Feddes Repertorium **116** (2005) 3–4, 243–276 DOI: 10.1002/fedr.200411072 Weinheim, August 2005

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The vegetation of mining dumps in SW-Sardinia

With one Map, 4 Figures and 13 Tables

Summary

The vegetation of mining dumps of SW-Sardinia includes several endemic or rare species, that have been confined to such artificial habitats by a millennial mining activity. The extreme edaphic specialization of these species reflects with unusual fidelity the heterogeneity of substrata, therefore creating a system of plant communities that largely contributes to the environmental diversity of this part of the island. The phytosociological study presented in this paper recognized eight associations, distinguished by the cluster analysis in two main groups, the first including hemicrypto-chamaephytic vegetation, the second including nanophanerophytic garigues.

Six associations are belonging to the first group, five of which newly described: **Helichryso tyrrhenici-Dianthetum sardoi** ass. nova occurring on gross-grained, hard-sloping dumps deriving from the geologic unit of Gonnesa; **Coincyo recurvatae-Helichrysetum tyrrhenici** ass. nova colonizing dumps made of metamorphitic flakes and finer particles; **Resedo luteolae-Limonietum merxmuelleri** ass. nova colonizing small-grained mining dumps with high concentrations in sulphides and heavy metals**; Ptilostemono casabonae-Iberidetum integerrimae** ass. nova replacing the previous one on older and more consolidated dumps, where the concentration of phytotoxic elements was reduced by the meteoric agents; **Epipactidetum tremolsii** ass. nova colonizing muddy deposits originating from ferrous clay; Euphorbio cupanii-Santolinetum insularis ANGIOLINI & BACCHETTA 2003, occurring on very old, stabilized dumps. All these associations can be ascribed to the class Scrophulario-Helichrysetea BRULLO, SCELSI & SPAMPINATO 1998. Within this class, a new Sardo-Corsican alliance, **Ptilostemono casabonae-Euphorbion cupanii** all. nov. is here proposed, differentiated by a pool of rare or endemic species. In addition to the above-mentioned

Zusammenfassung

Zur Vegetation auf Bergbauhalden in Südwestsardinien

Die Vegetation auf Bergbauhalden in Südwestsardinien beheimatet einige endemische oder seltene Pflanzenarten, die sich auf diesen künstlichen Lebensräumen, geschaffen durch einen tausendjährigen Bergbau, spezialisiert haben. Bedingt durch die Anpassung an die extremen Bodenverhältnisse, reflektieren diese Arten mit außergewöhnlicher Konstanz die heterogenen Bodentypen, welche ein System von Pflanzengesellschaften hervorbringen, die wesentlich zu der Vielfalt der Lebensräume dieser Region beitragen. Die hier präsentierte pflanzensoziologische Studie beschreibt acht Pflanzengesellschaften, die sich mittels „Cluster Analysis“ in zwei Hauptgruppen aufspalten lassen. Die erste Gruppe umfasst die hemikryptophytische Vegetation, während die zweite Gruppe die nanophanerophytischen Garigues zusammenführt.

In der ersten Gruppe lassen sich sechs Pflanzengesellschaften abgrenzen, fünf davon werden neu beschrieben: **Helichryso tyrrhenici-Dianthetum sardoi** ass. nova auf grobkörnigen und steil abfallenden Halden des Gonnesa-Abraums; **Coincyo recurvatae-Helichrysetum tyrrhenici** ass. nova kolonisiert die Abraumhalden aus grobkörnigen metamorphen Gesteinen und feineren Partikeln; **Resedo luteolae-Limonietum merxmuelleri** ass. nova bewächst feinkörnigen Abraum mit hoher Konzentration an Sulfiden und Schwermetallen; **Ptilostemono casabonae-Iberidetum integerrimae** ass. nova ersetzt die vorhergehende Gesellschaft auf älteren und verfestigteren Abraumhalden, in denen die phytotoxischen Substanzen stärker ausgewaschen sind; **Epipactidetum tremolsii** ass. nova wächst auf schlammigen Sedimenten, die von eisenhaltigen Lehmen abstammen; Euphorbio cupanii-Santolinetum insula-

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associations, it is proposed, as well, to include into the new alliance the Polygono scoparii-Helichrysetum tyrrhenici BIONDI, VAGGE, FOGU & MOSSA 1996 corr., that was described for the gravelly riverbeds of Central-Southern Sardinia.

As concerns the second group, two new association have been recognized: **Dorycnio suffruticosi-Genistetum corsicae** ass. nova, found on abandoned, well consolidated mining dumps, with an upper layer altered by pedogenetic processes; **Polygalo sardoae-Linetum muelleri** ass. nova, occurring in the vicinities of the mines on steep rocky slopes made of Paleozoic metalliferous limestones. Both of them can be ascribed to the alliance Teucrion mari GAMISANS & MURACCIOLE 1985, grouping the Sardo-Corsican aspects of Cisto-Lavanduletea BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940.

Two taxa are new for science: ***Dianthus sardous*** BACCHETTA, BRULLO, CASTI & GIUSSO, sp. nova and ***Helichrysum microphyllum*** (WILLD.) CAMB. subsp. ***tyrrhenicum*** BACCHETTA, BRULLO & GIUSSO, subsp. nova.

ris ANGIOLINI & BACCHETTA 2003 kommt auf alten, stabilisierten Abraumhalden vor.

Alle diese Pflanzengesellschaften können in die Klasse der Scrophulario-Helichrysetea BRULLO, SCELSI & SPAMPINATO 1998 eingeordnet werden. Innerhalb dieser Klasse wird hier eine neue sardo-korsische Allianz, **das Ptilostemono casabonae-Euphorbion cupanii** all. nov., benannt, welche sich durch eine Vielzahl von endemischen Pflanzenarten auszeichnet. Neben den oben genannten Pflanzengesellschaften wird hier vorgeschlagen, das Polygono scoparii-Helichrysetum tyrrhenici BIONDI, VAGGE, FOGU & MOSSA 1996 corr., das auf Geröll-Flussbetten im zentralen Südsardinien beschrieben wurde, in die neue Allianz mit einzugliedern.

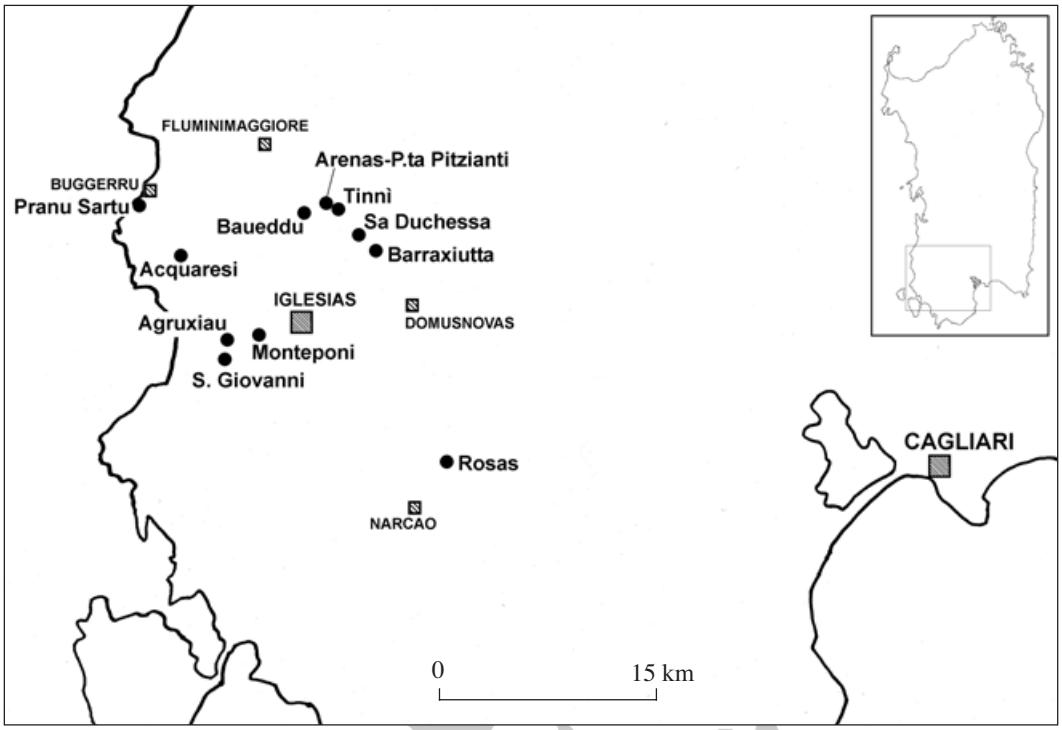
In der zweiten Gruppe konnten zwei neue Pflanzengesellschaften abgetrennt werden: das Dorycnio suffruticosi-Genistetum corsicae ass. nova, welche auf aufgelassenen, gut verfestigten Abraumhalden mit beginnender Bodenbildung zu finden ist, und das Polygalo sardoae-Linetum muelleri ass. Nova, das auf steilen Felsabhängen aus paläozoischen metallhaltigen Kalken in der direkten Nachbarschaft der Abraumhalden vorkommt. Beide Pflanzengesellschaften können in den Verband Teucrion mari GAMISANS & MURACCIOLE 1985 eingegliedert werden, welcher die sardo-korsischen Elemente der Cisto-Lavanduletea BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940 umfasst.

Es werden zwei neue Arten beschrieben: ***Dianthus sardous*** BACCHETTA, BRULLO, CASTI & GIUSSO, sp. nova und ***Helichrysum microphyllum*** (WILLD.) CAMB. subsp. ***tyrrhenicum*** BACCHETTA, BRULLO & GIUSSO, subsp. nova.

1. Introduction

Mines represent a main feature of the Sardinian landscape, and particularly of Sulcis-Iglesiente (SW-Sardinia). This area includes the oldest geologic units of the island (CARMIGNANI 2001), whose richness in metalliferous layers is well known since ancient times. The mining activity started about 3800 yrs b. p., and became a profitable industry in the last two centuries, before getting exhausted around 1990 (MEZZOLANI & SIMONCINI 2001). At the end of the industrial activity, the mining districts have been abandoned without taking care of any reclaim or mitigation, so that dumps and racking basins became soon a serious source of pollution for the neighbouring territories.

Mining dumps of SW-Sardinia are quite a critical habitat for plant life, as high concentrations of exchangeable heavy metals and an extreme acidification of substrata derive from the oxidation of sulphides and other minerals (DI GREGORIO & MASSOLI-NOVELLI 1988; CIDU et al. 2001). Nevertheless, many plants, including several endemic or rare species, can stand such environmental conditions. Many papers focussed on the taxonomic and phytogeographic interest of these species (ARRIGONI 1980; ERBEN 1980; VALSECCHI 1986; BACCHETTA et al. 2000; ANGIOLINI & BACCHETTA 2003), but still a phytosociological study on the pioneer plant communities that colonize the mining dumps was missing. Aim of this paper is to describe such vegetation and to highlight the ecological behaviour and syndynamic role of its character species.



Map 1
Map of the Sardinian investigated mines (black dots)

2. Study area

The studied sites are located in Sulcis-Iglesiente (Map 1): a geologic complex that is separated from the rest of the island by the Grabens of Campidano. From the administrative viewpoint, the surveyed areas belong to the province of Cagliari and to the municipalities of Iglesias (Mines of Monteponi, Agruxiau, Acquaresi), Fluminimaggiore (Arenas-P.ta Pitzianti, Tinnì, Baueddu), Domusnovas (Barraxiutta, St. Giovanni, Sa Duchessa), Buggerru (Pranu Sartu) and Narcao (Rosas).

