BEST | Tutela e conservazione della biodiversità

Programma di Cooperazione Europea Interreg V-A Grecia - Italia 2014/2020

Interreg Greece-Italy BEST European Regional Development Fund

EUROPEAN UNION

"Analysis of the floristic-vegetational terrestrial component and *in situ* conservation in the area action pilot 1 of the project "Best" and *ex situ* conservation in the Germplasm Bank of plants of conservation concern"

Checklist and syntaxonomic scheme of the plant communities of "Ambito ristretto"

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INDEX

INTRODUCTION

According to the art.1 of the invitation letter n. 6185/2020 (approved by executive determination n. 165 06/08/2020) and to the technical proposal submitted by the Department of Biologia (now Department of Bioscienze, Biotecnologie e Ambiente), the detailed vegetation analysis of “Ambito ristretto” has been produced and it is here presented. The detailed vegetation analysis regards the “Ambito ristretto” of the Project area, that is the areas of significant naturalistic, landscape and historical-cultural value of "Costa Ripagnola" Regional Natural Park (terrestrial zone 1, as defined and bounded in the shapefiles of the Annex A of the Regional law n. 30/2020), of those falling within the perimeter of the "Palude la Vela" Regional Nature Reserve (included in the zone 1 of the "Mar Piccolo" Regional Natural Park established with Regional law n. 30/2020), and of those of higher naturalistic interest of the coastal area Costa Merlata - Torre Pozzelle, as defined jointly with the internal working group of the BEST Project and with the procedural officer dr. Pierfrancesco Semerari.

This document reports the results of this vegetational analysis carried out with phytosociological method, and consists of the checklist and the syntaxonomic scheme of all the plant communities identified within the "Ambito ristretto".

Of the three areas making up the "Ambito ristretto", those of Costa Ripagnola and Costa Merlata present a certain environmental homogeneity and, therefore, in this document they are treated together and, for expository convenience, indicated with the acronym CRM. The area of Palude la Vela, on the other hand, is indicated with the acronym PV.

MATERIAL AND METHODS

Literature data on vegetation of the study area was examined (i.e. Chiesura-Lorenzoni & Lorenzoni 1977; Biondi et al 2006) and phytosociological relevès selected and organized in a data-set. Original vegetation data were sampled in the field on a period between 2021 and 2022, according to the phytosociological approach (Braun-Blanquet 1964, Westhoff & van der Maarel 1978), and to fundamental and updated concepts suggested by Dengler et al. (2005). A total of 187 relevés have been performed in the field and poured into the data-set. The whole data-set was then divided in two sub-sets, one for each study area: the CRM sub-set formed by a total of 110 relevés (8 from literature, i.e. Biondi et al (2006); 102 original relevés); and the PV data-set, formed by only the 77 original relevés. The 29 literature relevés from Chiesura-Lorenzoni & Lorenzoni (1977) were not included in the elaboration, due to some issues about the real taxonomic identity of some species reported in the work; as an example, Chiesura-Lorenzoni & Lorenzoni report 19 relevè of *Salicornia fruticosa* communities (the *Salicornietum fruticosae* (Br.-Bl. 1928 em.1933) Pignatti 1953), while do not mention neither *Salicornia perennis* nor *Arthrocaulon macrostachyum.* In our field observation, no *Salicornia fruticosa* has been detected; the perennial schrub vegetation of the salt marshes of PV is made of *Salicornia perennis* and *Arthrocaulon macrostachyum* extensive communities. Chiesura-Lorenzoni & Lorenzoni (1977) refer also of a *Salicornietum herbaceae* Van Langedonk, 1933 s.l., that is *Salicornia patula* communities. In our field observation, no *Salicornia patula* has been detected; on the contrary, widespread communities of *S. emerici* and *S. dolichostachya* have been detected and surveyed during our field work. Neither *S. emerici* nor *S. dolichostachya* are mentioned in Chiesura-Lorenzoni & Lorenzoni (1977). For this reason, we preferred to not include these data in our analysis.

In order to visualize the general data structure and to detect the presence of outliers, the two matrices were subjected to different agglomerative methods based on cluster analysis, by using different combinations of distance measures and group linkage methods, on both presence/absence values and cover values (transformed according to the method proposed by van der Maarel (1979). Outliers were removed (i.e. corresponding to single relevés attributable to high rank syntaxa different than the most of relevés forming the data-set; or

relevés made in degraded/disturbed areas and then floristically not well characterized; etc.) Species with frequency lower than 1% were removed from the dataset.

Finally, two matrices were obtained:

99 (objects) relevés x 136 (variables) species for the CRM data-set

66 (objects) relevés x 31 (variables) species for the PV data-set

For the definition of plant communities within each dataset, hierarchical clustering was performed by using flexible beta linkage, with the Bray-Curtis coefficient, according to Tichý et al. (2010). Beta was set at −0.25 so that flexible beta clustering became a space-conserving method (McCune & Grace 2002).

The results thus obtained will be compared with the up-to-date phytosociological literature, to get at the identification of plant associations (Biondi et al., 2006; Biondi & Casavecchia, 2010; Sciandrello & Tomaselli, 2014; Margiotta et al., 2020; Tomaselli & Terzi, 2019; Tomaselli et al., 2020) and higher syntaxa (Rivas-Martinez et al. 2001; Biondi et al. 2014; Mucina et al. 2016). For the high rank phytosociological scheme, we referred to the recent European Vegetation Checklist (Mucina et al 2016), and following upgrades (e.g. Landucci et al. 2019; Brullo et al. 2020; Tomaselli et al 2020; Di Pietro et al. 2021).

Hierarchical clustering and ordination analysis were run by PCOrd version 6.0 (McCune & Mefford 2010).

RESULTS

In Figures. 1 and 2 two dendrograms, resulting from the cluster analysis of the CRM and PV data sets respectively, are showed.

In the CRM dendrogram, three main clusters can be distinguished: A, B and C. Cluster A includes the halophilous perennial vegetation of *Salicornietea fruticosae* (subcluster A1) and of *Crithmo maritimi-Staticetea* (subcluster A2) classes. Cluster B includes the halophilous annual vegetation of *Saginetea maritimae* (B1), the therophytic calciphilous vegetation of *Stipo-Trachynietea distachyae* (B21), the therophytic psammophilous vegetation of *Helianthemetea guttatae* and the *Ononido-Rosmarinetea* garrigues (B22). Cluster C groups the "maquis" vegetation of *Pistacio-Rhamnetalia alaterni* (*Quercetea ilicis*), with the *Juniperion turbinatae* (C1) and the *Oleo-Ceratonion* (C2) alliances.

