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# New contributions to the class *Charybdido pancratii-Asphodeletea ramosi* Biondi 2016

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**Abstract**
This article deals with new contributions to the class *Charybdido pancratii-Asphodeletea ramosi*, which was recently described in the classification of the edge vegetation of the Mediterranean area. The most important aspect is the description of the new order *Bellido sylvestris-Arisaretalia vulgaris*, which increases the importance of the class, as it includes sciaphilous and semi-sciaphilous edge communities. In terms of its ecology, this new order contrasts with the previously described order *Asphodeletalia ramosi*, which instead includes heliophilous edge communities. Four alliances belong to this new order: *Cyclamino hederifolii-Arisarion vulgaris*, which is the *typus* of the order for the eastern Mediterranean and Illyrian area; *Cyclamino hederifolii-Ranunculion bullati* all. nova, which also occurs in the eastern Mediterranean area; *Leontodonto tuberosi-Bellidion sylvestris*, which has already been described for Sardinia, and also occurs in all the Tyrrhenian area down to Sicily; and *Ranunculion bullati*, which was previously described for the Baetica Province of Spain, and probably occurs in other areas of the Iberian territory; in a biogeographical sense, this last thus replaces the eastern European alliance *Cyclamino hederifolii-Ranunculion bullati*. Moreover, six associations belong to the new order: *Cyclamino hederifolii-Arisaretum vulgaris* ass. nova; *Drymochloo exaltatae-Cyclaminetum hederifolii* ass. nova; *Allio chamaemoly-Ranunculetum bullati* ass. nova; *Cyclamino hederifolii-Ranunculetum bullati* ass. nova; *Scillo obtusifoliae-Bellidetum sylvestris*; and *Scillo autumnalis-Bellidetum sylvestris*. For the last of these associations, the new subassociation *arisaretosum vulgaris* is here described. The association *Scillo autumnalis-Ranunculetum bullati* that occurs in the Baetica Province completes the present review. Finally, the new association *Euphorbio characiae-Thapsietum garganicae* and the new subssociation *festucetosum circummediterraneae* are described, which are part of the order *Asphodeletalia ramosi*. The syntaxonomic scheme that includes all of the communities described within the class, and the synoptic table of all of the syntaxa that are part of the same class, complete the article.

Key words: *Asphodeletalia ramosi, Bellido sylvestris-Arisaretalia vulgaris*, bioclimate, biogeography, dynamic process, edge community, Mediterranean area.

## Introduction

The aim of the present study is to add new contributions to the class *Charybdido pancratii-Asphodeletea ramosi* that was recently described in the classification of the Mediterranean edge vegetation (Biondi *et al*., 2016). The new order *Bellido sylvestris-Arisaretalia vulgaris* adds to the order *Asphodeletalia ramosi* that was described by Biondi *et al*. (2016), and includes heliophilous edge vegetation. The new order extends the importance of the class, as this adds sciaphilous and semi-sciaphilous edge communities. These communities were sampled in the area of the Gargano peninsula (south-east Italy), in addition to other surveys carried out in other Italian and European areas. Moreover, a new contribution to the vegetation of the order *Asphodeletalia ramosi* is described, which includes a new association.

## Material and methods

### *Study area*

The study area includes an area in southern Spain and three different areas within Italy: the Gargano peninsula; part of the central Apennines; and the northern end of Sardinia (Fig. 1).

### *Vegetation data*

An edge community vegetation dataset collected together here (which is prevalently dominated by *Asphodelus ramosus* and *Arisarum vulgare*) includes 63 phytosociological relevés carried out according to the Braun-Blanquet method: 43 published, and 20 unpublished.

For each phytosociological relevé, the following bioclimatic indices were derived (except for the southern Spain area) from the bioclimate of Italy (Pesaresi *et al*., 2014): Compensated Thermicity Index (Itc), Annual Ombrothermic Index (Io), Continentality Index (Ic), and Bimonthly Summer Ombrothermic Index ($Ios_2$) (Rivas-Martínez *et al*., 2011). Furthermore, the Ellenberg indicator values (Ellenberg *et al*., 1992; Pignatti *et al*., 2005) and the Raunkiaer life-forms (Raunkiaer, 1934) were considered as the species functional traits.

The taxonomic nomenclature was standardised according to the 'anarchive' checklist (Lucarini *et al*., 2015). The phytosociological nomenclature follows the International Code of Phytosociological Nomenclature (Weber *et al*., 2000). The syntaxonomic nomenclature at the level of alliance, order and class follows the 'Prodrome of the Italian Vegetation' (Biondi *et al*., 2014b), and its subsequent integrations (Biondi

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Fig. 1 - The black-coloured points represent the studied areas.

*et al*., 2014a; 2014c; 2015a; 2015b), and the variations and integrations of syntaxa indicated on the specific interactive site of the Italian Botanical Society, as recently upgraded (http://www.prodromo-vegetazione-italia.org/).

***Vegetation analysis***

*Classification*

To update and extend the syntaxonomic classification of the *Charybdido pancratii-Asphodeletea ramosi* class, two-step cluster analysis was performed (De Cáceres *et al*., 2015) for the vegetation dataset: (i) plot-based classification, as a semi-supervised fuzzy classification (De Cáceres *et al*., 2010), to identify associations and subassociations; and (ii) type-based classification, as a hierarchical cluster analysis, to identify higher syntaxa.

To identify the diagnostic species for the associations and the higher syntaxa, indicator species analysis was performed using the phi coefficient (Chytrý *et al*., 2002).

*Indirect gradient analysis*

Principal component analysis (PCA) was performed on the chord-transformed vegetation data, to identify the main compositional gradients (PCA axes). The significant bioclimatic indices and the functional traits were fitted into the PCA space using generalised additive models.

## Results

The numerical classification allowed the syntaxonomic scheme of the class *Charybdido pancratii-Asphodeletea ramosi* to be updated and extended. The 'plot-based classification' identified 19 clusters, and the 'type-based classification' identified eight. The ordered and classified floristic composition of this class are reported in the synoptic table (Tab. 7), with the indicators detected by the indicator species analysis.

The alliances were superimposed on the PCA ordination plot (Fig. 2). The PCA ordered the phytosociological relevés according to the main compositional gradients of the vegetation. In the PCA sites plot (Fig. 2), the relevés were sorted according to the PC1 and PC2 axes (with 18% and 10% variation explained by PC1 and PC2, respectively). PC1 opposes the communities dominated by *Arisarum vulgare* for those dominated by *Asphodelus ramosum*, while PC2 separates the communities of *Cyclamen hederifolium* from those rich in *Ranunculus bullatus* and *Bellis sylvestris*.

In functional species traits terms, the PC1 and PC2 axes represent a light gradient (L). The PC2 axis opposes communities rich in rosulate hemicryptophytes (H ros) for those completely dominated by geophytes, which in bioclimatic terms represents a thermoxeric ($Ios_2$) and a continentality gradient (Ic) (Fig. 2).

All of the syntaxa are now described.