The rock outcrops in the study area date from the Cambrian to the Lower Silurian and consist of four main geologic units: the Nebida- and Gonnesa Formations (both Lower Cambrian), the Cabitza Formation (Lower Cambrian to Lower Ordovician), and the Mt. Orri Formation, dated from the Lower Silurian (CARMIGNANI 2001). The mining activity dealt with all of them, and mainly with the lodes embedded in Cambrian metalimestones and metadolostones, belonging to the Gonnesa Formation, also called "Metallifero".

The ombrothermic diagrams of Fluminimaggiore, Iglesias, St. Giovanni (Domusnovas) and Rosas (Narcao) are reported in Fig. 1. With reference to the Rivas-Martínez' bioclimatic classification (RIVAS-MARTÍNEZ et al. 1999, 2002) and basing on the termopluviometric data processed by BACCHETTA (2000), the whole study area is characterized by a Mediterranean pluviseasonal bioclimate, with thermotypes ranging between the upper thermo- and the upper mesomediterranean and ombrotypes between the upper dry and the upper subhumid.

3. Material and methods

The phytosociological survey was based on 73 relevés, sampled between the years 2000–2003. To ensure a complete overview on the vegetation at

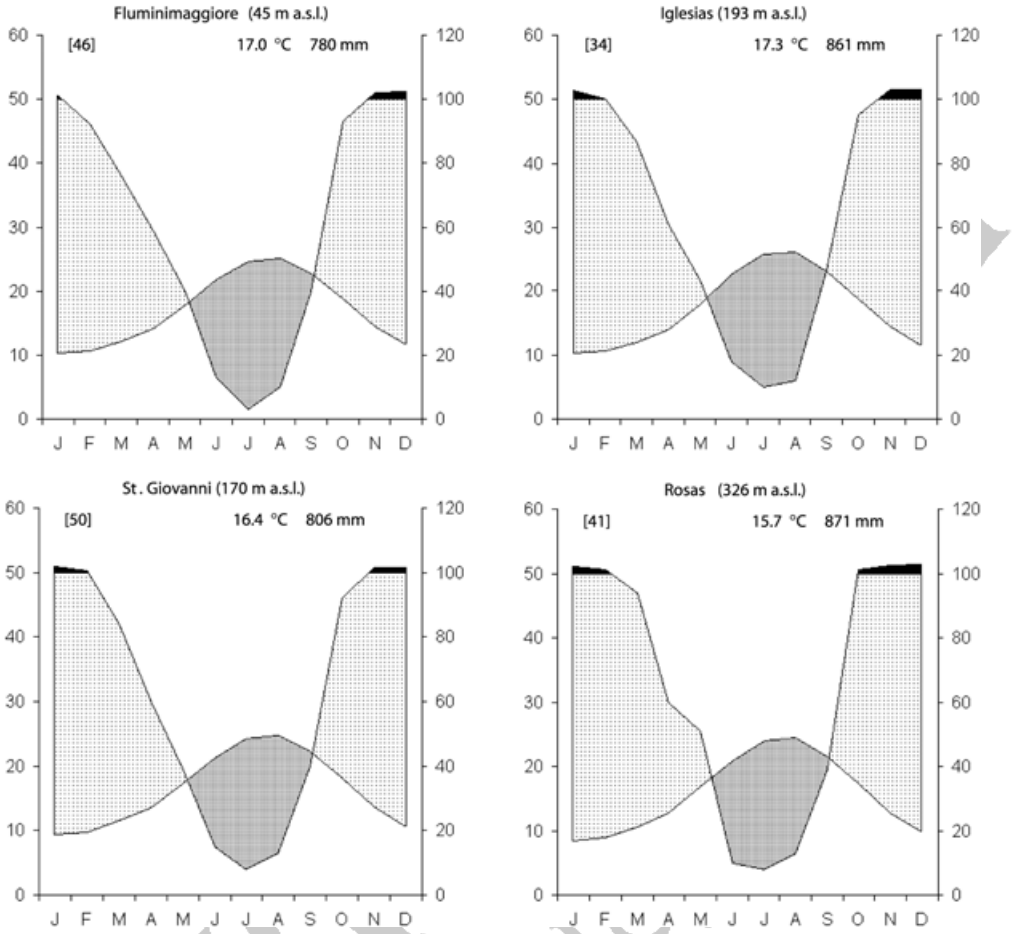


Fig. 1
Ombrothermic diagrams of some stations within the studied area

issue, some relevés taken from literature (ANGIOLINI & BACCHETTA 2003) have been added to the original ones (Table 9) and included, as well, in the multivariate data processing.

In order to obtain floristically homogeneous groups of relevés, a matrix of 96 species × 73 relevés was submitted to cluster analysis, by adopting the average link (UPGMA) as agglomeration criterion, applied to a dissimilarity matrix obtained by the percentage difference. Cluster analysis was performed by the software package Syn-Tax 5.1 (PODANI 1997). To obtain the cluster diagram in Fig. 1, the Braun-Blanquet values were transformed into the ordinal scale of van der Maarel (VAN DER MAAREL 1979; NOEST et al. 1989). Sporadic species, i.e. those occurring in less than three relevés, have been excluded from the data processing.

The adopted taxonomic nomenclature, the chorologic groups, the biologic and growth forms of the observed taxa are reported in the Appendix. Biologic and growth forms have been checked in the field and expressed according to the abbreviations proposed by PIGNATTI (1982). The chorologic groups follow the classification proposed by BRULLO et al. (1998), except for the endemics, that follow ARRIGONI (1983).

The biologic and chorologic spectra in Figs. 3 and 4 have been weighted by the cover values of each species and expressed as cumulative percentage. In the chorologic spectrum, under "other endemics" there are grouped all the W-Mediterranean insular endemics, whose distribution range includes not only Sardinia and Corsica but also some other W-Mediterranean islands and, in the case of *Crepis*

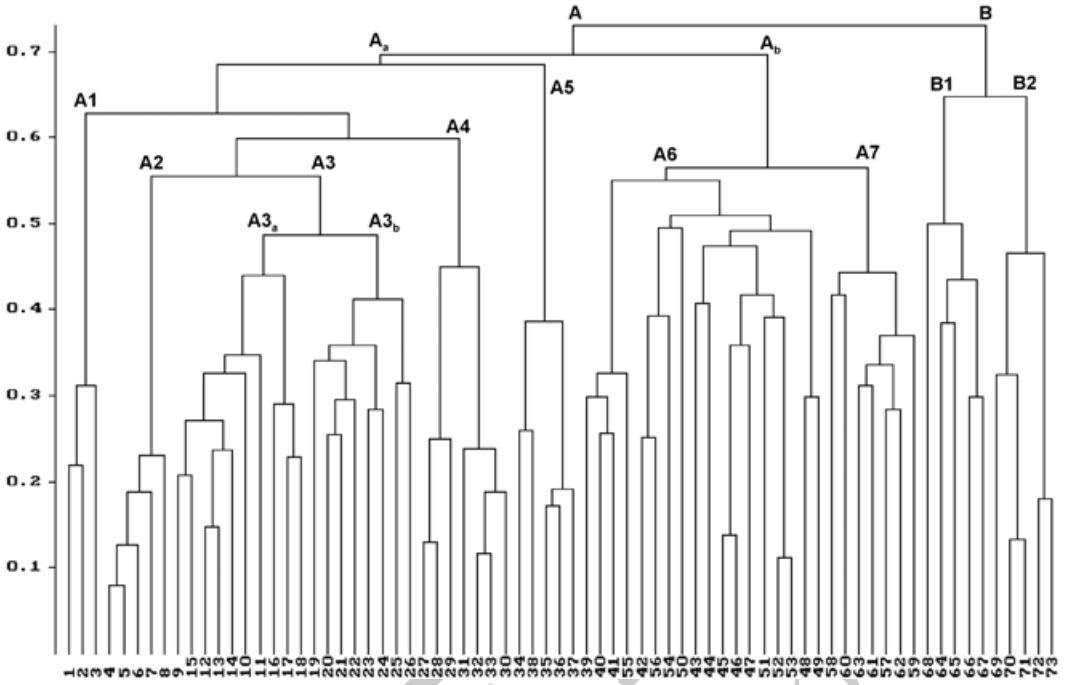


Fig. 2
Cluster diagram of the relevés reported in Tables 4–12

A1 — Helichryso microphylli-Dianthetum sardoi; A2 — Coincyo recurvatae-Helichrysetum microphylli; A3 — Resedo luteolae-Limonietum mermuelleri (A3$_a$ — typicum; A3$_b$ — iberidetosum integerrimae); A4 — Ptilostemono casabonae-Iberidetum integerrimae; A5 — Epipactidetum tremolsii; A6 — Euphorbio cupanii-Santolinetum insularis scrophularietosum bicoloris; A7 — *Genista sulcitana*-community; B1 — Dorycnio suffruticosi-Genistetum corsicae; B2 — Polygalo sardoae-Linetum muelleri. Relevés are numbered as in Tabs. 4–12.

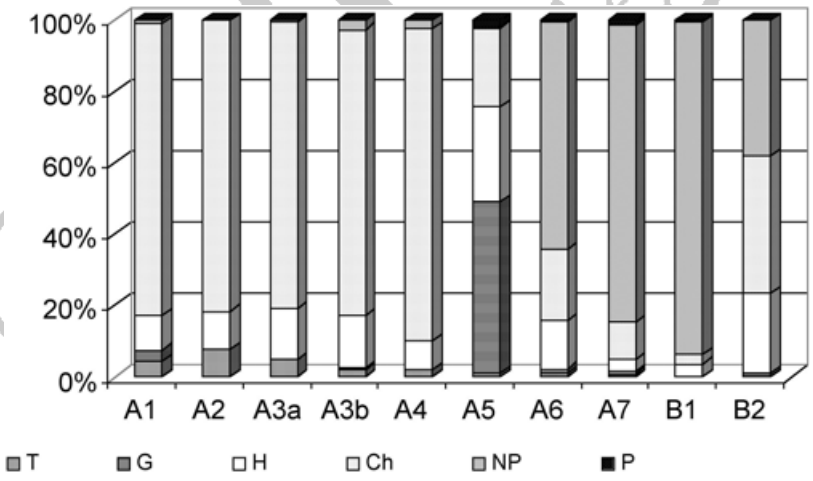


Fig. 3
Biologic spectrum of the surveyed associations. Labels are the same of Fig. 2

T = therophytes, G = geophytes, H = hemicryptophytes, Ch = chamaephytes, NP = nanophaneophytes, P = phanerophytes

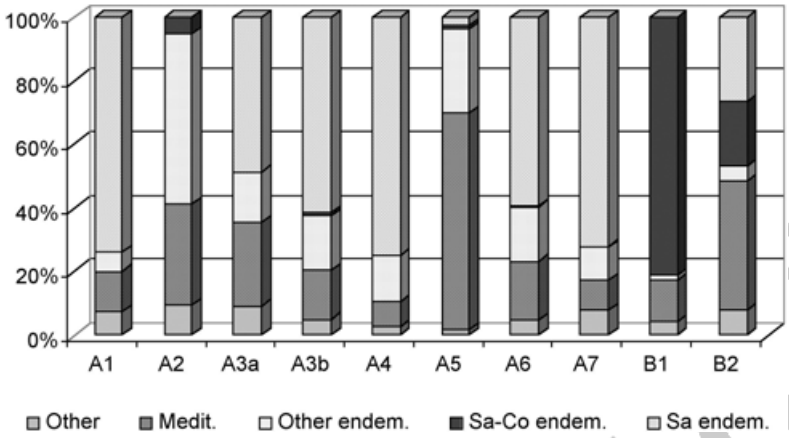


Fig. 4
Chorologic spectrum of the surveyed associations. Labels are the same of Fig. 2

bellidifolia, it sprawls up to the western coast of Central Italy. Under "Mediterranean" there are grouped taxa ranging over large parts or on the whole Mediterranean basin. Under "Other" there are grouped taxa whose distribution range exceeds the limits of the Mediterranean region.