In the PV dendrogram three main clusters can be distinguished: A, B and C. Cluster A includes the the halophilous perennial vegetation of *Salicornietea fruticosae* with the three alliances (*Salicornion fruticosae, Suaedion verae* and *Arthrochnemion glauci*) well distinct in the three subclusters A1, A2, A3. Cluster B includes the *Therosalicornietea,* with *Salicornion emerici* (B1) and *Thero-Suaedion splendentis* (B2). Finally, cluster C groups the *Saginetea maritimae* vegetation.

Summarizing, the vegetation analysis allowed the identification of 45 vegetation types (including associations, sub-associations, and some *facies*, and plant communities), attributable to the following classes: *Phragmito australis-Magnocaricetea elatae* (2), *Ammophiletea* (1), *Crithmo maritimi-Staticetea* (3), *Juncetea maritimi* (3), *Salicornietea fruticosae* (7), *Therosalicornietea* (6), *Saginetea maritimae* (6), *Helianthemetea guttatae* (1), *Stipo-Trachynietea distachyae* (4), *Lygeo sparti-Stipetea tenacissimae* (2), *Ononido-Rosmarinetea* (2), *Quercetea ilicis* (6), *Chenopodietea* (2).

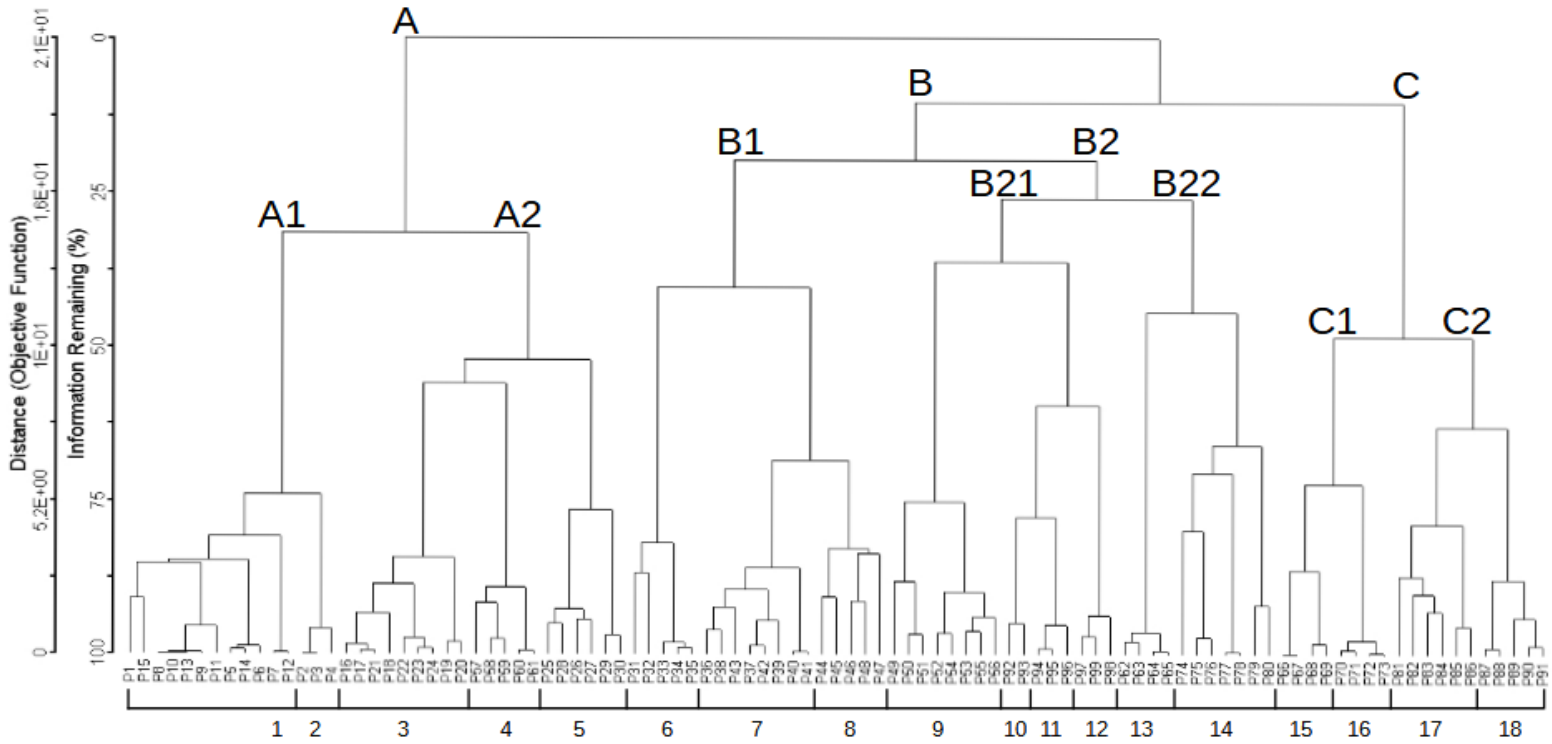

Figure 1 - Dendrogram resulting from the cluster analysis of the data-set of phytosociological relevés performed in the CRM area.

1-*Limonio virgati-Arthrocnemetum macrostachyi*; 2- *Arthrocaulon macrostachyum* communities; 3- *Crithmo-Limonietum apuli*; 4- *Limonio virgati-Sporoboletum arenarii*; 5- *Crithmo maritimi-Inuletum crithmoidis*, and *facies* with *Halimione portulacoides*; 6- *Sileno sedoidis-Hymelobetum revelieri*; 7- *Phleo cesii-Anthemidetum tomentosae*; 8- *Parapholido incurvae-Catapodietum balearici*; 9- *Convolvulus lineatus* communities; 10- *Trifolio scabri-Hypochoeridetum achyrophori*; 11- *Hypochoerido achyrophori-Stipetum capensis*; 12- *Triticum biunciale* communities; 13- *Alkanno tinctoriae-Plantaginetum albicantis*; 14- *Thymbra capitata* and *Satureja cuneifolia* communities; 15- *Asparago acutifolii-Juniperetum macrocarpae* typicum; 16- *Asparago acutifolii-Juniperetum macrocarpae juniperetosum turbinatae*; 17- *Pistacia lentiscus* vegetation (*Myrto-Pistacetum lentisci* rell. 81-84; *Pistacia lentiscus* and *Olea europaea* communities rell. 85-86); 18- *Pistacia lentiscus* and *Phlomis fruticosa* communities

