata* 0.3, *Ranunculus millefoliatus* 0.3, *Bellis perennis* 0.3, *Hypochaeris cretensis* 0.3, *Vicia sativa* 0.3, *Plantago lagopus* 0.3

Constant species: *Petrorhagia saxifraga* subsp. *gasparrinii* 0.8, *Festuca circummediterranea* 0.8, *Scleranthus annuus* 0.5

Dominant species: *Plantago cupanii* 0.8, *Vulpia sicula* 0.4, *Festuca circummediterranea* 0.4, *Cynosurus cristatus* 0.4, *Armeria nebrodensis* 0.3, *Potentilla calabra* 0.2, *Pilosella leucopsilon* 0.2,

Trifolium striatum 0.1, *Lolium perenne* 0.1, *Leontodon tuberosus* 0.1, *Bromus hordeaceus* 0.1

Ecology and distribution: This association inhabits flat land or gentle slopes between 1400 and 1600 m a.s.l., which are periodically flooded due to the presence of marly-clay substrates of the Numidian flysch. This association is distributed in the western part of the Madonie Mountains, including Portella Mandarini, Pizzo Catarineci, and others (Brullo, 1984).

***Plantagini humilis-Armerietum nebrodensis* Pignatti et Nimis in E. Pignatti et al. 1980 (group d)**

Name-giving taxa: *Plantago humilis* and *Armeria nebrodensis*

Typus: Pignatti et al., 1980, relevé 92, table 10 (*holotypus*).

Diagnostic species: *Plantago humilis* 1, *Armeria nebrodensis* 0.7, *Saxifraga granulata* 0.7, *Rumex* acetosella subsp. *multifidus* 0.6, *Minuartia recurva* subsp. *condensata* 0.6, *Bellardiochloa variegata* subsp. *nebrodensis* 0.6, *Anthemis cupaniana* 0.5, *Juniperus communis* subsp. *hemisphaerica* 0.5, *Genista cupanii* 0.5, *Jasione montana* 0.4, *Draba verna* 0.4, *Aira caryophyllea* 0.4, *Scleranthus annuus* 0.4, *Hornungia petraea* 0.4, *Avenella flexuosa* 0.3, *Dianthus arrostii* 0.3, *Minuartia verna* 0.3, *Sedum amplexicaule* 0.3

Constant species: *Festuca circummediterranea* 0.8, *Polycarpon polycarpoides* 0.7, *Valeriana tuberosa* 0.6, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.6, *Herniaria nebrodensis* 0.6, *Pilosella leucopsilon* 0.5, *Silene conica* 0.5, *Arabis collina* subsp. *rosea* 0.5, *Acinos alpinus* 0.5, *Silene sicula* 0.4, *Cynosurus echinatus* 0.4, *Arenaria serpyllifolia* 0.4

Dominant species: *Plantago humilis* 1, *Festuca circummediterranea* 0.5, *Minuartia recurva* subsp. *condensata* 0.3

Ecology and distribution: Vegetation dominated by small pulvinate chamaephytes and caespitose hemicryptophytes, colonising acidic stony soils (pH: 5.4-6), with evidence of cryoturbation, on quartz sandstones located on windy ridges, between 1700 and 1900 m a.s.l. It is restricted to the siliceous summits of the Madonie, namely on Mt. San Salvatore (Pignatti et al. 1980).

***Lino punctati-Seslerietum siculae* Nimis in E. Pignatti et al. 1980 mut. Brullo et al. 2005 (group f)**

Original form of the name (Pignatti et al. 1980, p. 59): "*Lino-Seslerietum nitidae"*

Name-giving taxa of the original association name: *Linum punctatum*, 1822 and *Sesleria nitida* Ten., 1811

Name-giving taxa of the mutated association name*:* *Sesleria nitida* subsp. *sicula* Brullo & Giusso, 2006

Authoritative taxonomic treatments that use the name *Sesleria nitida* subsp*. sicula*: Pignatti et al. (2017-2019), Bartolucci et al. (2018)

Typus: Pignatti et al., 1980, relevé 74, table 8 (*holotypus*)