The syntaxonomic nomenclature follows the rules of the third edition of the international code of phytosociological nomenclature (WEBER et al. 2000).

The concentrations of heavy metals in the soil have (Table 13, s. p. ▮) been measured at two different depth (0–30 and 30–60 cm) on 9 samples (1–6 sampled on 15th May 2004; 7–9 sampled on 22nd May 2004) from the dumps of Monteponi. All the chemical analyses have been performed according to the US Soil Taxonomy.

4. Results

The field research let to identify ten distinct vegetation types, that are confirmed by the results of cluster analysis. The diagram in Fig. 2 highlights two main clusters: A and B, the former grouping plant communities dominated by hemicryptophytes and chamaephytes, the latter dominated by nanophanerophytes.

The A cluster includes two main subclusters: A_a and A_b, the former grouping the most pioneer vegetation types, the latter including more evolved and mature plant communities.

The subcluster A_a branches into five groups at more than 0.5 dissimilarity ratio. Each of these groups can be treated as a distinct association. The group A5, that separates first, corresponds to a sparse and paucispecific plant community dominated by *Epipactis tremolsii*. In the same way, the group A1 branches at a relatively low similarity ratio, due to the abundance of *Dianthus sardous*, exclusively growing in this context. The remaining groups correspond to plant communities fairly richer in species and with higher cover values. These groups are differentiated, respectively, by the abundance of *Coincya monensis* subsp. *recurvata* (A2), *Limonium merxmuelleri* (A3) and *Iberis integerrima* (A4).

Moreover, within the group A3, still it is possible to recognize two subgroups, that can be treated as different subassociations: the first one corresponding to stands with unstable substrata, where *Limonium merxmuelleri* finds its optimal ecological requirements, the second one, corresponding to more stabilized situations, where the vegetation becomes more dense, the number of species increases and the leadership of *Limonium merxmuelleri* tends to decrease.

The subcluster A_b groups plant communities that are more complex and mature than those belonging to the subcluster A_a. From a dynamic viewpoint, they occupy an intermediate position between the most pioneer vegetation (belonging to A_a) and the garigues grouped within the cluster B. Indeed, the plant communities at issue differ from the previous ones for structure and physiognomy, given by the large prevalence of *Santolina insularis* and by the occur-

rence of several other nanophanerophytes. Two different aspects can be made out of the subcluster A_b: a typical one (A6) and another one, differentiated by the abundance of *Genista sulcitana* (A7).

In the cluster B, finally, the garigues dominated by *Genista corsica* (B1) are clearly differentiated from those with *Linum muelleri* (B2).

As concerns syntaxonomy, the plant communities of cluster A, owing to their pioneer character, ecologic requirements, and by the occurrence of *Dittrichia viscosa, Scrophularia canina* subsp. *bicolor, Rumex scutatus* subsp. *glaucescens*, can be ascribed to the class Scrophulario-Helichrysetea italici BRULLO, SCELSI & SPAMPINATO 1998. This class, first described by BRULLO et al. (1998) for Sicily and Central-Southern Italy, includes hemicrypto-chamaephytic glareolus vegetation, dwelling incoherent substrata, wherever the pedogenesis is slowed or hindered by peculiar environmental conditions. The vegetation belonging to this class is linked to the Mediterranean bioclimatic region and it can be considered a Centre-Mediterranean vicariant of Thlaspietea rotundifolii BR.-BL. 1948, the latter ranging over territories with more temperate or continental climatic conditions.

The class Scrophulario-Helichrysetea italici is represented by the sole order Scrophulario-Helichrysetalia italici BRULLO 1984, that is quite similar to the order Andryaletalia ragusinae RIVAS-GODAY ex RIVAS-GODAY & ESTEVE 1972, grouping the vegetation of riverbeds in the Iberian peninsula, included by RIVAS-MARTÍNEZ et al. (2001) within the class Thlaspietea rotundifolii.

According to BRULLO (1984), BRULLO & SPAMPINATO (1990) and BRULLO et al. (1998), two main physiotypes are featured within the order Scrophulario-Helichrysetalia italici: screes and riverbeds. Clasts of screes undergo to a gravitative selection that creates well defined granulometric gradients, whereas on riverbeds, boulders, pebbles and minor particles are mixed together, creating a less hostile, although periodically flooded, substratum. This difference is well reflected by different species pools, namely characterizing the two alliances Linarion purpureae BRULLO 1984 and Euphorbion rigidae BRULLO & SPAMPINATO 1990.

Although the character species of Scrophulario-Helichrysetea italici are well represented also on the mining dumps of Sulcis-Iglesiente, the character species of the two above mentioned alliances are missing. Species like *Linaria purpurea, Ptilostemon niveum, Arrhenatherum nebrodense, Secale strictum, Euphorbia rigida* and *Artemisia variabilis* are in Sardinia substituted by other rare or endemic species, so that the vegetation at issue looks quite different from that of Sicily and Central-Southern Italy. These species are: *Ptilostemon casabonae, Euphorbia cupanii, Dipsacus ferox, Anagallis monelli, Limonium merxmuelleri, Iberis integerrima* and *Epipactis tremolsii*, to whom *Helichrysum microphyllum* subsp. *tyrrhenicum* (a local vicariant of *Helichrysum italicum*) can be added as differential species, due to its high frequency (Table 1). For this reason, it is here proposed to include the coenoses of cluster A into the new alliance Ptilostemono casabonae-Euphorbion cupanii, that groups five new associations: Resedo luteolae-Limonietum merxmuelleri, Ptilostemono casabonae-Iberidetum integerrimae, Epipactidetum tremolsii, Helichryso tyrrhenici-Dianthetum sardoi and Coincyo recurvartae-Helichrysetum tyrrhenici.

By the light of these new data, it seems proper to include into the new alliance also the Euphorbio cupanii-Santolinetum insularis, association described by ANGIOLINI & BACCHETTA (2003) for the riverbeds and mining dumps of Central-Southern Sardinia and previously ascribed by these authors to the class Cisto-Lavanduletea. Another association, that could be better ascribed to the new alliance is the Polygono scoparii-Helichrysetum tyrrhenici BIONDI, VAGGE, FOGU & MOSSA 1996 nom. corr. hoc loco (= Polygono scoparii-Helichrysetum microphylli, BIONDI, VAGGE, FOGU & MOSSA 1996, Coll. Phytosoc., 24: 816, Art. 43), a glareolus community described for the riverbeds of Central-Southern Sardinia and by the authors included in the Andryaletalia ragusinae (BIONDI et al. 1996). Indeed, in the last association, *Euphorbia cupanii*, *Helichrysum microphyllum* subsp. *tyrrhenicum*, *Ptilostemon casabonae* and *Dipsacus ferox* play a relevant role, together with *Scrophularia canina* subsp. *bicolor*, *Dittrichia viscose* and *Rumex scutatus* subsp. *glaucescens*. In Table 2, some unpublished relevés of Polygono scoparii-Helichry-

Table 1
Association of the class Scrophulario-Helichrysetea italici

Association number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31
Number of relevés	3	5	10	8	7	5	21	13	16	9	18	12	10	12	12	8	8	8	30	26	4	5	3	7	13	10	2	7	3	5	11
Char. association and subassociation																															
Dianthus sardous	3	.	.	.	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Coincya monensis subsp. *recurvata*	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Limonium merxmuelleri	.	.	V	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Echium anchusoides	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iberis integerrima	.	.	.	V	V	III	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Epipactis tremolsii	.	.	.	II	.	V	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Santolina insularis	.	.	I	.	.	.	V	V	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia dendroides	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum scoparium	.	.	.	.	.	.	.	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arenaria grandiflora	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio candidus	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Iberis pruitii	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Achnatherum calamagrostis	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio siculus	.	.	.	.	.	.	.	.	.	.	.	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio ambiguus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Senecio glaber	.	.	.	.	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardamine graeca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hesperis cupaniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scutellaria rubicunda	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melica cupani	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus lanceolatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Solidago virgaurea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	IV	.	.	.	.	.	.	.	.	.	.	.	.
Lotus commutatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	2	.	.	.	.	.	.	.	.	.	.
Epilobium dodonaei	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.
Verbascum macrurum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.
Ononis ramosissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	.	.	.	.	.	.	.	.
Calendula fulgida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.	.	.
Moricandia arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	III	.	.	.	.	.	.	.	.	.
Senecio gibbosus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.	.	.	.	.	.	.
Putoria calabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	II	.	.	.	.	.	.
Onobrychis tenoreana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.	.	.
Echinops spinosissimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.	.	.
Onobrychis echinata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	V	3	.	.
Helianthemum apenninum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	V	.	.	.
Picris scaberrima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.

Alkanna tinctoria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.
Centaurea sonchifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.	.	.
Dianthus arrostii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	.	.
Erysimum crassistylum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	.
Senecio bicolor	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V
Centaurea aeolica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	II
Char. Ptilostemono casabonae-Euphorbion cupanii																															
Helichrysum microphyllum	3	V	V	V	V	V	V	V	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilostemon casabonae	2	V	IV	V	V	V	V	V	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia cupanii	2	V	IV	V	III	V	V	V	IV	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Dipsacus ferox	.	.	.	.	.	III	II	II	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anagallis monelli	.	.	.	IV	.	.	II	I	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Char. Linarion purpureae																															
Linaria purpurea	.	.	.	.	.	.	.	.	.	.	IV	II	IV	V	V	IV	II	V	II	.	.	.	.	.	.	.	.	.	.	V	.
Arrhenatherum nebrodense	.	.	.	.	.	.	.	.	.	.	V	.	V	V	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex scutatus subsp. *scutatus*	.	.	.	.	.	.	.	.	.	.	V	.	IV	.	.	V	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.
Secale strictum	.	.	.	.	.	.	.	.	.	.	IV	.	.	.	III	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ptilostemon niveus	.	.	.	.	.	.	.	.	.	.	V	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Aethionema saxatilis	.	.	.	.	.	.	.	.	.	.	II	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arrhenatherum sardoum	.	.	.	.	.	.	.	.	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Char. Euphorbion rigidae																															
Micromeria graeca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	4	V	3	V	V	V	.	V	.	V	I
Euphorbia rigida	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	III	1	V	1	IV	.	.	2	V	2	V	.
Char. Scrophulario-Helichrysetea italici																															
Scrophularia canina subsp. *bicolor*	.	V	V	IV	I	.	III	.	III	II	IV	V	V	V	V	V	.	V	V	V	2	V	3	IV	II	V	2	.	3	V	V
Dittrichia viscosa	3	.	IV	IV	V	III	III	IV	V	III	.	II	.	.	.	.	.	.	.	V	4	V	3	IV	IV	V	1	.	1	.	III
Helichrysum italicum	.	.	.	.	.	.	.	.	.	.	II	V	.	.	V	II	.	.	.	V	4	V	3	V	V	V	2	V	3	V	.
Centranthus ruber	.	.	.	.	.	.	.	.	.	.	.	IV	II	V	V	.	.	V	II	I	.	.	1	.	.	.	2	.	2	V	.
Lactuca viminea	.	.	.	.	.	.	.	.	.	.	IV	V	II	V	III	II	V	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Artemisia variabilis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	V	V	.	.	.	.	V	V	.	2	V	3	.	.
Rumex scutatus subsp. *glaucescens*	.	.	.	.	I	.	.	.	V	V	.	.	.	.	V	.	.	.	.	I	.	.	.	.	.	.	.	.	.	V	.