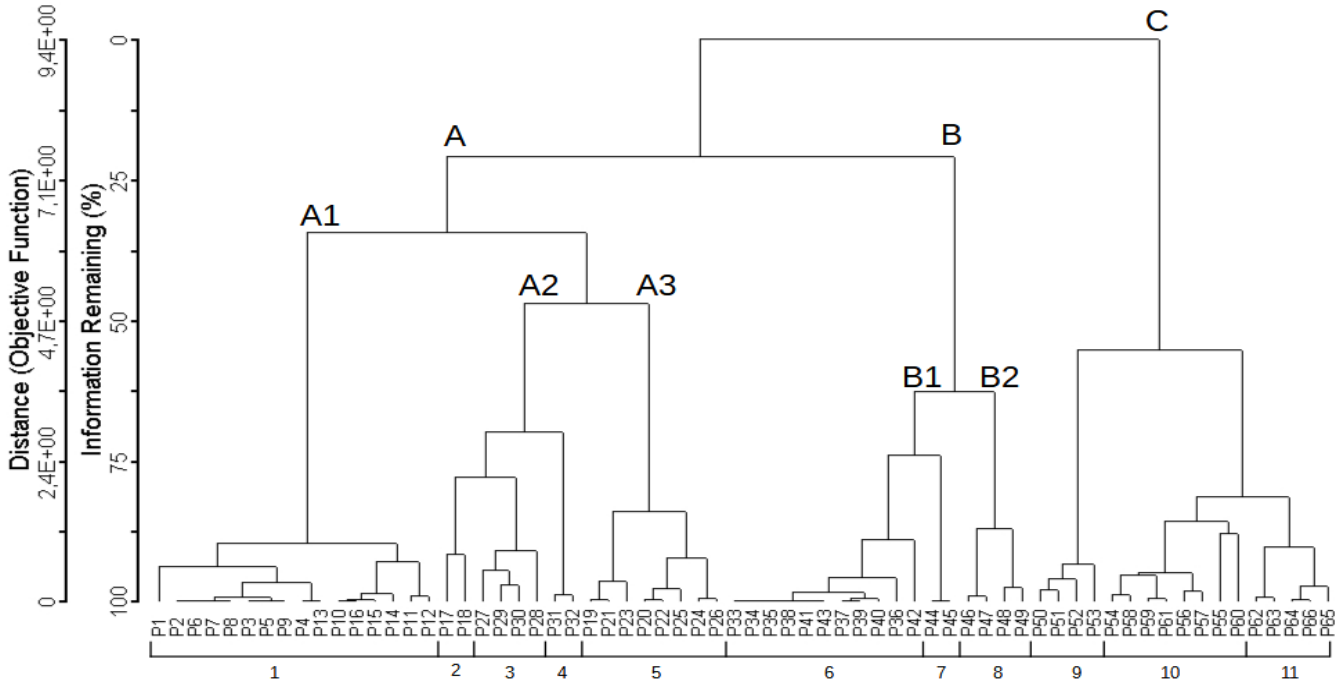

Figure 2 - Dendrogram resulting from the cluster analysis of the data-set of phytosociological relevés performed in the PV area.

1- *Halimiono portulacoidis-Sarcocornietum alpini*; 2- *Halimione portulacoidis* communities; 3- *Elytrigio elongatae-Inuletum crithmoidis*; 4- *Suaeda vera* and L*imonium narbonense* communities; 5- *Arthrocaulon macrostachyium* and *Halimione portulacoides* communities; 6- *Salicornietum emerici*; 7- *Salicornietum dolichostachyae*; 8- *Suaedetum spicatae*; 9- *Parapholidetum filiformis*; 10- *Parapholido incurvae-Frankenietum pulverulentae*; 11- *Sphenopus divaricatus* and *Spergularia marina* communities

RESULTS - CHECKLIST OF THE PLANT COMMUNITIES

The checklist of all identified plant communities identified within the "Ambito ristretto" is reported below.

A short description of each syntaxa is provided.

Each syntaxon at association, subassociation, *facies* or community level, is marked with a symbol indicating the specific geographical area where it was found:

∗ = CRM ♦ = PV

PHRAGMITO AUSTRALIS-MAGNOCARICETEA ELATAE Klika in Klika & Novák 1941

Helophytic communities (reeds, sedges and herbs) colonizing marshes, fens and fluvial areas of Eurasia, with brackish or fresh, eutrophic or meso-oligotrophic waters

***PHRAGMITETALIA AUSTRALIS* Koch 1926**

Reed swamps, sedge beds and herblands of mesotrophic and eutrophic stagnating or slowly flowing freshwater or brackishwater bodies of Eurasia

***Phragmition communis* Koch 1926**

Reed swamp vegetation, generally almost mono-specific or poor in species, of mesotrophic and eutrophic standing freshwater bodies or gently moving streams of Eurasia.

Phragmitetum communis (Koch 1926) Schmale 1939 ∗ ♦

Phragmites australis stands occurring around marshes, along streams, canals, and in abandoned field in correspondence of wet areas or reclaimed lands. This vegetation occurs on soils flooded for only a short period during the year, or on moist soils without flood water. It is often anthropogenically influenced and generally has a very wide ecological range.

***BOLBOSCHOENETALIA MARITIMI* Hejny in Holub et al. 1967**

Meso-eutrophic brackish swamp sedges of European temperate and Mediterranean coasts and subcontinental inland regions of Central and Southern Europe

Scirpion maritimi Dahl et Hadac 1941

Meso-eutrophic brackish swamp sedges of European temperate and Mediterranean coastal regions

Scirpetum maritimi (Christiansen 1934) R. Tx. 1937 ♦

Bolboschoenus maritimus plant communities, almost monospecific, growing on soils periodically flooded by brackish waters, in correspondence of coastal salt marshes and/or river mouths.

AMMOPHILETEA Br.-Bl. et Tx. ex Westhoff et al.1946

Grassland-like communities dominating coastal dunes distributed along the coastal systems of the Mediterranean Sea, the Atlantic Ocean (Morocco, Portugal and Spain) and the Black Sea.