All.: *CYCLAMINO HEDERIFOLII-ARISARION VULGARIS* all. nova *hoc loco*

(*Holotypus*: *Cyclamino hederifolii-Arisaretum vulgaris* ass. nova; present study)

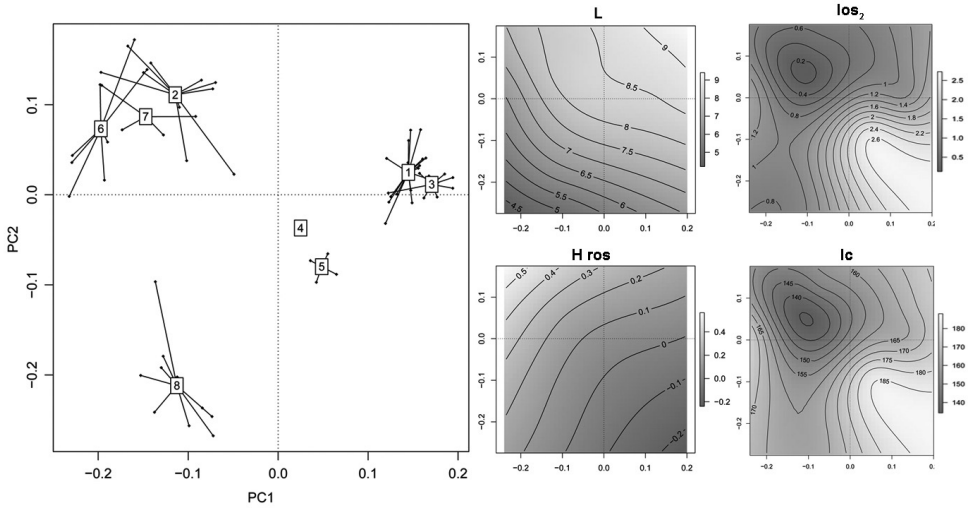


Fig. 2 - Indirect gradient analysis. Left: PCA ordination plot of the chord-transformed abundance for the *Charybdido pancratii-Asphodeletea ramosi* vegetation data. Spiders are the alliance (derived from the cluster analysis step 2). Right: Smoothed surfaces of the significant species functional traits (L and H ros) and bioclimatic indices ($Ios_2$ and Ic) fitted on the PCA plot ordination. Spider labels: 1 - *Charybdido pancratii-Asphodelion ramosi*, 2 - *Leontodonto tuberosi-Bellidion sylvestris*, 3 - *Asphodelo ramosi-Ferulion communis*, 4 - *Asphodelion fistulosi*, 5 - *Asphodelo ramosi-Ferulion glaucae*, 6 - *Cyclamino hederifolii-Ranunculion bullati*, 7 - *Ranunculion bullati*, 8 - *Cyclamino hederifolii-Arisarion vulgaris*.

This alliance occurs in the northern coastal parts of the Gargano promontory, where there are post-fire maquis and Mediterranean mesophilous forests of the association *Cyclamino hederifolii-Quercetum ilicis* Biondi *et al*. ex Biondi, Casavecchia & Gigante in Biondi *et al*. 2013. The characteristic species of the alliance are: *Cyclamen hederifolium*, *Brachypodium sylvaticum* and *Arisarum vulgare*. This develops in areas with lower mesoMediterranean thermotype and dry ombrotype.

Ass.: *CYCLAMINO HEDERIFOLII-ARISARETUM VULGARIS* ass. nova *hoc loco*
(*Holotypus*: rel. 1 of Tab. 1; present study)

This association is the *typus* of the alliance *Cyclamino herifolii-Arisarion vulgaris*.This association has been reported for the northern areas of Gargano, along the coast close to post-fire maquis and mesophilous Mediterranean woods of the association *Cyclamino hederifolii-Quercetum ilicis*.

The characteristic species of the association are: *Arisarum vulgare*, *Cyclamen hederifolium*, *Brachypodium sylvaticum* and *Viola alba* subsp. *dehnhardtii*.

Ass.: *DRYMOCHLOO EXALTATAE-CYCLAMINETUM HEDERIFOLII* ass. nova *hoc loco*
(*Holotypus*: rel. 2 of Tab. 2; present study)

The characteristic species of the association are: *Drymochloa drymeja* subsp. *exaltata* and *Carex hallerana*. This association occurs close to the most mesophilous *Quercus ilex* woods in the same area of Gargano and in other territories of Apulia, and is defined as the association *Festuco exaltatae-Quercetum ilicis* Biondi *et al*. ex Biondi, Casavecchia & Gigante in Biondi *et al*. 2013.

All.: *CYCLAMINO HEDERIFOLII-RANUNCULION BULLATI* all. nova *hoc loco*
(*Holotypus*: *Cyclamino hederifolii-Ranunculetum bullati* ass. nova; present study)

This alliance includes the edge vegetation dominated by *Ranunculus bullatus* of the Gargano peninsula, which occurs along the edge strip between grassland and mesophilous maquis, and the south-eastern part of the Italian peninsula. It also probably includes the Illyrian communities of the east-Adriatic area. In addition to *Ranunculus bullatus*, the characteristic species of the alliance are *Cyclamen hederifolium*, *Allium subhirsutum*, *Arum maculatum*, *Umbilicus rupestris*, *Allium chamaemoly* and *Plantago serraria*. This develops in areas with lower mesoMediterranean thermotype and dry ombrotype.

Ass.: *CYCLAMINO HEDERIFOLII-RANUNCULETUM BULLATI* ass. nova *hoc loco*
(*Holotypus*: rel. 2 of Tab. 3; present study)

This association occurs in the surroundings of Torre Mileto (Gargano), where its distribution range shows a sinuous shape due to the shadows of the Mediterranean maquis that is dominated by *Pistacia lentiscus* and

Tab. 1 - *Cyclamino hederifolii-Arisaretum vulgaris* ass. nova.

| Relevé (N.) | 1* | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Altitude (m a.s.l.) | 731 | 745 | 701 | 731 | 742 | |
| Aspect | NNW | WNW | ENE | - | NW | |
| Slope (%) | 25 | 15 | 35 | - | 15 | |
| Area ($m^2$) | 25 | 80 | 60 | 30 | 40 | Presences |
| Coverage (%) | 90 | 90 | 85 | 98 | 90 | |
| Char. species of the ass. *Cyclamino hederifolii-Arisaretum vulgaris* | | | | | | |
| Arisarum vulgare O. Targ.Tozz. | 5.5 | 3.4 | 3.4 | 5.5 | 5.5 | 5 |
| Cyclamen hederifolium Aiton | 2.2 | 2.3 | 4.4 | 2.3 | 2.2 | 5 |
| Brachypodium sylvaticum (Huds.) P. Beauv. | 2.2 | 5.5 | 2.2 | . | 4.4 | 4 |
| Viola alba Besser subsp. dehnhardtii (Ten.) W. Becker | 2.3 | 1.2 | . | . | 1.2 | 3 |
| Char. and diff. species of the all. *Cyclamino-Arisarion* and upper levels | | | | | | |
| Asparagus acutifolius L. | 1.2 | 1.2 | 1.2 | 1.1 | 1.2 | 5 |
| Allium subhirsutum L. | 1.2 | . | . | 1.2 | + | 3 |
| Bellis sylvestris Cirillo | . | 1.2 | . | 1.2 | +.2 | 3 |
| Charybdis pancration (Steinh.) Speta | . | r | . | + | . | 2 |
| Carex halleriana Asso | . | . | 1.1 | . | . | 1 |
| Drymochloa drymeja subsp. exaltata (C. Presl) B. Foggi & Signorini | . | . | + | . | . | 1 |
| Leontodon tuberosus L. | . | . | . | 1.2 | . | 1 |
| Anemone hortensis L. | . | . | . | + | . | 1 |
| Other species | | | | | | |
| Arum italicum Mill. | 1.2 | 1.2 | 1.2 | + | 1.2 | 5 |
| Prasium majus L. | 2.2 | + | . | . | + | 3 |
| Pistacia lentiscus L. | . | . | 1.2 | 1.2 | +.2 | 3 |
| Smilax aspera L. | . | . | 1.2 | + | + | 3 |
| Reichardia picroides (L.) Roth | + | . | . | 1.2 | . | 2 |
| Ranunculus lanuginosus L. | 2.2 | . | . | + | . | 2 |
| Myrtus communis L. | +.2 | . | . | + | . | 2 |
| Theligonum cynocrambe L. | . | + | . | . | + | 2 |
| Rubia peregrina L. | . | + | . | . | 1.1 | 2 |
| Sporadic species | 2 | 8 | 4 | 3 | 3 | |