Diagnostic species: *Laserpitium siler* subsp. *siculum* 0.7, *Edraianthus graminifolius* subsp. *siculus* 0.5, *Teucrium montanum* 0.5, *Sesleria nitida* subsp. *sicula* 0.5, *Sorbus graeca* 0.5, *Lomelosia crenata* 0.5, *Onosma echioides* subsp. *canescens* 0.4, *Juniperus communis* subsp. *hemisphaerica* 0.4, *Koeleria splendens* 0.4, *Arenaria grandiflora* 0.4, *Linum punctatum* 0.4, *Iberis violacea* 0.4, *Orchis quadripunctata* subsp. *brancifortii* 0.4, *Pimpinella tragium* 0.4, *Anthemis cupaniana* 0.4, *Helianthemum croceum* 0.3, *Quercus ilex* 0.3, *Hypochaeris laevigata* 0.3, *Dianthus arrostii* 0.3, *Asperula aristata* subsp. *oreophila* 0.3, *Odontites bocconei* 0.3, *Euphorbia rigida* 0.3, *Carlina nebrodensis* 0.3

Constant species: *Astragalus nebrodensis* 0.9, *Galium lucidum* subsp. *bernardii* 0.8, *Festuca circummediterranea* 0.8, *Centaurea parlatoris* 0.8, *Pilosella leucopsilon* 0.7, *Cerastium tomentosum* 0.7, *Anthyllis vulneraria* subsp. *maura* 0.7, *Sedum album* 0.6, *Helictochloa cincinnata* 0.6, *Arabis collina* subsp. *rosea* 0.6, *Silene sicula* 0.6, *Minuartia verna* 0.6, *Helianthemum cinereum* 0.6, *Alyssum nebrodense* 0.6, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.5, *Acinos alpinus* 0.5, *Phleum ambiguum* 0.4, *Bunium petraeum* 0.4, *Allium sphaerocephalon* subsp. *arvense* 0.4

Dominant species: *Sesleria nitida* subsp. *sicula* 0.6, *Astragalus nebrodensis* 0.5, *Lomelosia crenata* 0.4, *Helianthemum croceum* 0.3, *Laserpitium siler* subsp. *siculum* 0.2, *Koeleria splendens* 0.1, *Cerastium tomentosum* 0.1, *Asperula aristata* subsp. *oreophila* 0.1

Ecology and distribution: This association is exclusive to dolomitic substrates and thrives on consolidated debris on the base of steep slopes. Its distribution is limited to the area between Monte Quacella and Portella di Mele in the Madonie Mountains, where it occurs approximately from 1300 to 1700 m a.s.l. (Pignatti et al., 1980; Brullo, 1984).

***Astragaletum nebrodensis* Nimis in E. Pignatti et al. 1980 (group g)**

Name-giving taxon: *Astragalus nebrodensis*

Typus: Pignatti et al., 1980, relevé 66, table 7 (*holotypus*)

Diagnostic species: *Hyoseris radiata* 0.6, *Festuca ovina* 0.5, *Achillea ligustica* 0.5, *Thymus striatus* 0.4, *Phleum ambiguum* 0.3, *Ilex aquifolium* 0.3, *Daphne oleoides* 0.3, *Helictochloa cincinnata* 0.3, *Astragalus nebrodensis* 0.3, *Silene vulgaris* 0.3, *Silene sicula* 0.3

Constant species: *Galium lucidum* subsp. *bernardii* 1, *Cerastium tomentosum* 1, *Helianthemum cinereum* 0.8, *Centaurea parlatoris* 0.8, *Hypochaeris laevigata* 0.7, *Asperula aristata* subsp. *oreophila* 0.7, *Sesleria nitida* subsp. *sicula* 0.5, *Sedum amplexicaule* 0.5, *Sedum album* 0.5, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.5, *Lomelosia crenata* 0.5, *Koeleria splendens* 0.5, *Helianthemum croceum* 0.5, *Alyssum nebrodense* 0.5, *Festuca circummediterranea* 0.4, *Erysimum bonannianum* 0.4, *Eryngium campestre* 0.4, *Dactylis glomerata* 0.4, *Cachrys ferulacea* 0.4, *Arabis collina* subsp. *rosea* 0.4, *Anthyllis vulneraria* subsp. *maura* 0.4

Dominant species: *Astragalus nebrodensis* 1, *Sesleria nitida* subsp. *sicula* 0.1, *Rosa sicula* 0.1, *Helictochloa cincinnata* 0.1, *Festuca ovina* 0.1

Ecology and distribution: This association, dominated by *Astragalus nebrodensis*, mainly occurs at elevations of 1400 to 1600 m, although it may sporadically also occur at higher elevations. It primarily occupies loose substrates characterised by a rich content of shale clay, with a notable presence of sand (Pignatti et al., 1980; Brullo, 1984).