AMMOPHILETALIA Br.-Bl. et Tx. ex Westhoff et al. 1946

Tall-grass perennial swards on mobile white and embryonic coastal dunes of the temperate Atlantic and Mediterranean coasts and of the Black Sea and Caspian Sea coasts.

Ammophilion Br.-Bl. 1921 [= *Agropyrion juncei* Pignatti 1953 (syntax.syn.)]

This alliance includes perennial plant communities colonizing embryonic and foredunes, affected by strong winds, waves, salt spray and summer drought; it is widely distributed along the Mediterranean basin and the Iberian Atlantic coast.

Limonio virgati-Sporoboletum arenarii Biondi, Casavecchia & Guerra 2006 ∗

Sporobolus arenarius and *Limonium virgatum* communities occurring on small accumulations of sand (microdunes) that develop from the erosion of the underlying calcarenitic rocks.

CRITHMO MARITIMI-STATICETEA Br.-Bl. in Br- Bl., Roussine & Nègre 1952

Rupicolous vegetation of salt-sprayed coastal cliffs of the Atlantic and Mediterranean seaboards of Europe, North Africa and Middle East

CRITHMO MARITIMI-STATICETALIA Molinier 1934

Rupicolous vegetation of salt-sprayed cliffs of the Atlantic and Mediterranean coasts of Europe, North Africa and Middle East.

Crithmo maritimi-staticion Molinier 1934

Rupicolous pioneer halophilous dwarf-herb vegetation of salt-sprayed limestone cliffs of central-Mediterranean.

Crithmo-Limonietum apuli Bartolo, Brullo & Signorello 1989 ∗

Perennial halophilous aerohaline vegetation, formed mainly by chamaephytes with pulvinate habitus well adapted to marine aerosol, and endemic to the lowcliffs of Adriatic central Puglia. It is characterized by the endemic *Limonium apulum.*

Crithmo maritimi-Inuletum crithmoidis Biondi, Casavecchia & Guerra 2006 ∗

Crithmum maritimum and *Inula crithmoides* communities, occurring on limestones that, under the effects of wind and waves, produce corrosion basins with pebbly material.

Crithmo maritimi-Inuletum crithmoidis, **facies *Halimione portulacoides*** ∗

Halimione portulacoides dominated plant communities, growing in correspondence of corrosion basins along the rocky coast of CRM, and in close contact to the *Crithmo maritimi-Inuletum crithmoidis* vegetation.

JUNCETEA MARITIMI Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

Perennial grasslands and herb-rich vegetation dominated by tall rushes and sedges and forming extended and thick formations in coastal and inland wetlands and salt marshes, and sea-cliffs, of the Mediterranean Sea and the Atlantic and Arctic Oceans

JUNCETALIA MARITIMI Br.Bl. ex Horvatic 1934

Mediterranean and thermo-Atlantic tall-rush saline wetland vegetation

Juncion maritimi Br.Bl. ex Horvatic 1934 [incl. *Inulion crithmoidis* S. Brullo et Furnari 1988 (syntax.syn.)]

Mediterranean and thermo-atlantic coastal saline rush marsh vegetation under a prolonged flooding regime

Inulo-Juncetum maritimi Brullo in Brullo, De Sanctis, Furnari, Longhitano & Ronsisvalle 1988 ∗

Vegetation dominated by *Limbarda crithmoides* and *Juncus maritimus*, occuring in correspondence of coastal salt marshes, as well as of stream and river mouths, on loamy-clayey soils subject to prolonged flooding periods with brackish-salt waters.

Juncetum maritimi (Rübel 1930) Pignatti 1953 ♦

Juncus maritimus dominated vegetation that, in the area of PV, are mostly limited to the edges of canals with brackish waters.

Elytrigio elongatae-Inuletum crithmoidis Br.-Bl. (1931) 1952 ♦

This association occurs in the most raised parts of the salt marshes, generally not or rarely subject to flooding. Physiognomically, it is characterized by the dominance of *Limbarda crithmoides*, with *Thinopyrum elongatum* and many other halophytes

SALICORNIETEA FRUTICOSAE Br.-Bl. et Tx. ex A. Bolòs y Vayreda et O. de Bolòs in A. Bolòs y Vayreda 1950

Halophilous low shrubs of both coastal and inland areas, developing on halomorphic soils of salt marshes, estuaries, coastal lagoons, spreading in the Mediterranean and Atlantic European regions. The vegetation is characterized mainly by succulent *Amaranthaceae* (*Chenopodiaceae*) with a chamaephytic to nanophanerophytic habit.

SALICORNIETALIA FRUTICOSAE Br.-Bl. 1933

Halophilous succulent chenopod scrub spreading in the Mediterranean and thermo-Atlantic coastal tidal, supralittoral and inland temporarily flooded lands

Salicornion fruticosae Br.-Bl. 1933 [incl. *Sarcocornion perennis* S. Brullo et Furnari 1988 (syntax.syn.)]

Mediterranean and thermo-Atlantic intertidal succulent dwarf chenopod scrub

Salicornietum fruticosae (Br.-Bl. 1928 em.1933) Pignatti 1953 ∗

Vegetation characterized by high cover of *Salicornia fruticosa,* subject to very long flooding periods and characterized by salty soils located in littoral coastal areas; within the Project area, *Salicornietum fruticosae* vegetation was found at a stream mouth on a sandy beach (CRM).

Halimiono portulacoidis-Sarcocornietum alpini Rivas-Martínez & Costa 1984 ♦

This association usually colonizes the part of the salt marshes subject to prolonged periods of submersion. The structure is given by a dense thicket of *Sarcocornia perennis* subsp. *alpini,* shrubby chamaephyte with a reptant habit, mixed with scattered bushes of *Halimione portulacoides*

Arthrocnemion glauci Rivas-Mart. et Costa M. 1984

Mediterranean hypersaline coastal supratidal succulent chenopod scrub on sandy and rocky soils

Arthrocaulon macrostachyium and ***Halimione portulacoides*** communities ♦

Vegetation physiognomically dominated by *Arthrocaulon macrostachyum,* with frequent presence of *Halimione portulacoides,* growing on periodically flooded soils; it supports long drought periods and finds its optimal conditions even on hypersaline soils.

Arthrocaulon macrostachyium communities ∗

Dense pioneering communities of *Arthrocaulon macrostachyum*, forming the first vegetated belt of the rocky coasts (CRM), subject to continuous spray of salt water determining the formation of a thin salt layer on soils.