Tab. 2 - *Drymochloo exaltatae-Cyclaminetum hederifolii* ass. nova.

| Relevé (N.) | 1 | 2* | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Altitude (m a.s.l.) | 345 | 787 | 736 | 785 | 787 | |
| Aspect | N | - | NE | NNE | NNW | |
| Slope (%) | 10 | - | 10 | 5 | 5 | |
| Area ($m^2$) | 100 | 150 | 80 | 15 | 60 | Presences |
| Coverage (%) | 90 | 90 | 90 | 90 | 85 | |
| Char. species of the ass. *Drymochloo exaltatae-Cyclaminetum hederifolii* | | | | | | |
| Drymochloa drymeja subsp. exaltata (C. Presl) B. Foggi & Signorini | 3.4 | 3.4 | 3.3 | 5.5 | 2.3 | 5 |
| Carex hallerana Asso | 1.2 | 1.2 | . | 1.2 | . | 3 |
| Prunella vulgaris L. | 1.2 | 1.2 | . | . | . | 2 |
| Viola odorata L. | 1.2 | . | 3.3 | . | . | 2 |
| Vinca major L. | . | 1.2 | . | . | . | 1 |
| Char. and diff. species of the all. *Cyclamino-Arisarion* and upper levels | | | | | | |
| Cyclamen hederifolium Aiton | 4.4 | 4.5 | 1.2 | 3.3 | 2.2 | 5 |
| Asparagus acutifolius L. | 1.2 | + | 2.3 | + | 1.1 | 5 |
| Brachypodium sylvaticum (Hudson) Beauv. | 2.3 | 1.2 | 2.3 | + | . | 4 |
| Allium subhirsutum L. | + | . | + | 1.2 | . | 3 |
| Arisarum vulgare Targ.-Tozz. | . | . | 2.3 | 1.2 | 4.5 | 3 |
| Anemone hortensis L. | . | + | . | . | . | 1 |
| Other species | | | | | | |
| Rubia peregrina L. | 2.2 | 1.2 | 2.3 | 1.2 | 1.2 | 5 |
| Smilax aspera L. | + | + | 1.1 | + | 1.1 | 5 |
| Arum italicum Miller | +.2 | 2.2 | + | 1.2 | . | 4 |
| Quercus ilex L. | 1.2 | 1.2 | 1.1 | . | + | 4 |
| Rubus ulmifolius Schott | +.2 | . | + | +.2 | + | 4 |
| Tamus communis L. | + | . | + | + | + | 4 |
| Ruscus aculeatus L. | 1.2 | . | + | 1.2 | 1.2 | 4 |
| Emerus major Mill. subsp. emeroides (Boiss. et Spruner) Soldano et F. Conti | + | + | . | . | 1.1 | 3 |
| Rosa sempervirens L. | + | . | . | + | . | 2 |
| Theligonum cynocrambre L. | . | + | . | + | . | 2 |
| Clematis flammula L. | . | . | + | . | 1.2 | 2 |
| Sporadic species | 0 | 2 | 0 | 1 | 2 | |

*Myrtus communis*. This is indeed a sciaphilous edge community that includes species resistant to trampling by animals. It mainly occurs on soils of Terra Rossa Mediterranea that are rich in organic matter. The characteristic species of the association are: *Allium subhirsutum*, *Cyclamen hederifolium*, *Arum maculatum* and *Umbilicus rupestris*.

Ass.: *ALLIO CHAMAEMOLY-RANUNCULETUM BULLATI* ass. nova *hoc loco*
(*Holotypus*: rel. 2 of Tab. 4; present study)

This plant community occurs on Terra Rossa, in positions that are slightly more advanced with respect to the maquis edge. The characteristic species of this association are: *Allium chamaemoly*, *Plantago serraria* and *Ornithogalum etruscum* subsp. *umbratile*, which is the differential species of the association.

All.: *LEONTODONTO TUBEROSI-BELLIDION SYLVESTRIS* Biondi, Filigheddu & Farris 2001

This alliance occurs in the Mediterranean macrobioclimate (from thermo to upper-Mediterranean thermoype), and its distribution range is the western Mediterranean. The characteristic species are: *Bellis sylvestris*, *Leontodon tuberosus*, *Anemone hortensis*, *Ambrosina bassii*, *Prospero obtusifolium* (= *Scilla obtusifolia*), *P. autumnale* (= *Scilla autumnalis*), *Ornithogalum corsicum* and *Charybdis undulata* (= *Urginea undulata*). This develops in areas with lower mesoMediterranean-thermoMediterranean thermotypes and dry ombrotype.

Ass.: *SCILLO OBTUSIFOLIAE-BELLIDETUM SYLVESTRIS* Biondi, Filigheddu & Farris 2001

It is the association *typus* of the alliance (Tab. 48 of Biondi, Filigheddu & Farris, 2001: 55). The association was originally reported and described for the Nurra peninsula (north-western Sardinia).

Ass.: *SCILLO AUTUMNALIS-BELLIDETUM SYLVESTRIS* Biondi, Filigheddu & Farris 2001
*TYPICUM* subass. nova *hoc loco* (*Holotypus*: rel. 2 of Tab. 5, corresponding to rel. 30 of Tab. 49 in Biondi, Filigheddu & Farris, 2001: 55).

This association was described in Biondi, Filigheddu & Farris (2001). It was originally reported for the inner hills next to Nurra, but was not included in the Nurra territories. The characteristic species are: *Prospero autumnale* and *Ranunculus paludosus* (=*R. flabellatus*) (Tab. 5, this paper, corresponding to Tab. 49 in Biondi, Filigheddu & Farris, 2001: 55, and Tab. 61 in Biondi & Bagella, 2005: 48)
*ARISARETOSUM VULGARIS* subass. nova *hoc loco* (*Holotypus*: rel. 5 of Tab. 5, corresponding to rel. 2 of Tab. 61 in Biondi & Bagella 2005: 48)

The same association (*Scillo autumnalis-Bellidetum sylvestris*) was also found in the La Maddalena Archipelago (Biondi & Bagella, 2005). The relevés in Tab. 61 of Biondi & Bagella (2005) did not actually completely match with the association. Therefore, with these relevés, the new subassociation *arisaretosum vulgaris* is here described. Its differential species are *Arisarum vulgare* and *Cistus monspeliensis*.