Table 1
(continued)

Source of the relevés:
1 – Helichryso microphylli-Dianthetum sardoi Table 4
2 – Coincyo recurvatae-Helichrysetum microphylli Table 5
3 – Resedo luteolae-Limonietum merxmuelleri typicum Table 6(a)
4 – Resedo luteolae-Limonietum merxmuelleri iberidetosum integerrimae Table 6(b)
5 – Ptilostemono casabonae-Iberidetum integerrimae Table 7
6 – Epipactidetum tremolsii Table 8
7 – Euphorbio cupanii-Santolinetum insularis scrophularietosum bicoloris Table 9
8 – Euphorbio cupanii-Santolinetum insularis euphorbietosum dendroidis (after Angiolini & Bacchetta, 2003. Tab. 3, rel: 18–30)
9 – Polygono scoparii-Helichrysetum microphylli Table 2
10 – Polygono scoparii-Helichrysetum microphylli (after Biondi et al., 1996. Tab. 1, rel. 2, 5–7, 14, 16, 17, 20, 22)
11 – Arenario-Rumicetum scutati (after Brullo 1984, Tab. 6)
12 – Helichryso-Achnatheretum calamagrostis (after Brullo et al. 1998, Tab. 1) 1998, Tab. 7)
13 – Senecionetum siculi (after Brullo 1984, Tab. 7)
14 – Senecionetum siculi (after Brullo et al. 1998, Tab. 2)
15 – Centrantho-Senecionetum ambigui (after Brullo 1984, Tab. 8)
16 – Rumici-Cardaminetum graecae (after Brullo et al. 1998, Tab. 3)
17 – Scutellario-Melicetum cupanii (after Brullo et al. 1998, Tab. 4)
18 – Solidago-Artemisietum variabilis (after Brullo et al. 1998, Tab. 5)
19 – Solidago-Artemisietum variabilis (after Mazzoleni et al. 1989)
20 – Loto-Helichrysetum italici (after Brullo & Spampinato 1990, Tab. 8)
21 – Ononido-Helichrysetum italici (after Brullo & Spampinato 1990, Tab. 9)
22 – Calendulo-Helichrysetum italici (after Brullo & Spampinato 1990, Tab. 10)
23 – Senecioni-Helichrysetum italici (after Brullo & Spampinato 1990, Tab. 11)
24 – Artemisio-Helichrysetum italici (after Brullo & Spampinato 1999, Tab. 12)
25 – Artemisio-Helichrysetum italici (after Biondi et al. 1994, Tab. 2)
26 – Echinopo-Helichrysetum italici (after Brullo et al. 1998, Tab. 6)
27 – Onobrychido-Artemisietum variabilis (after Brullo et al. 1998, Tab. 7)
28 – Onobrychido-Artemisietum variabilis helianthemetosum (after Brullo et al. 1998, Tab. 7)
29 – Onobrychido-Artemisietum variabilis dianthetosum (after Brullo et al. 1998, Tab 7)
30 – Erysimo-Helichrysetum italici (after Brullo et al. 1998, Tab. 8)
31 – Scrpphulario-Senecionetum bicoloris (after Brullo et al. 1998, Tab. 9)

setum tyrrhenici are reported, extending the range of this association northwards and westwards.

As concerns the plant communities of cluster B, due to the dominance of acidophilous shrubs, like *Lavandula stoechas*, *Cistus salvifolius*, *C. eriocephalus* and *C. mospeliensis*, they can be ascribed to the class Cisto-Lavanduletea BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940 and to the order Lavanduletalia stoechadis BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940 em. RIVAS-MARTÍNEZ 1968. The occurrence of Sardo-Corsican endemics, such as *Genista corsica* and *Stachys glutinosa*, allows to include them within the Teucrion mari GAMISANS & MURACCIOLE 1985. In the studied sites, this alliance is represented by two associations: Dorycnio suffruticosi-Genistetum corsicae, linked to very old and leached dumps, and Polygalo sardoae-Linetum muelleri, linked to metalliferous outcrops next to the mines.

Basing on the above written considerations, the following syntaxonomical scheme is proposed and commented.

Scrophulario-Helichrysetea italici BRULLO, SCELSI & SPAMPINATO 1998

Itinera Geobot. 11: 407 [Thlaspietea rotundifolii sensu BRULLO 1984, Boll. Acc. Gioenia Sci. Nat. 16(322): 372 and BRULLO & SPAMPINATO 1990, Boll. Acc. Gioenia Sci Nat. 23(336): 179 non BR.-BL. 1948]

Holotypus: Scrophulario-Helichrysetalia italici BRULLO 1984.

Character species: *Helichrysum italicum*, *Centranthus ruber*, *Dittrichia viscosa*, *Scrophularia canina* subsp. *bicolor*, *Lactuca viminea*, *Rumex scutatus* subsp. *glaucescens*.

Structure and synecology: Perennial pioneer vegetation dominated by chamaephytes and hemicryptophytes, colonizing incoherent substrata (shales, gravels, pyroclastites, sands, etc.) from the sea-level up to 1800 m of altitude, within the Mediterranean bioclimatic region.

Syndynamism: The class includes permanent plant communities, often forming special series within the climactic belts of Quercetea ilicis BR.-BL. ex A. & O.BOLÒS 1950 and Querco-Fagetea BR.-BL. & VLIEGER in VLIEGER 1937.

Table 2
Polygono scoparii-Helichrysetum microphylli Biondi, Vagge, Fogu & Mossa 1995

Rel. number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Altitude (m a.s.l.)	65	50	240	200	65	80	60	70	50	60	65	60	70	40	220	220
Exposure	–	–	–	E	–	–	–	–	–	–	–	–	–	–	N	–
Sloping angle ()	–	–	–	20	–	–	–	–	–	10	–	–	–	–	<5	5
Plot size (sq. meters)	30	10	40	40	10	15	20	20	10	20	15	20	10	10	20	30
Plant cover (%)	90	70	70	90	80	80	80	70	70	80	100	70	60	90	80	80
Mean vegetation height (m)	0,6	0,5	0,4	0,5	0,6	0,7	0,4	0,4	0,5	0,8	0,5	0,5	0,6	0,4	0,6	0,5
Char. association																
Polygonum scoparium	+	+	+	1	1	2	1	1	2	2	2	2	1	4	4	4
Char. Ptilostemono casabonae-Euphorbion cupanii																
Helichrysum microphyllum	4	4	4	4	3	3	4	4	3	4	5	3	3	+	2	2
Euphorbia cupanii	.	.	+	2	1	+	+	+	+	.	.	.	.	+	1	1
Ptilostemon casabonae	.	+	+	.	+	.	.	.	.	.	.	+	.	.	+	.
Dipsacus ferox	.	.	.	+	+	.	.	.	.	.	.	+	1	.	.	.
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici																
Dittrichia viscosa	+	+	1	2	2	+	1	1	1	+	1	1	.	+	.	+
Rumex scutatus ssp. *glaucescens*	1	2	.	.	1	+	+	1	2	2	1	1	2	2	+	.
Scrophularia canina subsp. *bicolor*	.	.	1	+	1	.	+	1	.	.	.	2	1	.	.	.
Transgr. Cisto-Lavanduletea																
Cistus monspeliensis	1	1	+	.	1	.	.	+	.	+	+	1	1	.	.	+
Lavandula stoechas	+	1	+	.	1	.	.	+	1	.	.	1	2	+	.	.
Cistus salvifolius	+	.	.	.	+	.	.	.	.	.	.	.	1	.	+	+
Teucrium flavum subsp. *glaucum*	+	.	.	.	.	.	+	.	.	.	+	.	.	.	.	+
Stachys glutinosa	1	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.
Teucrium massiliense	+	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.
Cistus eriocephalus	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Genista corsica	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Other species																
Carlina corymbosa	.	.	1	+	.	+	+	+	.	+	.	+	.	.	1	1
Galactites tomentosa	+	.	.	.	.	+	+	.	.	+	+	.	.	+	+	.
Sedum sediforme	.	+	.	.	+	.	+	+	1	.	.	1	.	.	.	.
Micromeria graeca subsp. *Graeca*	.	+	+	.	+	+	.	1	1	.	.	1	.	.	.	.
Asphodelus ramosus subsp. *ramosus* var. *Ramosus*	.	.	+	+	.	+	.	.	+	.	.	+	.	.	+	.
Rubus gr. *ulmifolius*	.	.	+	1	.	.	+	.	.	.	.	.	.	.	+	1
Oryzopsis miliacea subsp. *miliacea*	.	.	+	1	.	.	.	.	.	.	.	.	.	.	1	+
Reichardia picroides	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	+
Sanguisorba minor subsp. *muricata*	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	+
Mentha pulegium	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	+
Phillyrea latifolia	.	.	+	.	.	+	.	.	.	.	+	.	.	.	.	+
Nerium oleander	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	+
Santolina insularis	.	.	+	1	.	.	.	.	.	.	.	.	.	.	+	.
Verbascum sinuatum	.	.	+	.	.	+	+	.	.	.	.	.	.	.	.	.
Urospermum dalechampii	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.
Daucus carota subsp. *maritimus*	.	.	+	+	.	.	+	.	.	+	.	.	.	.	.	.
Asphodelus fistulosus	.	.	.	.	+	+	+	.	1	+	.	1	.	+	.	.
Mercurialis annua	.	.	.	+	.	.	+	.	.	+	+	.	.	+	.	.

Table 2
(continued)

Rel. number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Altitude (m a.s.l.)	65	50	240	200	65	80	60	70	50	60	65	60	70	40	220	220
Exposure	–	–	–	E	–	–	–	–	–	–	–	–	–	–	N	–
Sloping angle ()	–	–	–	20	–	–	–	–	–	10	–	–	–	–	<5	5
Plot size (sq. meters)	30	10	40	40	10	15	20	20	10	20	15	20	10	10	20	30
Plant cover (%)	90	70	70	90	80	80	80	70	70	80	100	70	60	90	80	80
Mean vegetation height (m)	0,6	0,5	0,4	0,5	0,6	0,7	0,4	0,4	0,5	0,8	0,5	0,5	0,6	0,4	0,6	0,5
Convolvulus althaeoides subsp. *althaeoides*	.	.	.	.	.	.	+	.	.	+	+	.	.	+	.	.
Avena fatua	.	.	.	.	.	+	+	.	.	+	+	.	.	.	.	.
Vicia bithynica	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Urospermum picroides	+	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.
Pistacia lentiscus	+	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.
Olea europaea var. *sylvestris*	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Oxalis pes-caprae	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.
Calamintha nepeta subsp. *glandulosa*	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Vicia hybrida	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Bituminaria bituminosa	.	+	.	.	+	.	.	.	.	.	.	+	.	.	.	.
Ferula communis subsp. *communis*	.	.	+	+	.	.	.	.	.	.	.	.	.	.	1	.
Carex distachya	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+
Pyrus spinosa	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.
Foeniculum vulgare subsp. *Piperitum*	.	.	+	1	.	.	.	.	.	.	+	.	.	.	.	.
Geranium purpureum	.	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.
Theligonum cynocrambe	.	.	.	+	.	.	+	.	.	.	+	.	.	.	.	.
Borago officinalis	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.
Arisarum vulgare	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.
Euphorbia characias	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.
Glaucium flavum	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
Orobanche purpurea	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Hyparrhenia hirta subsp. *hirta*	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Thymelaea hirsuta	.	.	.	.	+	.	.	.	.	.	.	1	.	.	.	.