Limonio virgati-Arthrocnemetum macrostachyi Biondi, Casavecchia & Guerra 2006 ∗

This is the vegetation belt immediately landward and in contact to the *Arthrocaulon macrostachyum* communities, growing on a thin layer of sandy-silt deposits.

***Suaedion brevifoliae* Br.-Bl. et O. de Bolòs 1958**

Mediterranean and Cantabro-Atlantic subnitrophilous supralittoral succulent chenopod scrub on loamy-sandy soils

Suaeda vera and ***Limonium narbonense*** communities ♦

Halo-nitrophilous shrub vegetation, which develops in the most elevated parts of salt marshes, only exceptionally subject to submersion, with high levels of organic substance and subject to anthropic pressure. It tends to form dense dwarf bushes dominated by *Suaeda vera,* with the almost constant presence of *Limonium narbonense.*

Halimione portulacoides communities ♦

Halo-nitrophilous shrub vegetation, which develops in the most elevated parts of salt marshes, only exceptionally subject to submersion, with high levels of organic substance and subject to anthropic pressure. It tends to form dense dwarf bushes dominated by *Halimione potulacoides.*

THEROSALICORNIETEA Tx. in Tx. et Oberd. 1958

Pioneer coastal or continental vegetation, with Eurasian distribution, formed of annual succulent halophytes belonging to the *Amaranthaceae* (*Chenopodiaceae*) family, growing in maritime and inland salt marshes, occupying those sites with the highest salt concentration, on raw (mineral) soils, from sandy to loamy or clay, temporarily flooded and drying out in summer. The phenological optimum is late summer to autumn.

THEROSALICORNIETALIA Pignatti 1952

Pioneer vegetation of annual succulent halophytes of tidal mud flats and edges of salt marshes, widespread in the Mediterranean, and temperate, boreal and subarctic Europe

***Salicornion emerici* Géhu & Géhu-Franck 1984**

Halophilous pioneer vegetation, dominated by tetraploid *Salicornia* species, of tidal flats and salt marshes, widespread in the Mediterranean area.

Salicornietum emerici (O. de Bolòs 1962) Brullo & Furnari 1976 ♦

Therophytic vegetation made up of the annual tetraploid glasswort *Salicornia emerici*, flooded for a long time, with summer-early autumn phenology

Salicornietum dolichostachyae Géhu et Géhu Frank 1984 ♦

Therophytic vegetation made up of the annual tetraploid glasswort *Salicornia dolichostachya*, flooded for a long time, with summer-early autumn phenology

***Thero-Suaedion splendentis* Br.-Bl. in Br.-Bl. & al. 1952**

Halo-nitrophilous pioneer vegetation of annual succulent plants of salt marshes in the Mediterranean area

Salsoletum sodae Pignatti 1953 ♦

Halo-nitrophilous and termophilous vegetation, growing on soils rich in organic content and forming floristically very poor communities dominated by *Soda inermis* (= *Salsola soda*)

Suaedetum spicatae Pignatti 1953 corr. Brullo & al. 2019 ♦

Plant community dominated by *Suaeda spicata*, which is observed from summer to autumn on well-draining soils, with a high sandy component and abundant organic matter, on the edge of coastal lagoons.

Suaedo-Kokietum hirsutae Br.-Bl. 1928 ♦

Spirobassia hirsuta dense nitrophilous communities, usually localized at the edges of lagoons, and reported by Chiesura Lorenzoni & Lorenzoni (1970) for PV.

***Microcnemion coralloidis* Rivas-Mart. et Géhu in Rivas-Mart. 1984**

Annual succulent halophytes on solonchak soils of temporarily wet inland salt pans

Halopeplidetum amplexicaulis Burollet 1927 ♦

Vegetation domnated by *Halopeplis amplexicaulis,* S-Mediterranean species of semi-arid zones, occurring in the innermost belt of the haloseries, far from the sea, characterized by very high salt concentration and a long period of summer drought.

SAGINETEA MARITIMAE Westhoff, Van Leeuwen & Adriani 1962

Atlantic-Mediterranean and Macaronesian ephemeral winter-annual vegetation in disturbed saline habitats and inland saline badlands

***SAGINETALIA MARITIMAE* Westhoff, Van Leeuwen & Adriani 1962**

Atlantic-Mediterranean ephemeral and halo-tolerant vegetation of disturbed salt-marsh fringes

***Sileno sedoidis-Catapodion balearici* de Foucault & Bioret 2010 corr. Tomaselli et al. 2020 ∗**

Thermophilous therophytic halophilous, sub-halophilous and sub-nitrophilous communities with central-eastern Mediterranean distribution (E-Mediterranean optimum).

Sileno sedoidis-Hymelobetum revelieri Brullo & Giusso 2003 ∗

Thero-halophytic vegetation of cliffs and rocky coasts, on thin, sandy to coarse-sandy soils exposed to the sea spray, and characterized by the dominance of *Silene sedoides* and by the occurrence of the rare *Hornungia procumbens* (= *Hymenolobus procumbens* (L.) Nutt. subsp. *revelierei* (Jord.) Greuter & Burdet.)

Parapholido incurvae-Catapodietum balearici Rivas-Martínez et al. 1990 corr. Brullo & Giusso 2003 ∗

Plantago coronopus and *Parapholis incurva* dominated vegetation, characterized by the presence of *Catapodium balearicum* and *C. pauciflorum,* growing on both rocky and sandy seashores, in disturbed areas usually subject to trampling.

Phleo cesii-Anthemidetum tomentosae Tomaselli, Di Pietro & Sciandrello 2011 corr. Tomaselli et al 2020 ∗

Thero-halophytic communities of rocky coasts, characterized by the dominance of *Anthemis peregrina*, and by the occurrence of *Phleum arenarium* subsp. *caesium*, often in catenal contact with the *Parapholido incurvae-Catapodietum balearici.*

FRANKENIETALIA PULVERULENTAE Rivas-Martínez ex Castroviejo & Porta 1976

Late spring or early-summer communities which preferentially develop at the edges of Mediterranean salt marshes, on sandy loamy substrates.

***Frankenion pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976**

Therophytic, termophilous communities dominated by annual halotolerant to halophilous species, widespread in Mediterranean salt marshes, on clay or sandy-clay soils, often in disturbed sites.

Parapholido incurvae-Frankenietum pulverulentae Rivas Martinez ex Castroviejo & Porta 1976 ♦

Halo-nitrophilous communities dominated by *Frankenia pulverulenta*, that usually develop on periodically flooded, silty soils at the edges of coastal lagoons and salt pans, in very xeric environments.