All.: *RANUNCULION BULLATI* Pérez La Torre & Cabezudo 2008

This alliance has been described to include ephemeral meadows characterised by thermo-Mediterranean winter blooming geophytes and hemicryptophytes, which have a distribution range that extends into the Baetic province (south-eastern Spain). This develops

Tab. 3 - *Cyclamino hederifolii-Ranunculetum bullati* ass. nova.

| Relevé (N.) | 1 | 2* | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Altitude (m a.s.l.) | 715 | 600 | 285 | 714 | 892 | |
| Aspect | - | - | - | - | - | Presences |
| Slope (%) | - | - | - | - | - | |
| Area ($m^2$) | 20 | 20 | 30 | 20 | 20 | |
| Coverage (%) | 95 | 90 | 95 | 100 | 93 | |
| Char. species of the ass. *Cyclamino hederifolii-Ranunculetum bullati* | | | | | | |
| Cyclamen hederifolium Aiton | 2.3 | 2.3 | 2.3 | 2.3 | 3.4 | 5 |
| Ranunculus bullatus L. | 3.3 | 2.3 | 3.3 | 2.3 | 2.2 | 5 |
| Allium subhirsutum L. | 1.2 | 1.2 | . | + | 1.1 | 4 |
| Arum maculatum L. | 1.2 | 1.2 | +.2 | . | . | 3 |
| Umbilicus rupestris (Salisb.) Dandy | . | + | 2.3 | . | . | 2 |
| Char. and diff. species of the all. *Cyclamino-Ranunculion* and upper levels | | | | | | |
| Bellis sylvestris Cirillo | 3.3 | 2.3 | 2.3 | 3.3 | 3.3 | 5 |
| Arisarum vulgare O. Targ.Tozz. | 1.2 | 4.5 | 3.3 | 3.4 | 4.4 | 5 |
| Leontodon tuberosus L. | . | 1.2 | 1.2 | 2.2 | 2.2 | 4 |
| Ornithogalum etruscum Parl. subsp. umbratile (Tornad. et Garbari) Peruzzi et Bartolucci | . | . | . | 1.2 | 1.2 | 2 |
| Carlina corymbosa L. | + | . | . | . | . | 1 |
| Anemone hortensis L. | 1.1 | . | . | . | . | 1 |
| Sonchus bulbosus (L.) N. Kilian et Greuter | +.2 | . | . | . | . | 1 |
| Asphodelus ramosus L. | . | + | . | . | . | 1 |
| Hyparrhenia hirta (L.) Stapf | . | + | . | . | . | 1 |
| Arum italicum Mill. | . | . | . | +.2 | . | 1 |
| Brachypodium sylvaticum (Huds.) P. Beauv. | . | . | . | . | + | 1 |
| Allium chamaemoly L. | . | . | . | . | 1.2 | 1 |
| Sporadic species | 3 | 5 | 5 | 5 | 1 | |

Tab. 4 - *Allio chamaemoly-Ranunculetum bullati* ass. nova.

| Relevé (N.) | 1 | 2* | 3 | |
|---|---|---|---|---|
| Altitude (m a.s.l.) | 711 | 719 | 715 | |
| Aspect | - | - | - | Presences |
| Slope (%) | - | - | - | |
| Area ($m^2$) | 6 | 35 | 30 | |
| Coverage (%) | 100 | 100 | 95 | |
| Char. species of the ass. *Allio chamaemoly-Ranunculetum bullati* | | | | |
| Ranunculus bullatus L. | 4.5 | 4.5 | 4.5 | 3 |
| Plantago serraria L. | 3.4 | 2.2 | 2.3 | 3 |
| Allium chamaemoly L. | . | 1.2 | 1.2 | 2 |
| Ornithogalum etruscum Parl. subsp. umbratile (Tornad. et Garbari) Peruzzi et Bartolucci | . | 1.2 | 1.1 | 2 |
| Char. and diff. species of the all. *Cyclamino-Ranunculion* and upper levels | | | | |
| Leontodon tuberosus L. | 1.1 | 2.2 | 1.2 | 3 |
| Bellis sylvestris Cirillo | +.2 | 3.3 | 2.3 | 3 |
| Carlina corymbosa L. | . | + | . | 1 |
| Anemone hortensis L. | . | + | . | 1 |
| Arisarum vulgare O. Targ.Tozz. | . | . | 1.2 | 1 |
| Allium subhirsutum L. | . | . | + | 1 |
| Brachypodium sylvaticum (Huds.) P. Beauv. | . | . | + | 1 |
| Other species | | | | |
| Theligonum cynocrambe L. | +.2 | 1.2 | . | 2 |
| Sporadic species | 4 | 0 | 2 | |

in areas with thermoMediterranean thermotype and dry ombrotype.

Ass.: *SCILLO AUTUMNALIS-RANUNCULETUM BULLATI* Pérez La Torre & Cabezudo 2008

This is a plant community that is characterised by geophytes. Hemicryptophytes and nanophanerophytes also occur, which are winter blooming (October, November), similar to those of Nurra and La Maddelena Archipelago. According to the association authors, the characteristic species are: *Ranunculus bullatus*, *Prospero autumnale*, *Narcissus obsoletus* (= *N. serotinus*), *Acis autumnalis* (=*Leucojum autumnale*), *Arisarum vulgare* and *Lobularia maritima* (Pérez La Torre & Cabezudo, 2008: 240).

Ord.: *BELLIDO SYLVESTRIS-ARISARETALIA VULGARIS* Biondi ordo novo *hoc loco*
(*Holotypus*: *Cyclamino hederifolii-Arisarion vulgaris* all. nova *hoc loco*)

The alliances and associations here presented are classified within the new order *Bellido sylvestris-Arisaretalia vulgaris*. This new order includes the mesophilous, sciaphilous and semi-sciaphilous edge communities that occur in Mediterranean areas close to maquis and woods, with thermotypes from thermo-Mediterranean to supraMediterranean. They can also occur in the Temperate macrobioclimate in the sub-Mediterranean bioclimate variant. The characteristic species of the order are: *Arisarum vulgaris*, *Bellis sylvestris*, *Leontodon tuberosus*, *Anemone hortensis, Ambrosina bassii, Prospero obtusifolium, P. autumnale, Ornithogalum corsicum, Cyclamen hederifolium, C. repandum, Ranunculus bullatus, Vinca major, Viola alba* subsp. *dehnhardii* and *V. odorata*.

Ass.: *EUPHORBIO CHARACIAE-THAPSIETUM GARGANICAE* ass. nova *hoc loco*
(*Holotypus*: rel. 3 in Tab. 6; present study)
*TYPICUM* subass. nova hoc loco (*Holotypus*: rel. 3 in Tab. 6; present study)

The diagnostic species of the association are: *Thapsia garganica*, *Euphorbia characias*, and *Ornithogalum etruscum* subsp. *umbratile*.

This is an edge community that occurs on abandoned grasslands with carbonate outcrops with aggregates and nodules of flint, for the north-eastern side of Gargano close to *Juniperus phoenicea* subsp. *turbinata* and *J. oxycedrus* subsp. *macrocarpa* microwoods and *Quercus ilex*, *Q. cerris*, *Q. dalechampii* and *Q. virgiliana* woods. Occasionally, this coenosis occurs close to dry stone walls bordering private grasslands that are now abandoned.