Sporadic species: rel. 1: *Juniperus oxycedrus* subsp. *oxycedrus* (+), *Lavatera arborea* (+), *Biserrula pelecinus* (+), *Lotus corniculatus* (+), *Galium verrucosum* (+); rel. 3: *Dactylis hispanica* (+), *Melica arrecta* (1), *Teucrium flavum* subsp. *glaucum* (+), *Smilax aspera* (+), *Quercus ilex* (+), *Silene vulgaris* ssp. *angustifolia* (+), *Leontodon tuberosus* (+), *Linum bienne* (+); rel. 4: *Scirpoides holoschoenus* subsp. *holoschoenus* (+), *Oenanthe pimpinelloides* (+); rel. 5: *Lathyrus cicera* (+); rel. 6: *Reseda luteola* (+); rel. 7: *Osyris alba* (+); rel. 8: *Echium vulgare* (+), *Lathyrus aphaca* (+); rel. 9: *Andryala integrifolia* (+), *Prasium majus* (+), *Misopates orontium* (+), *Jasione montana* s.l. (+); rel. 10: *Sonchus oleraceus* (+); rel. 13: *Sixalix atropurpurea* subsp. *maritima* (1), *Bellium bellidioides* (+), *Allium triquetrum* (+), *Clematis vitalba* (+); rel. 16: *Erica arborea* (1)

Spot and date of relevs: rel. 1, 2, 5, 8–13: Flumendosa (S. Vito – CA) 27. 04. 1989; rel. 3, 4, 15, 16: Rio sa Duchessa (Domusnovas) 27. 04. 1999; rel. 6, 7, 14: Rio Flumendosa, at the confluence with Rio Domueu (S. Vito – CA) 28. 04. 1999

Distribution: The class probably ranges all over the Tyrrhenian area. Basing on literature and unpublished data, vegetation that could be ascribed to this class have been recorded, up to now, for Central and Southern Italy, Sicily, Sardinia and Corsica.

Scrophulario-Helichrysetalia italici BRULLO **1984**

Boll. Acc. Gioenia Sci. Nat. 16 (322): 373

Holotypus: Linarion purpureae BRULLO 1984.

Character species, structure, synecology, syndynamism and distribution are the same of the class.

Ptilostemono casabonae-Euphorbion cupanii ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, all. nova

Table 3

Holotypus: Resedo luteolae-Limonietum merxmuelleri ass. nova, hoc loco.

Character species: *Ptilostemon casabonae*, *Euphorbia cupanii*, *Dipsacus ferox*, *Anagallis monelli*, *Limonium merxmuelleri*, *Iberis integerrima*, *Helichrysum microphyllum* subsp. *tyrrhenicum* (diff.).

Structure and synecology: Thermophilous alliance, ranging from the thermo- to the mesomediterranean bioclimatic belt, with dry to subhumid ombrotypes. It includes sparse plant communities, dominated by suffruticose chamaephytes and hemicryptophytes. The species number of these communities is rather low, due to the high ecological specialization needed to colonize gravelly substrata. The vegetation belonging to this alliance is found on coarse incoherent debris deposits, wherever the pedogenesis is impeded by the environmental factors. Most of the plants forming this vegetation are indifferent to the edaphic conditions, as they can grow both on carbonatic or siliceous substrata. They are the first colonizers of screes and riverbeds, but, in relatively recent times, they found a new ecological niche on the heavily polluted and hyperacid rubbles of mining dumps. The pioneer character of these plants let them to settle also in steep and rocky places, up to 60° sloping.

Syndynamism: The phytocoenoses belonging to this alliance rarely take part to the normal dynamic series, but they often form special edaphic series. On mining dumps, they represent permanent pioneer communities, that, on more evolved and weathered substrata, tend towards a more structured vegetation, which can be ascribed to the class Cisto-Lavanduletea.

Distribution: The alliance extends on the whole Sardinia, even if it has been studied only in the SW part of the island (Sulcis-Iglesiente), where it is most represented on mining dumps, and in the SE part of the island (Sarrabus-Gerrei), where it mainly occurs on gravelly riverbeds. Given the chorology of most of the character species, the geographical range of the alliance stretches up to Corsica, as confirmed by unpublished relevés.

A1) Helichryso tyrrhenici-Dianthetum sardoi ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 4

Holotypus: rel. 2, hoc loco.

Character species: *Dianthus sardous*.

Structure and synecology: Sparse vegetation (av. cover: 57%), up to 40 cm high, dominated by chamaephytes (weighted av.: 82.0%, Fig. 3), mixed to small hemicryptophytes and therophytes. This association colonized the steep slopes (up to 60°) of dumps deriving from the geologic unit of Gonnesa. The dwelled sites are mainly N-facing, at about 120 m a.s.l., within the upper-thermomediterranean upper-dry bioclimatic unit.

Syndynamism: Remarkably pioneer vegetation, linked to incoherent and unstable dumps. It can be considered a vicariant of Resedo luteolae-Limonietum merxmuelleri (see after) on more coarse and mixed debris.

Distribution: This association exclusively occurs in Iglesiente, and particularly in the mining area of St. Giovanni. In the chorologic spectrum (Fig. 4), the Sardinian endemics are clearly prevailing (weighted av.: 73.8%), followed by the Mediterranean species (12.8%).

A2) Coincyo recurvatae-Helichrysetum microphylli ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 5

Holotypus: rel. 6, hoc loco.

Character species: Coincya monensis subsp. recurvata.

Structure and synecology: Relatively dense vegetation (av. cover: 75%), dominated by chamaephytes (weighted av.: 81.6%, Fig. 3), up to 50 cm high. The coenosis colonizes mining dumps made of small flakes and finer particles, deriving from metamorphic rocks (metaliststones and metasandstones, with interbedded metavolcanites) belonging to the Mt. Orri geologic unit. It requires fresh and shady environmental conditions, within the lower-mesomediterranean lower-subhumid bioclimatic unit, at about 230 m a.s.l.

Syndynamism: This vegetation follows pioneer therophytic communities dominated by *Rumex bucephalophorus* and preludes to nano-

Table 3
Synoptic table of Ptilostemono casabonae-Euphorbion cupanii

Syntaxon nr.	1	2	3	4	5	6	7	8	9	10
Number of relevés	3	5	10	8	7	5	21	13	16	9
Char. association and subassociation										
Dianthus sardous	3	.	.	.	.	.	II	I	.	.
Coincya monensis subsp. *recurvata*	.	V	.	.	.	.	.	.	.	.
Limonium merxmuelleri	.	.	V	V	III	.	.	.	.	.
Echium anchusoides	.	.	.	IV	.	.	.	.	.	.
Iberis integerrima	.	.	.	V	V	III	.	.	.	.
Epipactis tremolsii	.	.	.	II	.	V	I	.	.	.
Santolina insularis	.	.	I	.	.	.	V	V	I	.
Euphorbia dendroides	.	.	.	.	.	.	.	IV	.	.
Polygonum scoparium	.	.	.	.	.	.	.	.	V	V
Char. Ptilostemono casabonae-Euphorbion cupanii										
Helichrysum microphyllum	3	V	V	V	V	V	V	V	V	V
Ptilostemon casabonae	2	V	IV	V	V	V	V	V	II	I
Euphorbia cupanii	2	V	IV	V	III	V	V	V	IV	II
Dipsacus ferox	.	.	.	.	.	III	II	II	II	I
Anagallis monelli	.	.	.	IV	.	.	II	I	.	.
Char. Scrophulario-Helichrysetea italici										
Dittrichia viscosa	3	.	IV	IV	V	III	III	IV	V	III
Scrophularia canina subsp. *bicolor*	.	V	V	IV	I	.	III	.	III	II
Rumex scutatus subsp. *glaucescens*	.	.	.	.	I	.	.	.	V	V
Transgr. Cisto-Lavanduletea										
Cistus eriocephalus	1	.	.	.	III	I	II	I	I	III
Cistus salvifolius	.	.	.	IV	III	.	III	II	II	II
Genista corsica	.	.	.	IV	II	.	I	II	I	.
Lavandula stoechas	.	.	I	.	.	.	I	.	III	V
Stachys glutinosa	.	.	II	.	.	.	.	I	I	I
Teucrium marum	.	.	.	.	.	.	I	I	II	II
Cistus monspeliensis	.	.	.	.	.	.	III	.	IV	III
Linum muelleri	.	.	I	II	.	.	.	.	.	.
Teucrium massiliense	.	.	.	.	.	.	.	.	II	II
Genista valsecchiae	.	.	I	.	.	.	.	.	.	.
Frequent other species										
Reichardia picroides	2	IV	V	V	V	V	III	II	II	V
Daucus carota subsp. *maritimus*	2	I	IV	IV	V	II	V	V	I	II
Dactylis hispanica	3	V	IV	IV	II	IV	IV	III	I	.
Sixalix atropurpurea subsp. *maritima*	3	.	IV	IV	III	V	IV	III	I	.
Oryzopsis miliacea subsp. *miliacea*	3	IV	IV	II	.	III	I	.	II	III
Reseda luteola	3	V	V	V	III	.	II	I	.	.
Carlina corymbosa	.	I	IV	IV	.	.	V	V	III	II
Sanguisorba minor subsp. *muricata*	.	.	I	IV	.	.	III	.	II	.
Urospermum dalechampii	.	.	II	III	II	.	II	II	I	.

1 – Helichryso microphylli-Dianthetum sardoi Table 4
2 – Coincyo recurvatae-Helichrysetum microphylli Table 5
3 – Resedo luteolae-Limonietum merxmuelleri typicum Table 6(a)
4 – Resedo luteolae-Limonietum merxmuelleri iberidetosum integerrimae Table 6 (b)
5 – Ptilostemono casabonae-Iberidetum integerrimae Table 7
6 – Epipactidetum tremolsii Table 8
7 – Euphorbio cupanii-Santolinetum insularis scrophularietosum bicoloris Table 9
8 – Euphorbio cupanii-Santolinetum insularis euphorbietosum dendroidis (After Angiolini & Bacchetta, 2003. Table 3, rel: 18–30)
9 – Polygono scoparii-Helichrysetum microphylli Table 2
10 – Polygono scoparii-Helichrysetum microphylli (after Biondi et al., 1996. Table 1, rel. 2, 5–7, 14, 16, 17, 20, 22)

Table 4
Helichryso microphylli-Dianthetum sardoi ass. nova

Rel. number (with reference to Fig. 2)	1	2	3
Altitude (m a.s.l.)	115	120	120
Exposure	NNE	NNE	ENE
Sloping angle (°)	50	60	45
Plot size (sq. meters)	30	40	20
Plant cover (%)	50	60	60
Mean vegetation height (m)	0,3	0,4	0,3
Char. association			
Dianthus arrosti subsp. *sardous*	3	3	3
Char. Ptilostemono casabonae-Euphorbion cupanii			
Helichrysum microphyllum	1	1	1
Euphorbia cupanii	+	+	.
Ptilostemon casabonae	+	+	.
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici			
Dittrichia viscosa	1	+	+
Other species			
Reseda luteola	1	+	+
Dactylis hispanica	+	+	+
Sixalix atropurpurea subsp. *maritima*	1	+	+
Oryzopsis miliacea subsp. *miliacea*	1	+	+
Rumex bucephalophorus	+	+	+
Ferula communis subsp. *communis*	+	+	.
Geranium purpureum	+	+	.
Asphodelus ramosus subsp. *ramosus* var. *ramosus*	+	+	.
Reichardia picroides	+	+	.
Foeniculum vulgare subsp. *piperitum*	.	+	+
Allium subhirsutum	.	1	+
Centaurium erythraea	+	.	+
Daucus carota subsp. *maritimus*	+	.	+
Cistus eriocephalus	.	+	.
Teucrium flavum subsp. *glaucum*	.	+	.
Clematis cirrhosa	.	+	.
Thapsia garganica	.	+	.
Urginea maritima	.	+	.
Lonicera implexa	+	.	.
Convolvulus cantabrica	.	.	+

Spot and date of relevés: San Giovanni Miniera (Iglesias) 06. 06. 2002

phanerophytic shrublands dominated by *Genista corsica*.