Carthamo pinnati-Thymetum spinulosi **Brullo et Marcenò in Brullo 1984 *mut.* Marcenò et al. *nom. mut. nov.* (group h)**

Original form of the name (Brullo 1984, p. 383): "*Carduncello-Thymetum spinulosi* Brullo & Marcenò, *ass. nov.*"

Name-giving taxa of the original association name: *Carduncellus pinnatus* (Desf.) DC. 1838 and *Thymus spinulosus* Ten. 1811

Name-giving taxa of the mutated association name*:* *Carthamus pinnatus* Desf., 1799, *Thymus spinulosus* Ten. 1811

Authoritative taxonomic treatments adopting the name *Carthamus pinnatus*: Euro+Med PlantBase (2022), Pignatti et al. (2017-2019), WFO (2023)

Typus: Brullo, 1984, relevé 8, table 12 (*holotypus*)

Diagnostic species: *Thymus spinulosus* 0.8, *Carthamus pinnatus* 0.6, *Asphodelus ramosus* 0.6, *Scutellaria columnae* subsp. *columnae* 0.6, *Jacobaea candida* 0.6, *Catapodium rigidum* 0.6, *Sanguisorba minor* 0.5, *Stipa sicula* 0.4, *Saxifraga adscendens* 0.4, *Eryngium campestre* 0.4, *Micromeria juliana* 0.4, *Onosma echioides* subsp. *canescens* 0.4, *Saponaria sicula* 0.4, *Helictochloa cincinnata* 0.3, *Orobanche* species 0.3, *Rumex scutatus* 0.3, *Koeleria splendens* 0.3, *Asperula aristata* subsp. *oreophila* 0.3, *Sideritis italica* 0.3, *Carlina nebrodensis* 0.3, *Sixalix atropurpurea* subsp. *maritima* 0.3, *Secale strictum* 0.3, *Carex flacca* subsp. *erythrostachys* 0.3, *Bonannia graeca* 0.3, *Scorzonera villosa* subsp. *columnae* 0.3, *Pimpinella tragium* 0.3, *Linaria simplex* 0.3, *Euphorbia myrsinites* 0.3, *Brachypodium rupestre* 0.3, *Cuscuta* sp. 0.3

Constant species: *Festuca circummediterranea* 0.8, *Centaurea parlatoris* 0.8, *Helianthemum* cinereum 0.7, *Hypochaeris laevigata* 0.7, *Bunium petraeum* 0.7, *Astragalus nebrodensis* 0.7, *Sedum album* 0.6, *Pilosella leucopsilon* 0.6, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.6, *Anthyllis vulneraria* subsp. *maura* 0.6, *Alyssum nebrodense* 0.6, *Phleum ambiguum* 0.5, *Helianthemum croceum* 0.5, *Polycarpon polycarpoides* 0.5, Galium *lucidum* subsp. *bernardii* 0.5, *Teucrium montanum* 0.4, *Teucrium chamaedrys* 0.4, *Silene sicula* 0.4, *Lactuca viminea* 0.4, *Inula montana* 0.4, *Cerastium semidecandrum* 0.4

Dominant species: *Jacobaea candida* 0.4, *Thymus spinulosus* 0.2, *Astragalus nebrodensis* 0.2, *Koeleria splendens* 0.2, *Sideritis italica* 0.1, *Phleum ambiguum* 0.1, *Helictochloa cincinnata* 0.1, *Helianthemum cinereum* 0.1

Ecology and distribution: This association occurs at lower elevations (1200-1300 m a.s.l.) than the other grassland communities studied here. It prefers outcrops of scaly clay, quartz sandstones, and dolomite. The distribution of this association extends beyond the Madonie Mountains to other mountainous areas of north-western Sicily, including Rocca Busambra and Monte Cammarata (Brullo, 1984).