This association belongs to the alliance *Charybdido pancratii-Asphodelion ramosi*, order *Asphodeletalia ramosi*, and class *Charybdido pancratii-Asphodeletea ra-*

Tab. 5 - *Scillo autumnalis-Bellidetum sylvestris* Biondi *et al.* 2001

| Relevé (N.) | 1 | 2* | 3 | 4 | 5** | |
|---|---|---|---|---|---|---|
| Altitude (m a.s.l.) | | | | | | |
| Aspect | - | - | - | - | - | |
| Slope (%) | - | - | - | - | - | |
| Area ($m^2$) | 20 | 20 | 30 | 2 | 4 | Presences |
| Coverage (%) | 70 | 70 | 100 | 40 | 70 | |
| Char. species of the ass. *Scillo autumnalis-Bellidetum sylvestris* | | | | | | |
| Prospero autumnale (L.) Speta | 2.2 | 2.2 | 1.2 | 1.2 | 1.2 | 5 |
| Ranunculus paludosus Poir. | + | +.2 | 1.2 | . | . | 3 |
| Diff. species of the subass. arisaretosum vulgare | | | | | | |
| Cistus monspeliensis L. | + | + | . | + | 1.1 | 4 |
| Arisarum vulgare O. Targ.Tozz. | . | . | . | 1.2 | 1.2 | 2 |
| Char. and diff. species of the all. *Leontodonto-Bellidion* and upper levels | | | | | | |
| Ambrosina bassii L. | 3.2 | 2.2 | 3.3 | 2.3 | 3.3 | 5 |
| Leontodon tuberosus L. | 2.2 | 1.2 | 3.4 | . | 1.1 | 4 |
| Asphodelus ramosus L. | + | +.2 | + | + | . | 4 |
| Bellis sylvestris Cirillo | 2.3 | 3.3 | 2.2 | . | . | 3 |
| Anemone hortensis L. | 1.2 | +.2 | +.2 | . | . | 3 |
| Asparagus acutifolius L. | . | + | . | . | . | 1 |
| Charybdis undulata (Desf.) Speta | . | . | . | + | . | 1 |
| Other species | | | | | | |
| Plantago lanceolata L. | +.2 | 1.2 | 1.2 | . | . | 3 |
| Quercus ilex L. | + | +.2 | 1.2 | . | . | 3 |
| Pulicaria odora (L.) Rchb. | 2.3 | 2.3 | 1.2 | . | . | 3 |
| Reichardia picroides (L.) Roth var. maritima (Boiss.) Fiori | 1.2 | 1.2 | + | . | . | 3 |
| Carex flacca Schreb. subsp. erythrostachys (Hoppe) Holub | 2.2 | + | . | . | . | 2 |
| Galactites tomentosus Moench | . | +.2 | + | . | . | 2 |
| Plantago weldenii Rchb. | . | . | . | 1.1 | 1.1 | 2 |
| Tuberaria guttata (L.) Fourr. | . | . | . | 2.2 | 1.1 | 2 |
| Sporadic species | 4 | 4 | 1 | 1 | 0 | |

Tab. 6 - *Euphorbio characiae-Thapsietum garganicae* ass. nova.

| Relevé (N.) | 1 | 2 | 3* | 4 | 5** | |
|---|---|---|---|---|---|---|
| Altitude (m a.s.l.) | 444 | 645 | 594 | 603 | 604 | |
| Aspect | - | N | - | SE | SE | |
| Slope (%) | - | 5 | - | 10 | 5 | |
| Area ($m^2$) | 10 | 250 | 250 | 200 | 100 | Presences |
| Coverage (%) | 100 | 90 | 100 | 100 | 100 | |
| H veg. (m) | 150 | - | - | - | 160 | |
| Char. species of the ass. *Euphorbio characiae-Thapsietum garganicae* | | | | | | |
| Thapsia garganica L. | 3.3 | 4.5 | 4.5 | 5.5 | 3.3 | 5 |
| Euphorbia characias L. | 3.3 | 2.2 | 4.5 | 1.1 | 5.5 | 5 |
| Ornithogalum etruscum Parl. subsp. umbratile (Tornad. et Garbari) Peruzzi et Bartolucci | 1.2 | + | + | . | . | 3 |
| Diff. species of the subass. *festucetosum circummediterraneae* | | | | | | |
| Festuca circummediterranea Patzke | . | . | . | +.2 | 1.2 | 2 |
| Dasypyrum villosum (L.) P. Candargy | . | . | . | 2.2 | 1.2 | 2 |
| Char. and diff. species of the all. *Charybdido-Asphodelion* and upper levels | | | | | | |
| Carlina corymbosa L. | 1.2 | 1.2 | . | 2.2 | + | 4 |
| Anemone hortensis L. | 1.1 | 2.2 | 2.2 | 1.2 | . | 4 |
| Iris bicapitata Colas. | . | 2.3 | 2.3 | 3.3 | 2.2 | 4 |
| Asphodelus ramosus L. | 4.5 | 5.5 | 3.4 | . | . | 3 |
| Asparagus acutifolius L. | 2.2 | . | 1.2 | . | 1.2 | 3 |
| Asphodeline lutea (L.) Rchb. | . | 1.2 | . | 2.2 | 1.2 | 3 |
| Bellis sylvestris Cirillo | . | +.2 | +.2 | . | . | 2 |
| Charybdis pancration (Steinh.) Speta | 1.2 | . | . | . | . | 1 |
| Ferula communis L. | . | r | . | . | . | 1 |
| Other species | | | | | | |
| Carduus nutans L. | + | + | + | . | + | 4 |
| Eryngium campestre L. | + | + | . | + | . | 3 |
| Anthoxanthum odoratum L. | . | 1.2 | . | 1.2 | +.2 | 3 |
| Anacamptis papilionacea (L.) R.M. Bateman, Pridgeon et M.W. Chase | 1.1 | + | . | . | . | 2 |
| Reichardia picroides (L.) Roth | + | . | + | . | . | 2 |
| Rhamnus saxatilis Jacq. subsp. infectoria (L.) P. Fourn. | 3.3 | . | . | . | + | 2 |
| Galium aparine L. | . | 1.2 | 1.2 | . | . | 2 |
| Geranium molle L. | . | + | 1.2 | . | . | 2 |
| Pteridium aquilinum (L.) Kuhn | . | 1.2 | . | 1.1 | . | 2 |
| Dactylis glomerata L. | . | 1.2 | . | + | . | 2 |
| Geranium lucidum L. | . | + | . | . | 1.2 | 2 |
| Rubus ulmifolius Schott | . | . | + | . | + | 2 |
| Sporadic species | 11 | 12 | 6 | 5 | 5 | |

Tab. 7 - Synoptic table (percentage) of the communities belonging to the class *Charybdido pancratii-Asphodeletea ramosi*. In gray the diagnostic indicators of syntaxa (*phi* >= 0.5; p < 0.05).