Sphenopus divaricatus and ***Spergularia marina*** communities ♦

Halo-nitrophilous communities dominated by *Sphenopus divaricatus* and *Spergularia marina,* occurring in contact to the *Parapholido incurvae-Frankenietum pulverulentae.*

Parapholidetum filiformis Brullo, Scelsi & Siracusa 1994 ♦

Spring ephemeral grasslands dominated by *Parapholis filiformis,* always with high cover values, growing on wet clay or sandy-clay soils, flooded in winter for a short period and dried in summer, with moderate salinity and some nitrification.

HELIANTHEMETEA GUTTATI Rivas Goday & Rivas Martínez 1963

Mediterranean and sub-Mediterranean-atlantic annual small-size ephemeral herb and grass-rich vegetation on acidic substrates

VULPIETALIA Pignatti 1953

Mediterranean and Ibero-Atlantic ephemeral therophytic vegetation on coastal sand dunes under influence of salt spray

***Psammo-Vulpion* Pignatti 1953**

Ephemeral therophytic vegetation on coastal dunes along the northern seaboards of the Adriatic Sea

Alkanno tinctoriae-Plantaginetum albicantis Tomaselli, Di Pietro et Sciandrello 2011

Plantago albicans communities typical of sandy soils and characterized by the presence of *Alkanna tinctoria*. The communities analyzed in the CRM area are quite impoverished, and the presence of *A. tinctorial* has not been recorded.

STIPO-TRACHYNIETEA DISTACHYAE S. Brullo in S. Brullo et al. 2001

Mediterranean calciphilous annual and ephemeroid swards and grasslands

***BRACHYPODIETALIA DISTACHYI* Rivas-Mart. 1978**

Mediterranean ephemeral winter pastures on shallow soils over calcareous substrates

***Trachynion distachyae* Rivas-Mart. 1978**

Mediterranean ephemeral winter pastures on shallow base-rich soils over calcareous substrates

Trifolio scabri-Hypochoeridetum achyrophori Lapraz ex Biondi 1997 ∗

Brachypodium distachyon nanoterophytic communities occuring on very thin, poor, calcareus soils, characterized by the presence of *Trifolium scabrum* and *Hypochoeris achyrophorus.*

Hypochoerido achyrophori-Stipetum capensis Scoppola 1999 ∗

Subnitrophilous, therophytic communities dominated by small graminoids and, in particular, by *Stipellula capensis*; in contact to the *Trifolio scabri-Hypochoeridetum achyrophori,* they occur in areas subject to moderate anthropogenic disturbance.

Triticum biunciale communities ∗

Subnitrophilous, therophytic communities dominated by small graminoids and, in particular, by *Triticum biunciale;* in contact to the *Hypochoerido achyrophori-Stipetum capensis,* they occur in areas subject to moderate anthropogenic disturbance such as abandoned areas (fallow lands).

Convolvulus lineatus communities ∗

Subnitrophilous, therophytic communities dominated by *Convolvulus lineatus,* distributed in disturbed (mostly trampling) areas along the rocky coasts, often in contact to communities of *Saginetea maritimae*. The output of cluster analysis led us to frame this community within the *Trachynion distachyae*, but it has to be considered as provisional; further analyses are needed, and on wider dataset including more extended territories, to better define its correct phytosociological position.

LYGEO SPARTI-STIPETEA TENACISSIMAE Rivas-Mart.1978

Circum-mediterranean pseudosteppes and relict edaphic steppes on calcareous rocky substrates.

CYMBOPOGONO-BRACHYPODIETALIA RAMOSI **Horvatic 1963**

Circum-Mediterranean thermo to supra-Mediterranean pseudosteppes on sandy-loamy soils over calcareous bedrocks

Hyparrhenion hirtae **Br.-Bl. et al. 1956**

Thermo-meso-Mediterranean pseudosteppes on calcareous soils of the Western Mediterranean and southern regions of the Central Mediterranean

Stipo austroitalicae-Hyparrhenietum hirtae Biondi et Guerra 2008 ∗

Association characterized by two cespitous Poaceae, *Hyparrhenia hirta* and *Stipa austroitalica,* growing on poorly developed calcareous soils. The vegetation detected in the study are is rather degraded and floristically poor.

Hyparrhenia hirta degraded communities ♦

Degraded communities dominated by *Hyparrhenia hirta*

LYGEO-STIPETALIA TENACISSIMAE **Br.-Bl. et O. de Bolòs 1958**

Relict Mediterranean edaphic steppes on deep clayey soils

Moricandio-Lygeion sparti **S. Brullo et al.1990**

Relict Southern Italian and Ionian thermo-mesomediterranean edaphic steppes on deep clayey soils

Lygeum spartum communities ♦

Degraded communities dominated by *Lygeum spartum* and growing on clayey outcrops.

ONONIDO-ROSMARINETEA Br.-Bl. in A. Bolòs y Vayreda 1950

Mediterranean scrub with nanophanerophytes and chamaephytes, often with -thorny-cushion like habitus, growing on base-rich substrates, and corresponding to the vegetational aspects locally called tomillar, espleguer, romeral, garrigue, phrygana, batha,

***CISTO-MICROMERIETALIA JULIANAE* Oberd. 1954**

Thermo-mesomediterranean phrygana of the continental Hellas and the Adriatic and Ionian seaboards

***Cisto eriocephali-Ericion multiflorae* Biondi 2000**

Thermo-mesomediterranean calcicolous garrigues of the central and southern regions of the Adriatic and Ionian seaboards of the Apennine Peninsula

***Thymbra capitata* communities ∗**

Communities dominated by *Thymbra capitata,* with presence of *Cistus creticus* subsp. *eriocephalus* and *C. salvifolius*

***Satureja cuneifolia* communities ∗**

Communities dominated by *Satureja cuneifolia,* with presence of *Thymbra capitata* and *Fumana laevis*

QUERCETEA ILICIS Br.-Bl. ex A. Bolòs et O. de Bolòs in A. Bolòs y Vayreda 1950

Thermophilic forest and shrub vegetation characterized by evergreen macrophanerophytes and nanophanerophytes, mainly sclerophyllous, having its optimum in the Mediterranean region

***QUERCETALIA ILICIS* Br.-Bl. ex Molinier 1934**

Evergreen and semi-deciduous thermo to supramediterranean oak and relict laurel forests of the Central and Western Mediterranean

***Quercion ilicis* Br.-Bl. ex Molinier 1934**

Thermo-supramediterranean evergreen holm oak forests on calcareous substrates

***Pistacio-Quercetum ilicis* Brullo & Marcenò 1985 ∗**

Quercus ilex forest vegetation characterized by the presence of thermophilic elements of the *Pistacio-Rhamnetalia alaterni*, including *Pistacia lentiscus*, while mesophilic species are rare. It is linked to compact carbonate substrates such as limestones, marls, calcarenites, etc. Markedly thermophilic, climatophilous vegetation, sometimes edaphophilous, settling on rocky substrates with poorly evolved soils.