Siculosciadietum nebrodensis **Brullo et Giusso 2005 *mut.* C. Marcenò et al. *nom. mut. nov.* (group i)**

Original form of the name (Brullo et al., 2005, p. 118): "*Peucedanetum nebrodensis* Brullo & Giusso *ass. nova*"

Name-giving taxon of the original association name: *Peucedanum nebrodense* (Guss.) Nyman 1838

Name-giving taxon of the mutated association name*:* *Siculosciadium nebrodense* (Guss.) C. Brullo, Brullo, S.R. Downie et Giusso 2013

Authoritative taxonomic treatments adopting the name *Siculosciadium nebrodense*: Pignatti et al. (2017-2019), WFO (2023).

Typus: Brullo et al. 2005, relevé 8, table 12 (*holotypus*)

Diagnostic species: *Siculosciadium nebrodense* 0.9, *Sedum hispanicum* 0.9, *Malva moschata* 0.9, *Reichardia picroides* 0.8, *Trifolium pratense* subsp. *semipurpureum* 0.6, *Rumex nebroides* 0.6, *Aethionema saxatile* 0.6, *Crepis vesicaria* subsp. *vesicaria* 0.5, *Allium cupanii* 0.5, *Bunium petraeum* 0.4, *Trifolium repens* 0.4, *Erysimum bonannianum* 0.3, *Dactylis glomerata* 0.3, *Herniaria nebrodensis* 0.3, *Cachrys ferulacea* 0.3, *Anthyllis vulneraria* subsp. *maura* 0.3, *Euphorbia myrsinites* 0.3, *Cerinthe minor* subsp. *auriculata* 0.3, *Centaurea parlatoris* 0.3

Constant species: *Petrorhagia saxifraga* subsp. *gasparrinii* 1, *Festuca circummediterranea* 1, *Cerastium tomentosum* 1, *Polycarpon polycarpoides* 0.8, *Galium lucidum* subsp. *bernardii* 0.8, *Valeriana tuberosa* 0.7, *Medicago lupulin*a subsp. *cupaniana* 0.5, *Helianthemum cinereum* 0.5, *Astragalus nebrodensis* 0.5, *Anthemis arvensis* subsp. *sphacelata* 0.5, *Minuartia verna* 0.4, *Acinos alpinus* 0.4

Dominant species: *Siculosciadium nebrodense* 1, *Festuca circummediterranea* 1, *Cachrys ferulacea* 0.8, *Bunium petraeum* 0.7, *Trifolium repens* 0.5, *Centaurea parlatoris* 0.5, *Trifolium pratense* subsp. *semipurpureum* 0.4, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.4, *Dactylis glomerata* 0.4, *Reichardia picroides* 0.2, *Euphorbia myrsinites* 0.2, *Cerastium tomentosum* 0.2

Ecology and distribution: Vegetation colonising small depressions and the north-facing slopes of sinkholes, where the snow lasts for quite a long time and the soil humidity is fairly good even during the summer months. The association was described from the Carbonara Massif, where it occurs in the elevation range of 1800-1900 m a.s.l.

***Cachryetum ferulaceae* Raimondo 1980 (group j)**

Synonym: *Cerastio tomentosi-Cachryetum ferulaceae* Brullo et Marcenò in Brullo 1984, p. 385, nom. illeg. (art. 22)

Name-giving taxon of the association: *Cachrys ferulacea*

Typus: Raimondo 1980, relevé 1, table 5 (*holotypus*)