| Associations and subassociations (*) | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Alliances, suballiances number of figure 2 | 1 | 1 | 1 | 1 | 1 | 3 | 3 | 5 | 4 | 2 | 2 | 2 | 6 | 6 | 8 | 8 | 7 |
| Number of relevés | 5 | 5 | 3 | 2 | 3 | 2 | 4 | 5 | 2 | 3 | 2 | 5 | 5 | 3 | 5 | 5 | 4 |
| Ruta divaricata | 20 | 80 | | | | | | | | | | | | | | | |
| Satureja cuneifolia | 20 | 100 | | | | | | | | | | | | | | | |
| Hyparrhenia hirta | | 100 | | | | | | | | | | | 20 | | | | 25 |
| Sideritis italica | | 40 | 33 | | | | | | | | | | | | | | |
| Euphorbia characias | | 60 | 100 | 100 | | | | | | | | | | | | | |
| Festuca circummediterranea | | | | 100 | | | | | | | | | | | | | |
| Dasypyrum villosum | | | | 100 | 67 | | 25 | | 50 | | | | | | | | |
| Alkanna tinctoria | | | | | 100 | | | | 100 | | | | | | | | |
| Sonchus bulbosus | | | | | 100 | | | | | | | | 20 | | | | |
| Cynoglossum creticum | | | | | | 100 | | | | | | | 40 | 33 | | | |
| Anacamptis papilionacea | | 40 | 67 | | | | 75 | | | | | | | | | | |
| Cephalaria leucantha | | | | | | | | 80 | | | | | | | | | |
| Muscari neglectum | | 20 | 33 | | | | | 100 | | | | | | | | | |
| Artemisia alba | | | | | | | | 60 | | | | | | | | | |
| Sedum rupestre | | | 33 | | | | | 60 | | | | | | | | | |
| Verbascum niveum subsp. garganicum | | | | | 100 | | | | 100 | | | | | | | | |
| Euphorbia terracina | | | | | 100 | | | | 50 | | | | | | | | |
| Lotus cytisoides | | | | | 100 | | | | 100 | | | | | | | | |
| Ranunculus paludosus | | | | | | | | | | 100 | | | | | | | |
| Cistus monspeliensis | | | | | | | | | | 67 | 100 | 20 | | | | | |
| Prospero obtusifolium | | | | | | | | | | | | 100 | | | | | |
| Ornithogalum corsicum | | | | | | | | | | | | 60 | | | | | |
| Salvia verbenaca | | | | | | | | | | | | 60 | | 33 | | | |
| Arum maculatum | | | | | | | | | | | | | 60 | | | | |
| Allium chamaemoly | | | | | | | | | | | | | 20 | 67 | | | |
| Plantago serraria | | | | | | | | | | | | | 60 | 100 | | | |
| Viola alba subsp. dehnhardtii | | | | | | | | | | | | | | | 60 | 20 | |
| Drymochloa drymeja subsp. exaltata | | | | | | | | | | | | | | | 20 | 100 | |
| Carex halleriana | | | | | | | | | | | | | | | 20 | 60 | |
| Vinca major | | | | | | | | | | | | | | | | 20 | |
| Viola odorata | | | | | | | | | | | | | | | | 40 | |
| Narcissus obsoletus | | | | | | | | | | | | 20 | | | | | 50 |
| Acis autumnalis | | | | | | | | | | | | | | | | | 50 |
| ***ASPHODELETALIA RAMOSI and Charybdido pancratii-Asphodelion ramosi*** | | | | | | | | | | | | | | | | | |
| Thapsia garganica | 100 | | 100 | 100 | | | 100 | | | | | | | | | | |
| Charybdis pancration | 100 | 100 | 33 | | 100 | 100 | 75 | | | | | | | | 40 | | |
| Eryngium campestre | 20 | | 67 | 50 | | | 75 | | | | | | | | | | |
| Iris bicapitata | | 60 | 67 | 100 | | | | | | | | | | | | | |
| Carduus nutans | | | 100 | 50 | | | | | | | | | | | | | |
| Asphodeline lutea | | | 33 | 100 | | | 100 | 100 | | | | | | | | | |
| Sixalix atropurpurea subsp. maritima | | 60 | | | 67 | | 25 | | 50 | | | | | | | | |
| Hypochaeris radicata | 80 | | | | 33 | | | | | | | | | | | | |
| ***ASPHODELETALIA RAMOSI and Asphodelo ramosi-Ferulion communis*** | | | | | | | | | | | | | | | | | |
| Ferula communis | | | 33 | | | 100 | 100 | | | | | | | | | | |
| Onopordum illyricum | | | | | | 100 | 75 | | | | | | | | | | |
| Iris pseudopumila | | | | | | 50 | 25 | | | | | | | | | | |
| ***ASPHODELETALIA RAMOSI and Asphodelo ramosi-Ferulion glaucae*** | | | | | | | | | | | | | | | | | |
| Ferula glauca | | | | | | | | 100 | | | | | | | | | |
| ***ASPHODELETALIA RAMOSI and Asphodelion fistulosi*** | | | | | | | | | | | | | | | | | |
| Asphodelus fistulosus | | | | | | | | | 100 | | | | | | | | |
| ***BELLIDO SYLVESTRIS-ARISARETALIA VULGARIS and Leontodonto tuberosi-Bellidion sylvestris and Cyclamino hederifolii-Ranunculion bullati*** | | | | | | | | | | | | | | | | | |
| Charybdis undulata | | | | | | | | | | | 50 | 80 | | | | | |
| Ambrosina bassii | | | | | | | | | | 100 | 100 | 60 | | | | | |
| Prospero autumnale | | | | | | | | | | 100 | 100 | | | | | | 75 |
| Leontodon tuberosus | | | | | | | | | | 100 | 50 | 100 | 80 | 100 | 20 | | |
| Bellis sylvestris | 20 | 20 | 67 | | | | | | | 100 | | 100 | 100 | 100 | 60 | | 25 |
| Arisarum vulgare | 20 | 20 | | | | | | | | | 100 | 100 | 100 | 33 | 100 | 60 | 100 |
| ***BELLIDO SYLVESTRIS-ARISARETALIA VULGARIS and Cyclamino hederifolii-Arisarion vulgaris*** | | | | | | | | | | | | | | | | | |
| Umbilicus rupestris | | | | | | | | | | | | 20 | 40 | | | | 50 |
| Ranunculus bullatus | 60 | | | | | | | | | | | 80 | 100 | 100 | | | 100 |
| Allium subhirsutum | | 60 | | | | | | | | | | | 80 | 33 | 60 | 60 | |
| Cyclamen hederifolium | | 20 | 33 | | | | | | | | | | 100 | | 100 | 100 | |
| Brachypodium sylvaticum | | | | | | | | | | | | | 20 | 33 | 80 | 80 | |
| ***BELLIDO SYLVESTRIS-ARISARETALIA VULGARIS and Ranunculion bullati*** | | | | | | | | | | | | | | | | | |
| Thapsia villosa | | | | | | | | | | | | | | | | | 25 |
| Narcissus papyraceus | | | | | | | | | | | | | | | | | 25 |
| Charybdis maritima | | | | | | | | | | | | | | | | | 25 |
| Lavandula multifida | | | | | | | | | | | | | | | | | 25 |

| | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ***CHARYBDIDO PANCRATII-ASPHODELETEA RAMOSI*** | | | | | | | | | | | | | | | | | |
| Ornithogalum etruscum subsp. umbratile | 100 | 80 | 100 | | | 50 | 75 | | | | | | 40 | 67 | | | |
| Carlina corymbosa | 20 | 80 | 67 | 100 | | 100 | 25 | | | | | | 20 | 33 | | | |
| Asphodelus ramosus | 100 | 100 | 100 | | 100 | 100 | 100 | | | 100 | 50 | 60 | 20 | | | | 25 |
| Anemone hortensis | 60 | 60 | 100 | 50 | | 50 | 50 | 40 | | 100 | | 100 | 20 | 33 | 20 | 20 | |
| Asparagus acutifolius | 100 | 100 | 67 | 50 | 100 | 100 | 100 | 40 | | 33 | | 20 | | | 100 | 100 | |
| ***High frequence herbaceous perennial species*** | | | | | | | | | | | | | | | | | |
| Dactylis glomerata subsp. hispanica | 100 | 80 | | | 67 | | | | | 33 | | 100 | | | | | 25 |
| Carex flacca | 20 | | 33 | | 33 | | | 20 | | | | | | | | | |
| Arum italicum | 40 | | | | | | | 40 | | | | | 20 | | 100 | 80 | |
| Dactylis glomerata | | | 33 | 50 | | | 100 | 60 | | | | | | | | | |
| Hyoseris radiata | | 60 | 33 | | | | | | | 33 | | | | | 20 | | |
| Plantago lanceolata | | 40 | | | | | 75 | | | 100 | | 40 | | | | | |
| Reichardia picroides | | 80 | 67 | | | | 50 | | | | | | | | 40 | | |
| Stachys germanica | 20 | 60 | | | | | | | | | | | | | 20 | | |
| Piptatherum miliaceum | | | | | 33 | | | | | | | | | | 20 | | 25 |
| Ranunculus lanuginosus | | | | | | | | | | | | | 40 | | 40 | 20 | |
| Galium corrudifolium | | 60 | | | | 50 | 50 | | | | | | | | | | |
| Hypericum perforatum | | 20 | | | 33 | | 50 | | | | | | | | | | |

(*) Associations and subassociations: 1 - *Charybdido pancratii-Asphodeletum ramosi typicum*, 2 - *Charybdido pancratii-Asphodeletum ramosi hyparrhenietosum hirtae*, 3 - *Euphorbio characiae-Thapsietum garganicae*, 4 - *Euphorbio characiae-Thapsietum garganicae festucetosum circummediterraneae*, 5 - *Alkanno tinctoriae-Asphodeletum ramosi*, 6 - *Asphodelo ramosi-Feruletum communis*, 7 - *Asphodelino luteae-Feruletum communis*, 8 - *Asphodelino luteae-Feruletum glaucae*, 9 - *Verbasco garganici-Asphodeletum fistulosi*, 10 - *Scillo autumnalis-Bellidetum sylvestris*, 11 - *Scillo autumnalis-Bellidetum sylvestris arisaretosum vulgaris*, 12 - *Scillo obtusifoliae-Bellidetum sylvestris*, 13 - *Cyclamino hederifolii-Ranunculetum bullati*, 14 - *Allio chamaemoly-Ranunculetum bullati*, 15 - *Cyclamino hederifolii-Arisaretum vulgaris*, 16 - *Drymochloo exaltatae-Cyclaminetum hederifolii*, 17 - *Scillo autumnalis-Ranunculetum bullati*.

*mosi* (Biondi *et al*., 2016). This develops in areas with mesoMediterranean thermotype and dry-subhumid ombrotype.

*FESTUCETOSUM CIRCUMMEDITERRANEAE* subass. nova *hoc loco*

(*Holotypus*: rel. 5 of Tab. 6; present study)

The differential species are *Festuca circummediterranea* and *Dasypyrum villosum*. The subass. is characterised by the presence of species linked to the secondary grasslands, where they represent the most common grasses.

## Conclusions

To conclude, the complete syntaxonomic scheme of the class *Charybdido pancratii-Asphodeletea ramosi* is presented here through the updating of the data in Biondi *et al*. (2016) with the new data published here. We also present the synoptic table of the communities (Tab. 7) of the same class that are known to date. All of the new Italian syntaxa will be included in the updated version of the vegetation Prodrome, which will replace the original version (Biondi *et al*., 2014b). Most of the syntaxa that are to be included in the Prodrome mainly concern the Mediterranean and sub-Mediterranean European vegetation, which represents the greatest part of European biodiversity (Biondi *et al*., 2015b). Several of these syntaxa have been included in the European Vegetation Checklist (Mucina *et al*., 2016), and hopefully many others will be included in the announced revision of the same, including among others the dynamic Mediterranean vegetation of the class *Charybdido pancratii-Asphodeletea ramosi*.

There follows now the complete syntaxonomic scheme of the communities belonging to the class:

CHARYBDIDO PANCRATII-ASPHODELETEA RAMOSI Biondi in Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, del Viscio & Casavecchia 2016

*ASPHODELETALIA RAMOSI* Biondi in Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, del Viscio & Casavecchia 2016

***Charybdido pancratii-Asphodelion ramosi*** Biondi *et al*. 2016

*Charybdido pancratii-Asphodeletum ramosi* Biondi *et al*. 2016

subass. *typicum* Biondi *et al*. 2016

*hyparrhenietosum hirtae* Biondi *et al*. 2016

*Alkanno tinctoriae-Asphodeletum ramosi* Biondi *et al*. 2016

*Thapsio garganicae-Asphodeletum ramosi* Foggi *et al*. 2008

*Euphorbio characiae-Thapsietum garganicae* ass. nova *hoc loco*

*typicum* subass. nova *hoc loco*

*festucetosum circummediterraneae* subass. nova *hoc loco*

***Asphodelo ramosi-Ferulion communis*** Biondi *et al*. 2016

*Asphodelo ramosi-Feruletum communis* Biondi *et al*. 2016

*Asphodelino luteae-Feruletum communis* Biondi *et al*. 2016

*Carlino siculae-Feruletum communis* Gianguzzi, Ilardi & Raimondo 1993

*Thapsio garganicae-Feruletum communis* Brullo 1984

***Asphodelion fistulosi*** Biondi *et al*. 2016

*Verbasco garganici-Asphodeletum fistulosi* Biondi *et al*. 2016

***Asphodelo ramosi-Ferulion glaucae*** Biondi *et al*. 2016

*Asphodelino luteae-Feruletum glaucae* Casavecchia &

Biondi in Biondi, Pesaresi, Galdenzi, Gasparri, Biscotti, del Viscio & Casavecchia 2016.
*BELLIDO SYLVESTRIS-ARISARETALIA VULGARIS* Biondi ordo novo *hoc loco*
***Cyclamino hederifolii-Arisarion vulgaris*** all. nova *hoc loco*
*Cyclamino hederifolii-Arisaretum vulgaris* ass. nova *hoc loco*
*Drymochloo exaltatae-Cyclaminetum hederifolii* ass. nova *hoc loco*
***Cyclamino hederifolii-Ranunculion bullati*** all. nova *hoc loco*
*Allio chamaemoly-Ranunculetum bullati* ass. nova *hoc loco*
*Cyclamino hederifolii-Ranunculetum bullati* ass. nova *hoc loco*
***Leontodonto tuberosi-Bellidion sylvestris*** Biondi, Filigheddu & Farris 2001
*Scillo obtusifoliae-Bellidetum sylvestris* Biondi, Filigheddu & Farris 2001
*Scillo autumnalis-Bellidetum sylvestris* Biondi, Filigheddu & Farris 2001
*typicum* subass. nova *hoc loco*
*arisaretosum vulgaris* subass. nova *hoc loco*
***Ranunculion bullati*** Pérez Latorre & Cabezudo 2008
*Scillo autumnalis-Ranunculetum bullati* Pérez La Torre & Cabezudo 2008

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**Appendix I: Sporadic species**