***PISTACIO LENTISCI-RHAMNETALIA ALATERNI* Rivas-Martínez 1975**

Thermo-mesomediterranean low-grown matorral and macchia of the Mediterranean Basin

***Oleo sylvestris-Ceratonion siliquae* Br.-Bl. ex Giunochet & Drouineau 1944**

Thermo-mediterranean calcicolous sclerophyllous shrub vegetation

Myrto-Pistacetum lentisci (Molinier 1954 em. O.Bolòs 1962) Rivas-Martinez 1975 ∗

Shrub vegetation dominated by *Pistacia lentiscus* and *Myrtus communis*, with other evergreen sclerophyllous shrubs and liana-like species, occurring on carbonatic substrates, mainly in coastal areas. Climacic vegetation widespread in ventilated coastal environments affected by marine aerosol and in contact, toward the sea, with the halophilic communities of *Crithmo-Staticetea* or of *Juniperion turbinatae*.

Pistacia lentiscus and ***Olea europaea*** communities ∗

Shrub vegetation dominated by *Pistacia lentiscus* and with *Olea europaea*, with other evergreen sclerophyllous shrubs and liana-like species, occurring on carbonatic substrates, but generally further back from the coast than the *Myrto-Pistacetum lentisci* or also in inland area, where it can represent a secondary stage of the *Pistacio-Quercetum ilicis.*

Pistacia lentiscus and ***Phlomis fruticosa*** communities ∗

Shrub vegetation dominated by *Phlomis fruticosa* and with *Pistacia lentiscus* and *Olea europaea,* occurring along some engraves crossing the CRM area.

***Juniperion turbinatae* Rivas-Martínez 1975 corr. 1987**

Thermomediterranean tall juniper scrub on coastal dune systems of the Mediterranean seaboards

Asparago acutifolii-Juniperetum macrocarpae (Molinier et R. Molinier 1955) O. Bolòs 1962 ∗

Shrub vegetation on the consolidated soils of the coastal dune systems, dominated by *Juniperus macrocarpa*

typicum ∗

juniperetosum turbinatae Géhu & Biondi 1994 ∗

in inner and more sheltered areas, on more compact soils, with prevalence of *Juniperus turbinata*

CHENOPODIETEA Br.-Bl. in Br.-Bl. et al. 1952

Winter-annual weed segetal and ruderal vegetation of man-made habitats of the Mediterranean, the mild-winter Atlantic seaboards and Macaronesia

***BROMETALIA RUBENTI-TECTORUM* (Rivas Goday et Rivas-Mart. 1973) Rivas-Mart. et Izco 1977**

Winter-annual ruderal vegetation of summer-dry man-made habitats of the Mediterranean, the mild-winter Atlantic seaboards and Macaronesia

Echio-Galactition tomentosae O. de Bolòs et Molinier 1969

Mediterranean tall-herb ruderal vegetation on calcareous nutrient-rich disturbed man-made soils

Avena barbata communities ∗ ♦

Sub-nitrophilous to nitrophilous communities dominated by *Avena barbata*, with many other ruderal species of the *Echio-Galactition tomentosae,* quite widespread in fallow lands.

Anthemis incrassata communities ∗

Sub-nitrophilous communities physiognomically dominated by *Anthemis incrassata*

RESULTS - SYNTAXONOMIC SCHEME

Some of the syntaxonomic units reported are reported here for the first time for the area under study.

Therefore, below are the complete list and the syntaxonomic scheme of the study area, where the new units are highlighted in red.

- *PHRAGMITO AUSTRALIS-MAGNOCARICETEA ELATAE* Klika in Klika & Novák 1941
  - *PHRAGMITETALIA AUSTRALIS* Koch 1926
    - *Phragmition communis* Koch 1926
      - *Phragmitetum communis* (Koch 1926) Schmale 1939
  - *BOLBOSCHOENETALIA MARITIMI Hejny in Holub et al. 1967*
    - *Scirpion maritimi Dahl et Hadac 1941*
      - *Scirpetum maritimi (Christiansen 1934) R. Tx. 1937*

- *AMMOPHILETEA* Br.-Bl. et Tx. ex Westhoff et al.1946
  - *AMMOPHILETALIA* Br.-Bl. et Tx. ex Westhoff et al.1946
    - *Ammophilion* Br.-Bl. 1921
      - *Limonio virgati-Sporoboletum arenarii* Biondi, Casavecchia & Guerra 2006

- *CRITHMO MARITIMI-STATICETEA* Br.-Bl. in Br- Bl., Roussine & Nègre 1952
  - *CRITHMO MARITIMI-STATICETALIA* Molinier 1934
    - *Crithmo maritimi-staticion* Molinier 1934
      - *Crithmo-Limonietum apuli* Bartolo, Brullo & Signorello 1989

- *Crithmo maritimi-Inuletum crithmoidis* Biondi, Casavecchia & Guerra 2006
  - *facies* with *Halimione portulacoides*

❖ *JUNCETEA MARITIMI* Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

- *JUNCETALIA MARITIMI* Br.Bl. ex Horvatic 1934
  - *Juncion maritimi* Br.Bl. ex Horvatic 1934
    - *Inulo-Juncetum maritimi* Brullo in Brullo, De Sanctis, Furnari, Longhitano & Ronsisvalle 1988
    - *Juncetum maritimi* (Rübel 1930) Pignatti 1953
    - *Elytrigio elongatae-Inuletum crithmoidis* Br.-Bl. (1931) 1952

❖ *SALICORNIETEA FRUTICOSAE* Br.-Bl. et Tx. ex A. Bolòs y Vayreda et O. de Bolòs in A. Bolòs y Vayreda 1950