Distribution: This association has been observed in the mining area of Rosas. The Sardinian distribution of *Coincya monensis* subsp. *recurvata* is limited to the SW part of the island, so the Coincyo recurvartae-Helichrysetum tyrrhenici can be considered endemic to Sulcis-Iglesiente. In the chorologic spectrum (Fig. 4), the Tyrrhenian endemics are prevailing (weighted av.: 53.4%), followed by the Mediterranean element (31.8%).

Table 5
Coincyo recurvatae-Helichrysetum microphylli ass. nova

Rel. number (with reference to Fig. 2)	4	5	6	7	8
Altitude (m a.s.l.)	235	230	230	230	230
Exposure	SSW	WSW	WSW	SE	S
Sloping angle (°)	40	45	50	50	60
Plot size (sq. meters)	50	30	20	50	20
Plant cover (%)	70	80	60	80	80
Mean vegetation height (m)	0,5	0,4	0,3	0,5	0,3
Char. association					
Coincya monensis subsp. *recurvata*	1	1	2	+	+
Char. Ptilostemono casabonae-Euphorbion cupanii					
Helichrysum microphyllum	2	3	2	3	4
Euphorbia cupanii	2	1	1	2	+
Ptilostemon casabonae	1	1	+	+	1
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici					
Scrophularia canina subsp. *bicolor*	3	3	2	2	2
Other species					
Reseda luteola	1	1	1	1	+
Dactylis hispanica	+	+	+	+	+
Rumex bucephalophorus	1	2	+	+	1
Oryzopsis miliacea subsp. *miliacea*	+	+	+	1	.
Reichardia picroides	+	+	+	.	+
Jasione montana s.l.	+	+	+	.	+
Daucus carota subsp. *maritimus*	.	.	.	.	+
Carlina corymbosa	.	.	.	.	+
Stipa bromoides	.	.	.	.	+

Spot and date of relevés: Miniere di Rosas (Narcao) 03. 06. 2001

A3) Resedo luteolae-Limonietum merxmuelleri ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 6

Holotypus: rel. 13, hoc loco.

Character species: *Limonium merxmuelleri* and *Reseda luteola*.

Structure and synecology: Association with a relatively dense cover (av.: 70%), quite poor in species. Chamaephytes, and particularly *Limonium merxmuelleri*, dominate the structure of the community (weighted av.: 80.0%, Fig. 3). Hemicryptophytes, even if represented by a relatively high number of species, play a subordinated role (weighted av.: 13.9%). The association, in its typical aspect, dwells mining dumps rich in finer particles, with high concentrations in sulphides and heavy metals. It mainly occurs on sloping sites, at any exposure, between 90 and 150 m a.s.l., between the upper-thermomediterranean upper-dry and the lower-mesomediterranean lower-subhumid bioclimatic units.

Syndynamism: This association represents the first step in the colonization of the most contaminated and incoherent mining dumps. The concentration in heavy metals of the dwelled sites is reported in Table 13. On slopes the most exposed to the rill erosion, this vegetation acts as a permanent community, highlighting the absence of any pedogenetic process.

Distribution: The association exclusively occurs in the mining area of Monteponi (Iglesias), and particularly in the sector of "Fanghi Rossi" (i.e.: "red muds"). The prevailing chorologic element (Fig. 4) is the Sardinian endemic (weighted av.: 48.8%). In spite of the high number of Mediterranean species, they do not

imprint the association, due to their low frequency (av. cover: 26.1%).

Notes: Within the association, in addition to the subass. typicum (rel. 9–18), it is possible to distinguish the subass. iberidetosum integerrimae subass. nova (Holotypus: rel. 21, hoc loco), occurring on older dumps, on relatively more stable slopes formed by coarse carbonatic pebbles. The differential species of the subassociation are: *Iberis integerrima*, *Echium anchusoides* and *Anagallis monelli*. The optimal aspects of this subassociation are found between 220 and 280 m a.s.l., within the lower-mesomediterranean lower-subhumid bioclimatic unit. In this context, the Sardinian endemics are even more prevailing (weighted av.: 61.5%, Fig. 4). The subassociation represents a transitional step towards the Ptilostemono casabonae-Iberidetum integerrimae (see after).

A4) Ptilostemono casabonae-Iberidetum integerrimae ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 7

Holotypus: rel. 29, hoc loco.

Character species: *Iberis integerrima*.

Structure and synecology: Sparse vegetation (av. cover: 60%) up to 20 cm high, dominated by chamaephytes (weighted av.: 87.5%, Fig. 3). It occurs on the stabilized slopes of old dumps, most commonly on north-facing exposures. The colonized substrata are made of gross carbonatic stones. It ranges between 230 and 560 m a.s.l. within the lower-mesomediterranean subhumid bioclimatic unit.

Syndynamism: This association takes the place of Resedo luteolae-Limonietum merxmuelleri on carbonatic substrata, by now consolidated, where the concentration of phytotoxic elements has been reduced by the meteoric agents. The concentration in heavy metals of the dwelled sites is reported in Table 13. The further evolution of the vegetation bring towards phytocoenoses dominated by *Santolina insularis*.

Distribution: This association has been observed in the mining district of Monteponi (Iglesias) and in the areas of Tinny and Arenas (Domusnovas). The main chorologic element (Fig. 4) is the Sardinian endemic (weighted av.: 74.8%), followed by the Tyrrhenian and Mediterranean elements (14.5 and 7.8%, respectively).

Notes: *Iberis integerrima* also occurs in the limestone massifs of central Sardinia, where it colonizes screes and steep, rocky slopes. Therefore, the Ptilostemono casabonae-Iberidetum integerrimae, or a similar vegetation-type, may be also found in the mining districts of that part of the island.

A5) Epipactidetum tremolsii Angiolini, Bacchetta, Brullo, Casti, Giusso & Guarino, ass. nova

Table 8

Holotypus: rel. 37, hoc loco.

Character species: *Epipactis tremolsii*.

Structure and synecology: Very sparse vegetation (av. cover: 13%), up to 40 cm high, dominated by *Epipactis tremolsii*, whose abundance strongly influences the biologic spectrum of the association (Fig. 3), in which the weighted percentage of geophytes counts for 47.9%. It occurs at about 300 m a.s.l., on muddy deposits originating from steep ferrous clay, carved into bad-lands by the rill erosion. The bioclimatic unit is the lower-mesomediterranean lower-subhumid.

Syndynamism: This association is a permanent, highly specialized community, in sites where any dynamic process can be observed in the vegetation.

Distribution: The association was only recorded in the mining area of Barraxiutta (Oridda Valley) and, due to the peculiar edaphic and ecologic conditions, it is probably endemic to this area. *Epipactis tremolsii* together with other W-Mediterranean species, count for the 71% of the weighted chorologic spectrum (Fig. 4).

A6) Euphorbio cupanii-Santolinetum insularis ANGIOLINI & BACCHETTA 2003

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Table 9

Holotypus: Table 3, rel. 5 in ANGIOLINI & BACCHETTA 2003.

Character species: *Santolina insularis.*

Structure and synecology: Glareolus vegetation, up to 80 cm high, dominated by pioneer nanophanerophytes (weighted av.:

Table 6
Resedo luteolae-Limonietum merxmuelleri ass. nova
a. typicum subass. nova
b. iberidetosum integerrimae subass. nova

Rel. Number (with reference in Fig. 2)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Altitude (m a.s.l.)	120	95	145	110	100	115	90	120	125	130	280	285	280	235	230	245	220	220
Exposure	SSE	E	NW	SSW	ENE	S	E	S	SSW	SSW	W	NE	ENE	ENE	NNE	E	NW	WNW
Sloping angle (°)	40	20	60	35	50	45	40	20	30	50	35	45	50	60	40	50	40	20
Plot size (sq. meters)	30	20	20	50	20	20	30	30	40	20	20	40	30	20	30	15	30	10
Plant cover (%)	90	80	80	80	80	80	80	70	80	70	60	50	60	60	70	70	60	50
Mean vegetation height (m)	0,4	0,3	0,2	0,3	0,3	0,5	0,4	0,4	0,3	0,3	0,3	0,2	0,2	0,2	0,3	0,2	0,3	0,2
Subassociation	a	a	a	a	a	a	a	a	a	a	b	b	b	b	b	b	b	b
Char. association																		
Limonium merxmuelleri	3	3	4	3	3	2	4	4	4	4	3	2	4	3	4	4	3	3
Reseda luteola	1	+	+	1	1	1	1	2	1	2	.	+	1	+	1	.	1	+
Char. subass. iberidetosum																		
Iberis integerrima	.	.	.	.	.	.	.	.	.	.	1	1	2	1	+	1	1	2
Anagallis monelli	.	.	.	.	.	.	.	.	.	.	1	+	+	1	1	.	.	+
Echium anchusoides	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	+	.
Char. Ptilostemono casabonae-Euphorbion cupanii																		
Helichrysum microphyllum	1	2	2	3	2	1	1	+	1	+	2	2	1	1	2	2	+	1
Ptilostemon casabonae	.	+	+	1	1	1	+	+	+	.	+	+	+	2	1	1	1	1
Euphorbia cupanii	2	1	1	1	2	+	2	.	.	.	1	1	1	+	1	+	+	+
Epipactis tremolsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici																		
Scrophularia canina subsp. *bicolor*	2	3	.	2	1	3	2	+	2	2	2	1	+	.	+	1	.	+
Dittrichia viscosa	+	+	1	1	1	+	.	+	+	.	.	.	+	+	+	+	1	1
Transgr. Cisto-Lavanduletea																		
Genista corsica	.	.	.	.	.	.	.	.	.	.	+	1	.	+	+	+	.	1
Cistus salvifolius	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	1	1	1
Linum muelleri	.	.	+	.	.	.	.	.	.	.	+	.	.	+	.	.	.	+
Stachys glutinosa	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.
Genista valsecchiae	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lavandula stoechas	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Santolina insularis	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