Tab. 1 - Rel. 1: Emerus major Mill. subsp. emeroides (Boiss. et Spruner) Soldano et F. Conti +, Rosa sempervirens L. +.2. Rel. 2: Hyoseris radiata L. +, Piptatherum miliaceum (L.) Coss. +, Rubus ulmifolius Schott 1.2, Lobularia maritima (L.) Desv. R, Galium aparine L. +, Parietaria judaica L. 1.2, Solanum linnaeanum Hepper et P.-M.L. Jaeger +, Setaria viridis (L.) P. Beauv. +.2. Rel. 3: Carex halleriana Asso 1.1, Ruscus aculeatus L. +, Asplenium onopteris L. +, Phillyrea latifolia L. 1.1. Rel. 4: Stachys germanica L. 2.2, Sonchus oleraceus L. +, Centaurium erythraea Rafn +. Rel. 5: Briza maxima L. r, Geranium sanguineum L. +, Nigella damascena L. +.
Tab. 2 - Rel. 2: Viola alba Besser subsp. dehnhardtii (Ten.) W. Becker 1.2, Ranunculus lanuginosus L. var. umbrosus (Ten. & Guss.) P.Fourn. 1.2; Rel. 4: Prasium majus L. +; Rel. 5: Pistacia lentiscus L. +, Hedera helix L. 3.3.
Tab. 3 - Rel. 1: Theligonum cynocrambe L. 1.2, Geranium molle L. 1.2, Plantago serraria L. +.2; Rel. 2: Theligonum cynocrambe L. 1.1, Geranium molle L. 2.2, Cynoglossum creticum Mill. +, Lobularia maritima (L.) Desv. +, Ranunculus lanuginosus L. 1.2; Rel. 3: Theligonum cynocrambe L. 1.2, Geranium molle L. 1.2, Plantago serraria L. +, Cynoglossum creticum Mill. +, Lobularia maritima (L.) Desv. +; Rel. 4: Theligonum cynocrambe L. +.2, Geranium molle L. 1.2, Plantago serraria L. 1.2, Ranunculus lanuginosus L. +, Selaginella denticulata (L.) Spring. +.3; Rel. 5: Theligonum cynocrambe L. 1.2.
Tab. 4 - Rel. 1: Cynoglossum creticum Mill. +, Beta vulgaris L. subsp. maritima (L.) Arcang. +, Geranium molle L. +.2, Ajuga chamaepitys (L.) Schreb. r; Rel. 3: Petrorhagia saxifraga (L.) Link. +, Salvia verbenaca L. +.
Tab. 5 - Rel. 1: Dactylis glomerata L. subsp. hispanica (Roth) Nyman +.2, Hyoseris radiata L. +, Sanguisorba minor Scop. +.2, Neotinea lactea (Poir.) R.M. Bateman, Pridgeon et M.W. Chase +.2; Rel. 2: Petrorhagia saxifraga (L.) Link +.2, Lavandula stoechas L. +, Odontites luteus (L.) Clairv. +, Stachys glutinosa L. +; Rel. 3: Brachypodium retusum (Pers.) P. Beauv. +.2; Rel. 4: Dittrichia graveolens (L.) Greuter +.
Tab. 6 - Rel. 1: Alyssum simplex Rudolphi 1.2, Carex flacca Schreb. +, Euphorbia spinosa L. 3.3, Geranium rotundifolium L. +, Hypochaeris achyrophorus L. +, Juniperus phoenicea L. subsp. turbinata (Guss.) Nyman +, Micromeria graeca (L.) Benth. ex Rchb. 1.2, Pinus halepensis Mill. +, Scorzonera villosa Scop. 1.2, Sedum rupestre L. +, Sideritis italica (Mill.) Greuter et Burdet 1.2; Rel. 2: Arabis collina Ten. subsp. rosea (DC.) Minuto r, Aristolochia rotunda L. 1.2, Bellis perennis L. +.2, Clinopodium vulgare L. 1.2, Cyclamen hederifolium Aiton +, Lathyrus cicera L. +, Muscari neglectum Guss. ex Ten. +, Ranunculus millefoliatus Vahl 1.1, Rosa canina L. +, Sanguisorba minor Scop. 1.2, Silene latifolia Poir. subsp. alba (Mill.) Greuter et Burdet +, Tulipa sylvestris L. r; Rel. 3: Crepis leontodontoides All. 1.2, Hyoseris radiata L. +, Medicago arabica (L.) Huds. +, Prunus spinosa L. 2.3, Salvia clandestina L. +, Theligonum cynocrambe L. +; Rel. 4: Briza maxima L. +.2, Crepis vesicaria L. +, Linaria purpurea (L.) Mill. +, Ornithogalum umbellatum L. 1.1, Trifolium nigrescens Viv. +; Rel. 5: Clinopodium alpinum (L.) Kuntze +.2, Geranium sanguineum L. +, Pyrus spinosa Forssk. +, Rubus canescens DC. +, Teucrium chamaedrys L. +.2.

**Appendix II: Relevés dates and localities**

Tab. 1 - Rels. 1, 4: Calenella Bay (FG), 10/12/2016 (rel. 1: 41.74475° N, 16.01145° E; rel. 4: 41,94228° N, 15.98709° E); Rels. 2, 5: Necropolis of Calanella (FG), 10/12/2016 (rel. 2: 41.93945° N, 15.98705° E; rel. 5: 41.93961° N, 15.98703° E); Rel. 3: Pineta Marzini (FG), 18/02/2017, 41.89043° N, 15.90588° E.
Tab. 2 - Rels. 1, 3, 5: Pineta Marzini (FG), 18/02/2017 (rel. 1: 41.89043° N, 15.90588° E; rel. 3: 41.89043° N, 15.90588° E; rel. 5: 41.89043° N, 15.90588° E); Rel. 2: Mannaccore (FG), 16/02/2017, 41.93166° N, 16.05185° E; Rel. 4: Sfinale (FG), 16/02/2017, 41.93166° N, 16.05185° E.
Tab. 3 - Rels. 1-5: Torre Mileto (FG), 09/12/2016 (rel. 1: 41.92524° N, 15.61485° E; rel. 2: 41.92478° N, 15.61438° E, rel. 3: 41.92591° N, 15.61643° E; rel. 4: 41.92260° N, 15.64877° E; rel. 5: 41.92197° N, 15.64966° E.
Tab. 4 - Rels. 1-3: Torre Mileto (FG), 09/12/2016 (rel. 1: 41.92621° N, 15.61617° E; rel. 2: 41.92188° N, 15.64955° E; rel. 3: 41.92254° N, 15.64860° E.
Tab. 5 - Rel. 1 corresponds to rel. 31 in Tab. 49 in Biondi *et al*., 2001; Rel. 2 corresponds to rel. 30 in Tab. 49 in Biondi *et al*., 2001; Rel. 3 corresponds to rel. 32 in Tab. 49 in Biondi *et al*., 2001; Rel. 4 corresponds to rel. 1 in Tab. 61 in Biondi & Bagella, 2005; Rel. 5 corresponds to rel. 2 in Tab. 61 in Biondi & Bagella, 2005.
Tab. 6 - Rels. 1-5: Along the road from Foresta Umbra to Mattinata (FG) (rel. 1: 41.02503° N, 16.72983° E, 06/04/2017; rel. 2: 41.74241° N, 16.00896° E, 06/04/2017; rel. 3: 41.72960° N, 16.01625° E, 12/05/2017; Rel. 4: 41.74428° N, 16.01340° E, 12/05/2017; rel. 5: 41.74475 N, 16.01145° E, 12/05/2017°.

Reference system: WGS84 (WGS84)