- *SALICORNIETALIA FRUTICOSAE Br.-Bl. 1933*
  - *Salicornion fruticosae* Br.-Bl. 1933
    - *Salicornietum fruticosae (Br.-Bl. 1928 em.1933)* Pignatti 1953
    - *Halimiono portulacoidis-Sarcocornietum alpini* Rivas-Martínez & Costa 1984
  - *Arthrocnemion glauci* Rivas-Mart. et Costa M. 1984
    - *Arthrocaulon macrostachyium* communities
    - *Limonio virgati-Arthrocnemetum macrostachyi* Biondi, Casavecchia & Guerra 2006
    - *Arthrocnemum macrostachyium* and *Halimione portulacoides* communities
  - *Suaedion brevifoliae Br.-Bl. et O. de Bolòs 1958*
    - *Suaeda vera* and *Limonium narbonense* communities
    - *Haimoine portulacoides* communities

- *THEROSALICORNIETEA* Tx. in Tx. et Oberd. 1958
  - *THEROSALICORNIETALIA* Pignatti 1952
    - *Salicornion emerici* Géhu & Géhu-Franck 1984
      - *Salicornietum emerici* (O. de Bolòs 1962) Brullo & Furnari 1976
      - *Salicornietum dolichostachyae* Géhu et Géhu Frank 1984
    - *Thero-Suaedion splendentis* Br.-Bl. in Br.-Bl. & al. 1952
      - *Salsoletum sodae* Pignatti 1953
      - *Suaedetum spicatae* Pignatti 1953 corr. Brullo & al. 2019
      - *Suaedo-Kokietum hirsutae* Br.-Bl. 1928
    - *Microcnemion coralloidis* Rivas-Mart. & Géhu in Rivas-Mart. 1984
      - *Halopeplidetum amplexicaulis* Burollet 1927

- *SAGINETEA MARITIMAE* Westhoff, Van Leeuwen & Adriani 1962
  - *SAGINETALIA MARITIMAE* Westhoff, Van Leeuwen & Adriani 1962
    - *Sileno sedoidis-Catapodion balearici* de Foucault & Bioret 2010 corr. Tomaselli et al 2020
      - *Sileno sedoidis-Hymelobetum revelieri* Brullo & Giusso 2003
      - *Parapholido incurvae-Catapodietum balearici* Rivas-Martínez *et al.* 1990 corr. Brullo & Giusso 2003
      - *Phleo cesii-Anthemidetum tomentosae* Tomaselli, Di Pietro & Sciandrello 2011 corr. Tomaselli et al 2020
  - *FRANKENIETALIA PULVERULENTAE* Rivas-Martínez ex Castroviejo & Porta 1976
    - *Frankenion pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976
      - *Parapholido incurvae-Frankenietum pulverulentae* Rivas Martinez ex Castroviejo & Porta 1976
      - *Parapholidetum filiformis* Brullo, Scelsi & Siracusa 1994
      - *Sphenopus divaricatus* and *Spergularia marina* communities

- *HELIANTHEMETEA GUTTATI* Rivas Goday et Rivas-Mart. 1963
  - *VULPIETALIA* Pignatti 1953
    - *Alkanno-Maresion nanae* Rivas Goday ex Rivas Goday & Rivas-Martínez 1963 corr. Díez-Garretas, Asensi & Rivas-Martínez 2001
      - *Alkanno-Plantaginetum albicantis* Tomaselli, Di Pietro & Sciandrello 2011

- *STIPO-TRACHYNIETEA DISTACHYAE* Rivas Goday et Rivas-Mart. 1963
  - *BRACHYPODIETALIA DISTACHYI* Pignatti 1953
    - *Trachynion distachyae* Rivas-Mart. 1978
      - *Trifolio scabri-Hypochoeridetum achyrophori* Lapraz ex Biondi 1997
      - *Hypochoerido achyrophori-Stipetum capensis* Scoppola 1999
      - *Triticum biunciale* communities
      - *Convolvulus lineatus* communities

- *LYGEO SPARTI-STIPETEA TENACISSIMAE* Rivas-Mart.1978
  - *CYMBOPOGONO-BRACHYPODIETALIA RAMOSI* Horvatic 1963
    - *Hyparrhenion hirtae* Br.-Bl. et al. 1956
      - *Hyparrhenia hirta* communities
  - *LYGEO-STIPETALIA TENACISSIMAE* Br.-Bl. et O. de Bolòs 1958
    - *Moricandio-Lygeion sparti* S. Brullo et al. 1990
      - *Lygeum spartum* communities

- *ONONIDO-ROSMARINETEA* Br.-Bl. in A. Bolòs y Vayreda 1950
  - *CISTO-MICROMERIETALIA JULIANAE* Oberd. 1954
    - *Cisto eriocephali-Ericion multiflorae Biondi 2000*
      - *Thymbra capitata* communities
      - *Satureja cuneifolia* communities

- *QUERCETEA ILICIS* Br.-Bl. ex A. Bolòs et O. de Bolòs in A. Bolòs y Vayreda 1950
  - *QUERCETALIA ILICIS* Br.-Bl. ex Molinier 1934
    - *QUERCION ILICIS* Br.-Bl. ex Molinier 1934
      - *Pistacio-Quercetum ilicis* Brullo & Marcenò 1985
  - *PISTACIO LENTISCI-RHAMNETALIA ALATERNI* Rivas-Martínez 1975
    - *Oleo sylvestris-Ceratonion siliquae* Br.-Bl. ex Guinochet & Drouineau 1944
      - *Myrto-Pistacetum lentisci* (Molinier 1954 em. O.Bolòs 1962) Rivas-Martinez 1975
      - *Pistacia lentiscus* and *Olea europaea* communities
      - *Pistacia lentiscus* and *Phlomis fruticosa* communities
    - *Juniperion turbinatae* Rivas-Martínez 1975 corr. 1987
      - *Asparago acutifolii-Juniperetum macrocarpae* (Molinier et R. Molinier 1955) O. Bolòs 1962
        - *juniperetosum turbinatae* Géhu & Biondi 1994

- *CHENOPODIETEA* Br.-Bl. in Br.-Bl. et al. 1952
  - *BROMETALIA RUBENTI-TECTORUM* (Rivas Goday et Rivas-Mart. 1973) Rivas-Mart. et Izco 1977
    - *Echio-Galactition tomentosae* O. de Bolòs et Molinier 1969
      - *Avena barbata* communities
      - *Anthemis incrassata* communities

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31 January 2023