Other species																		
Reichardia picroides	+	+	+	+	+	1	+	.	+	+	.	+	+	1	+	+	+	+
Carlina corymbosa	1	+	1	+	+	+	1	.	.	.	1	1	+	.	+	1	+	.
Daucus carota subsp. *maritimus*	+	+	+	+	1	2	+	.	.	.	.	+	+	1	+	1	.	.
Sixalix atropurpurea ssp. *maritima*	.	.	1	1	+	+	+	+	+	.	.	.	1	+	1	1	+	.
Dactylis hispanica	+	2	2	+	+	1	1	.	+	.	+	+	.	+	.	1	.	.
Jasione montana s.l.	1	.	+	+	+	.	+	.	.	.	1	1	+	+	+	.	+	.
Oryzopsis miliacea subsp. *miliacea*	1	.	+	1	2	2	+	.	+	.	.	.	.	.	.	.	+	+
Lonicera implexa	+	.	+	+	+	+	.	.	+	+	.	.	.	.	.	.	+	+
Centaurium erythraea	.	.	+	+	.	.	.	.	.	.	.	+	+	+	1	+	.	+
Urospermum dalechampii	.	.	.	+	+	.	.	+	.	.	.	+	+	1	.	+	.	.
Allium subhirsutum	+	+	+	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.
Sanguisorba minor subsp. *muricata*	.	.	+	.	.	.	.	.	.	.	+	.	+	+	+	.	+	.
Bellium bellidioides	.	.	.	.	.	.	.	.	.	.	+	+	1	+	.	.	.	+
Dorycnium pentaphyllum subsp. *suffruticosum*	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	1	+
Smilax aspera	+	+	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+
Lobularia maritima	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	.
Teucrium flavum subsp. *glaucum*	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	+	+
Teucrium capitatum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	1	.	+
Convolvulus cantabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	+
Bituminaria bituminosa	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex bucephalophorus	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Asparagus acutifolius	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Plantago coronopus	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Scorzonera callosa	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.
Lavatera olbia	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hypochaeris achyrophorus	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Glaucium flavum	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Silene vulgaris subsp. *angustifolia*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.

Spot and date of relevés: rel. 9, 10, 12–18: Monteponi (Iglesias) 13. 07. 2000; rel. 11: Agruxiau (Iglesias) 13. 07. 2000; rel. 19–21: Monteponi (Iglesias) 13. 07. 2001; rel. 22–26: P.ta Pitzianti (Fluminimaggiore) 3.09.2000

Table 7
Ptilostemono casabonae-Iberidetum integerrimae ass. nova

Rel. number (with reference to Fig. 2)	27	28	29	30	31	32	33
Altitude (m a.s.l.)	560	560	550	240	230	235	245
Exposure	E	E	NNE	ENE	NE	NE	NNW
Sloping angle (°)	30	35	30	5	10	15	20
Plot size (sq. meters)	10	10	20	5	10	10	10
Plant cover (%)	60	60	70	50	50	60	70
Mean vegetation height (m)	0,1	0,2	0,2	0,1	0,1	0,1	0,1
Char. association							
Iberis integerrima	2	2	3	3	4	4	4
Char. Ptilostemono casabonae-Euphorbion cupanii							
Helichrysum microphyllum	2	2	1	+	1	1	1
Ptilostemon casabonae	+	+	+	+	2	+	+
Euphorbia cupanii	+	+	+	.	+	.	.
Limonium merxmuelleri	.	.	.	1	1	1	2
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici							
Dittrichia viscosa	1	1	+	+	+	+	+
Scrophularia canina subsp. *bicolor*	.	.	1	.	.	.	.
Rumex scutatus subsp. *glaucescens*	.	.	+	.	.	.	.
Transgr. Cisto-Lavanduletea							
Cistus salvifolius	.	.	.	+	+	+	1
Cistus eriocephalus	.	.	.	1	.	+	+
Genista corsica	.	.	.	.	.	+	+
Other species							
Reichardia picroides	+	+	+	+	1	+	+
Daucus carota subsp. *maritimus*	+	+	+	+	+	+	+
Hypochaeris achyrophorus	.	+	+	+	+	+	+
Reseda luteola	+	.	+	.	+	.	+
Blackstonia perfoliata	+	+	+	.	.	.	.
Brachypodium retusum	+	+	+	.	.	.	.
Sixalix atropurpurea subsp. *maritima*	+	.	.	.	+	+	.
Lonicera implexa	.	.	.	.	+	+	+
Convolvulus cantabrica	.	.	.	+	+	.	+
Rumex bucephalophorus	.	.	.	+	.	+	+
Dactylis hispanica	+	+	.	.	.	.	.
Urospermum dalechampii	.	.	.	+	+	.	.
Bellium bellidioides	.	+	.	.	.	.	.
Jasione montana s.l.	.	.	+	.	.	.	.

Spot and date of relevés: Monteponi (Iglesias) 0′) 03. 06. 2001

63.8%), often with a patchy spatial distribution (av. cover: 85%). Scattered hemicryptophytes and therophytes occur among the nanophanerophytes. The association colonizes old mining dumps, mainly on south-facing slopes. It also occurs on the recent alluvial layers of riverbeds, from 100 to 650 m a.s.l., within the thermo- and mesomediterranean subhumid bioclimatic units.

Syndynamism: On coarse mining dumps, it represents the most mature aspect of the pioneer vegetation ascribed to the class Scrophulario-Helichrysetea, and it directly forebode the shrublands belonging to the class Cisto-Lavanduletea. On seldom flooded terraces of riverbeds, it substitutes the Polygono scoparii-Helichrysetum tyrrhenici.

Table 8
Epipactidetum tremolsii ass. nova

Rel. number (with reference to Fig. 2)	34	35	36	37	38
Altitude (m a.s.l.)	315	330	305	310	320
Exposure	E	ENE	E	ENE	E
Sloping angle (°)	40	50	30	45	45
Plot size (sq. meters)	10	50	10	20	20
Plant cover (%)	15	10	10	15	15
Mean vegetation height (m)	0,3	0,3	0,4	0,3	0,4
Char. association					
Epipactis tremolsii	2	2	2	2	1
Char. Ptilostemono casabonae-Euphorbion cupanii					
Euphorbia cupanii	+	1	1	+	+
Ptilostemon casabonae	1	+	+	+	1
Dipsacus ferox	.	+	+	+	.
Iberis integerrima	1	.	.	+	+
Helichrysum microphyllum	+	.	.	.	2
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici					
Dittrichia viscosa	1	+	.	.	+
Other species					
Reichardia picroides	+	+	+	+	+
Sixalix atropurpurea subsp. *maritima*	+	+	1	+	1
Quercus ilex	+	+	+	+	.
Bellium bellidioides	.	+	1	+	+
Crepis bellidifolia	.	+	+	+	+
Dactylis hispanica	1	+	+	.	1
Oryzopsis miliacea subsp. *miliacea*	+	+	.	.	+
Orobanche canescens	+	.	+	.	+
Daucus carota subsp. *maritimus*	+	.	.	.	1
Melica arrecta	.	+	.	.	+
Cistus eriocephalus	.	.	.	.	+
Juniperus oxycedrus subsp. *oxycedrus*	.	.	.	+	.

Spot and date of relevés: Barraxiutta (Domusnovas) 10. 06. 2001

Distribution: This association is endemic to central-southern Sardinia. In Sulcis-Iglesiente it widely spreads in the whole mining district, from the coastal sites up to the inner parts of the Fluminese Territory. It is very frequent on Paleozoic metalliferous limestones, in the area of Marganai-Oridda, next to the mines of Monteponi and St. Giovanni. Less commonly, it also occurs in the mining areas of Acquaresi and Gutturu Cardaxius. The Sardinian endemic element dominates the weighted chorologic spectrum (59.2%).

Notes: On mining dumps, this association is represented by the subass. scrophularietosum bicoloris ANGIOLINI & BACCHETTA 2003, having as differential species *Euphorbia cupanii*, *Scrophularia canina* subsp. *bicolor* and *Melica arrecta.* As already mentioned, the vegetation dominated by *Santolina insularis* represents the most evolved aspect of Scrophulario-Helichrysetea. Such vegetation counts, as well, many character species of the class Cisto-Lavanduletea, so that ANGIOLINI & BACCHETTA (2003) previously included the association at issue within this class. With reference to Fig. 2, the relevés included in the cluster A7 are characterized by the occurrence of *Genista sulcitana*. These aspects bear a noteworthy floristic similarity with the Euphorbio-Santolinetum insularis, and they probably represent the primary

Table 9
Euphorbio cupanii-Santolinetum insularis scrophularietosum bicoloris Angiolini & Bacchetta 2003

Rel. number with reference in Fig. 2	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	56
Altitude (m a.s.l.)	578	580	582	190	525	395	320	320	300	320	320	275	640	320	320	140	585	190
Exposure	WSW	W	/	S	/	ESE	S	S	WSW	NE	NE	E	ENE	S	S	ENE	N	E
Sloping angle (°)	70	5	0	10	5	10	5	5	70	80	80	85	10	60	60	70	70	80
Plot size (sq. meters)	20	40	25	20	80	30	15	15	25	20	20	20	15	15	15	50	30	15
Plant cover (%)	90	80	50	100	90	95	75	80	90	60	70	80	80	85	90	80	60	70
Mean vegetation height (m)	0,5	0,4	0,3	0,8	0,5	0,6	0,5	0,5	0,6	0,6	0,6	0,8	0,4	0,5	0,5	0,5	0,4	0,4
Char. association																		
Santolina insularis	5	4	2	5	4	4	4	4	4	3	3	4	4	4	4	4	3	3
Char. Ptilostemono casabonae-Euphorbion cupanii																		
Euphorbia cupanii	1	1	+	2	1	+	+	1	+	+	+	+	2	+	+	1	2	+
Helichrysum microphyllum	1	2	3	+	2	2	2	2	2	1	1	.	2	2	2	2	1	+
Ptilostemon casabonae	+	+	+	+	.	+	1	1	2	+	+	+	1	2	2	1	1	1
Dipsacus ferox	.	.	.	.	+	+	.	.	1	.	.	.	1	1	1	.	.	.
Anagallis monelli	.	.	.	+	.	.	.	+	.	.	.	.	.	.	1	+	.	1
Epipactis tremolsii	.	.	.	.	.	.	.	+	.	.	1	.	.	.	.	.	.	.
Char. Scrophulario-Helicrysetalia italici and Scrophulario Helichrysetea italici																		
Dittrichia viscosa	.	.	.	+	.	.	1	1	2	.	.	+	1	1	1	2	.	+
Scrophularia canina subsp. *bicolor*	.	1	+	1	1	+	+	.	1	+	.	+	.	1	.	.	+	+
Transgr. Cisto-Lavanduletea																		
Cistus salvifolius	+	2	.	+	.	2	.	.	.	.	.	.	+	.	.	1	+	+
Cistus monspeliensis	+	+	.	1	+	.	.	.	.	.	.	.	+	+	.	.	+	+
Cistus eriocephalus	.	.	.	.	.	.	.	.	.	.	.	2	.	+	.	1	.	+
Lavandula stoechas	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	2
Genista corsica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Other species																		
Carlina corymbosa	+	1	1	+	1	1	+	+	+	1	1	+	+	1	1	1	+	1
Daucus carota subsp. *maritimus*	.	+	.	+	+	1	1	1	+	1	1	+	+	1	1	+	.	+
Sixalix atropurpurea subsp. *maritima*	+	+	1	+	+	.	+	+	.	.	.	+	1	+	+	+	1	1
Dactylis hispanica	.	+	.	+	1	.	1	1	1	1	1	1	1	+	+	1	.	1
Jasione montana s.l.	+	+	1	.	+	1	+	+	.	1	.	.	.	+	+	.	+	.
Sanguisorba minor subsp. *muricata*	+	+	+	.	.	.	.	.	.	+	+	.	+	+	+	.	+	.
Reichardia picroides	+	+	+	.	+	.	.	.	1	.	.	+	.	+	+	.	.	+
Melica arrecta	+	+	+	+	+	.	.	.	+	.	.	1	.	.	.	.	+	+
Rubia peregrina subsp. *peregrina*	.	.	.	+	.	.	.	.	+	+	+	.	.	+	+	+	.	+
Urospermum dalechampii	.	.	.	+	.	.	+	+	+	.	.	.	.	+	+	+	.	.
Silene vulgaris subsp. *angustifolia*	.	+	.	+	+	.	+	.	.	2	.	.	.	.	.	.	+	+
Foeniculum vulgare subsp. *piperitum*	.	.	.	+	.	.	.	.	.	+	+	.	.	+	+	+	.	+
Rubus gr. *ulmifolius*	.	.	.	.	+	+	.	.	+	.	+	.	+	.	.	.	+	.
Sesleria insularis subsp. *morisiana*	+	+	+	.	.	.	.	+	.	.	2	.	.	.	.	.	1	.
Reseda luteola	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	+	+