Diagnostic species: *Helianthemum nummularium* subsp. *tomentosum* 0.6, *Anthyllis vulneraria* subsp. *busambarensis* 0.6, *Sideritis italica* 0.5, *Lactuca viminea* 0.5, *Artemisia alba* 0.5, *Helianthemum oelandicum* subsp. *nebrodense* 0.4, *Verbascum rotundifolium* 0.4, *Sternbergia colchiciflora* 0.4, *Inula montana* 0.4, *Allium sphaerocephalon* subsp. *arvense* 0.4, *Asphodeline lutea* 0.4, *Melica cupanii* 0.4, *Viola nebrodensis* 0.4, *Allium flavum* 0.4, *Dactylis glomerata* 0.3, *Cachrys ferulacea* 0.3, *Matthiola fruticulosa* 0.3, *Valeriana tuberosa* 0.3, *Alyssum nebrodense* 0.3, *Helictochloa cincinnata* 0.3, *Silene sicula* 0.3, *Bunium petraeum* 0.3, *Arabis collina* subsp. *rosea* 0.3, *Linaria purpurea* 0.3, *Euphorbia myrsinites* 0.3, *Acinos alpinus* 0.3, *Arrhenatherum elatius* subsp. *nebrodense* 0.3

Constant species: *Cerastium tomentosum* 1, *Festuca circummediterranea* 0.9, *Astragalus nebrodensis* 0.9, *Petrorhagia saxifraga* subsp. *gasparrinii* 0.8, *Galium lucidum* subsp. *bernardii* 0.8, *Centaurea parlatoris* 0.8, *Erysimum bonannianum* 0.7, *Sedum album* 0.7, *Phleum ambiguum* 0.7, *Asperula aristata* subsp. *oreophila* 0.6, *Sesleria nitida* subsp. *sicula* 0.6, *Polycarpon polycarpoides* 0.6, *Crepis vesicaria* subsp. *vesicaria* 0.5, *Sedum amplexicaule* 0.5, *Poa bulbosa* 0.5, *Carlina nebrodensis* 0.4

Dominant species: *Cachrys ferulacea* 0.8, *Festuca circummediterranea* 0.7, *Astragalus nebrodensis* 0.5, *Sesleria nitida* subsp. *sicula* 0.4, *Artemisia alba* 0.4, *Phleum ambiguum* 0.3, *Melica cupanii* 0.3, *Helianthemum nummularium* subsp. *tomentosum* 0.3, *Cerastium tomentosum* 0.3, *Galium lucidum* subsp. *bernardii* 0.3, *Knautia calycina* 0.2, *Helictochloa cincinnata* 0.1, *Alyssum nebrodense* 0.1, *Vicia glauca* 0.1, *Inula montana* 0.1, *Dactylis glomerata* 0.1

Ecology and distribution: This association thrives on stony slopes on limestone and dolomite, typically between 1400 and 1900 m a.s.l. These communities are commonly dominated by *Cachrys ferulacea*, accompanied by dwarf shrubs and herbaceous species. Past grazing contributed to the abundance of forage species. Recently, these grasslands are grazed by an increasing population of feral fallow deer (*Dama dama*), which shows a preference for the flower primordia of *Cachrys ferulacea*, preventing them from reproducing. This association is distributed in Pizzo Carbonara and Monte Cervi (Brullo, 1984).

Supplement E4. Confusion matrix between the associations classified according to Brullo et al. (2005) (1), Brullo and Grillo (1978) (2), Raimondo (1983) (3) and the TWINSPAN classification. The newly described associations are marked with (*).

Anhang E4. Konfusionsmatrix zwischen den nach Brullo et al. (2005) (1), Brullo und Grillo (1978) (2), Raimondo (1983) (3) klassifizierten Assoziationen und der TWINSPAN-Klassifikation. Die neu beschriebenen Assoziationen sind mit (*) gekennzeichnet.

	TWINSPAN GROUPS										
Associations	**a**	**b**	**c**	**d**	**e**	**f**	**g**	**h**	**i**	**j**	**k**
**Androsaco breistrofferi-Potentilletum calabrae*	15										
2 – Armerio nebrodensis-Plantaginetum cupanii			15								
1 – Astragaletum nebrodensis						4	7	4			
1 – Cachryetum ferulaceae										12	
1 – Carthamo pinnati-Thymetum spinulosi						5		10			
3 – Cynosuro cristati-Plantaginetum cupanii		4									
**Helianthemo tomentosi-Festucetum crassifoliae*					15						
1 – Lino punctati-Seslerietum siculae						13		4			
1 – Siculosciadietum nebrodensis									7		
1 – Plantagini humilis-Armerietum nebrodensis				12							
1 – Seslerio siculae-Melicetum cupanii											7
1 – Sideritido siculae-Artemisietum albae										3	11