Vicia sativa subsp. *sativa*	.	.	.	.	.	.	+	+	.	.	.	.	+	+	+	.	.	.
Pistacia lentiscus	.	.	.	.	+	.	+	+	+	.	.	.	.	.	.	.	.	+
Teucrium flavum subsp. *glaucum*	.	1	1	.	+	.	.	.	.	.	+	.	.	.	.	.	1	.
Quercus ilex	.	.	.	.	+	+	.	.	.	.	+	+	.	.	.	.	.	.
Blackstonia perfoliata	.	.	.	.	.	.	+	+	+	.	+	.	.	.	.	.	.	.
Leontodon tuberosus	+	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Dianthus arrosti subsp. *sardous*	1	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Orchis antropophora	.	.	.	.	.	.	.	.	.	+	+	.	.	1	1	.	.	.
Ferula communis subsp. *communis*	.	.	.	+	+	.	.	.	+	.	.	+	.	.	.	.	.	.
Asparagus acutifolius	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+
Linum bienne	.	.	.	.	.	.	+	+	+	.	.	+	.	.	.	.	.	.
Centranthus calcitrapa	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	+	.
Polygala sardoa	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anthyllis vulneraria subsp. *praepropera*	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Orchis mascula subsp. *ichnusae*	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
Micromeria graeca subsp. *graeca*	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.
Verbascum sinuatum	.	.	.	.	+	.	.	.	.	.	.	.	.	+	+	.	.	.
Pyrus spinosa	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	.	.	.
Lathyrus cicera	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.
Oryzopsis miliacea subsp. *miliacea*	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	1	.	.
Dorycnium pentaphyllum subsp. *suffruticosum*	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	2	.	+
Geranium purpureum	.	.	.	+	.	.	.	.	.	.	.	+	+	.	.	.	.	.
Theligonum cynocrambe	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+
Taraxacum officinale	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.
Centaurium erythraea	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	+	.	.
Genista sulcitana	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.
Smilax aspera	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.
Asphodelus ramosus subsp. *ramosus* var. *ramosus*	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Bellium bellidioides	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Allium subhirsutum	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ornithogalum biflorum	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.
Rhamnus alaternus	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.
Tamus communis	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.
Carex distachya	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.
Bituminaria bituminosa	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Galactites tomentosa	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Lobularia maritima	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Phillyrea latifolia	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Serapias parviflora	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Brachypodium retusum	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hypericum perfoliatum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.

Sporadic species: rel. 47: *Avena fatua* (+); rel. 39: *Brachypodium retusum* (+); rel. 50: *Selaginella denticulata* (+), *Hypericum perfoliatum* (+); rel. 58: *Arabis verna* (+); rel. 51: *Ophrys fusca* subsp. *fusca* (+), *Calicotome villosa* (+); rel. 52: *Orobanche canescens* (+); rel. 42: *Vicia bithynica* (+), *Lavatera arborea* (+); rel. 68: *Convolvulus althaeoides* subsp. *althaeoides* (+), *Sonchus oleraceus* (+); rel. 46: *Allium roseum* (+); rel. 53: *Veronica cymbalaria* (+); rel. 54: *Rumex bucephalophorus* (+), *Daphne gnidium* (+), *Bellardia trixago* (+); rel. 49: *Arisarum vulgare* (+), *Euphorbia characias* (+), *Achillea ligustica* (+)

Spot and dates of relevés: rel. 46, 49, 53: Sa Duchessa (Domusnovas), 03. 09. 2000; rel. 54: San Giovanni (Iglesias) 06. 06. 2002; rel 39–45, 47–48, 50–52, 55–56 after Angiolini & Bacchetta 2003

aspects of this community. In this context, the floristic components of Scrophulario-Helichrysetea italici are so equivalent to those of Cisto-Lavanduletea that it is impossible to decide for the most suitable classification. For this reason, the aspects with *Genista sulcitana* are here proposed as a community (Table 10), that highlights the dynamic connection of *Santolina*-vegetation with the shrublands belonging to the class Cisto-Lavanduletea.

Cisto-Lavanduletea BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940

Prodr. Group. Vég. 7:1

Holotypus: Lavanduletalia stoechadis BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940 em. RIVAS-MARTÍNEZ 1968.

Character species in Sardinia: *Cistus salvifolius*, *C. eriocephalus*, *Citynus hypocistis*.

Structure and synecology: Acidophilous shrublands dominated by several *Cistus* species. They range from the thermo- to the supramediterranean bioclimatic belts, with ombrotypes from the upper-semiarid to the upper-subhumid.

Syndynamism: Chiefly secondary vegetation, occurring wherever the frequent burnover and coppicing of the potential vegetation reduced the carrying capacity of the soil, after the erosion of the upper layers.

Distribution: Mediterranean territories.

Lavanduletalia stoechadis BR.-BL. in BR.-BL., MOLINIER & WAGNER 1940

Prodr. Group. Vég. 7: 4 [Ulici-Cistetalia BR.-BL., P.SILVA & ROZEIRA 1964]

Holotypus: Cistion ladaniferi BR.-BL. ex A. & O.BOLÒS 1950.

Character species in Sardinia: *Cistus monspeliensis*, *Lavandula stoechas*.

Structure, synecology, syndynamism and distribution are the same of the class.

Teucrion mari GAMISANS & MURACCIOLE 1985

Ecol. Medit. 10: 186

Holotypus: Stachydi-Genistetum corsicae GAMISANS & MURACCIOLE 1985 Ecol. Medit. 10: 186.

Character species: *Teucrium marum*, *Genista corsica*, *Stachys glutinosa*.

Structure and synecology: Shrublands colonizing stony siliceous or decarbonated substrata. The communities up to now ascribed to this alliance are linked to initial or eroded soils, often in sites where a frequent burnover hampers the evolution of the soil-vegetation system.

On mining dumps, the vegetation belonging to this alliance occurs wherever the abandonment lasted for several decades, so to let a local enrichment in organic matter of the substratum and the washing away of a good fraction of phytotoxic elements. This vegetation differs from the coenoses ascribed to the class Scrophulario-Helichrysetea italici in having a more dense and higher structure, dominated by nanophanerophytes.

Syndynamism: In steep and windy places, the vegetation belonging to this alliance can be permanent, but more often it substitutes acidophilous wooden communities belonging to the class Quercetea ilicis.

Distribution: The alliance is widespread in Sardinia and Corsica.

B1) Dorycnio suffruticosi-Genistetum corsicae ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 11

Holotypus: rel. 65, hoc loco.

Character species: *Genista corsica*, *Dorycnium pentaphyllum* subsp. *suffruticosum*.

Structure and synecology: Dense shrublands (av. cover: 100%), on average 1.6 m high, dominated by *Genista corsica*, together with several *Cistus* species. Nanophanerophytes are largely prevailing (weighted av.: 92.9%, Fig. 3). The association can be found on abandoned, well consolidated mining dumps, where it is possible to recognize traces of the pedogenetic processes in the upper layer. Substrata are mainly made of limestone fragments, but the pH keeps very low, due to the eluviation and oxidation of sulphides and other minerals. The concentration in heavy metals of the dwelled sites is reported in Table 13. Such vegetation prefers north-facing slopes, between 100 and 300 m a.s.l., within the upper-thermomediterranean upper-dry and the lower-mesomediterranean lower-subhumid bioclimatic units.

Table 10
Genista sulcitana-community

Rel.number with reference to Fig. 2)	57	58	59	60	61	62	63
Altitude (m a.s.l.)	640	595	590	600	562	582	647
Exposure	SE	SSW	W	SSE	–	NNO	O
Sloping angle (°)	70	60	5	<5	–	10	70
Plot size (sq. meters)	20	50	30	15	30	25	20
Plant cover (%)	90	70	90	80	100	100	100
Mean vegetation height (m)	0,6	0,5	0,4	0,5	0,7	0,7	0,5
Diff. community							
Genista sulcitana	4	2	1	1	5	5	5
Char. Scrophulario-Helichrysetea italici							
Santolina insularis	1	3	3	4	3	1	1
Helichrysum microphyllum	2	1	2	1	1	2	2
Euphorbia cupanii	+	1	+	+	+	+	1
Ptilostemon casabonae	+	1	+	.	+	+	+
Dittrichia viscosa	+	1	.	+	+	.	+
Dipsacus ferox	.	+	.	.	.	.	+
Iberis integerrima	.	.	.	.	+	.	.
Char. Teucrion mari* and Cisto-Lavanduletea stoechadis							
Cistus salvifolius	2	+	2	+	+	+	2
Cistus eriocephalus	+	+	+	1	2	+	1
Cistus monspeliensis	+	2	2	.	+	.	+
Lavandula stoechas	+	+	1	.	.	+	.
*Genista corsica**	.	.	+	.	+	+	.
*Teucrium marum**	.	.	.	+	.	.	.
Other species							
Carlina corymbosa	+	+	+	1	+	+	+
Sanguisorba minor subsp. *muricata*	+	+	+	1	+	+	+
Arbutus unedo	1	.	+	+	+	+	+
Blackstonia perfoliata	+	+	.	+	+	+	+
Quercus ilex	+	.	+	+	.	+	+
Daucus carota subsp. *maritimus*	+	.	+	+	+	.	+
Scabiosa maritima	.	+	+	+	+	.	+
Dactylis hispanica	.	+	.	+	+	.	1
Rubia peregrina subsp. *peregrina*	+	.	+	+	+	.	.
Rubus gr. *ulmifolius*	+	.	+	.	+	+	.
Smilax aspera	+	+	.	+	.	.	.
Phillyrea latifolia	+	+	.	1	.	.	.
Reichardia picroides	+	+	+	.	.	.	.
Urospermum dalechampii	.	.	+	.	.	+	+
Vicia sativa subsp. *sativa*	+	.	+	.	.	+	.
Brachypodium rupestre	+	.	.	.	+	+	.
Phillyrea angustifolia	.	.	.	.	+	+	.
Serapias parviflora	.	+	+	.	.	.	.
Neotinea maculata	+	.	.	.	.	.	1
Erica arborea	+	.	.	.	.	+	.

Sporadic species: rel. 60: *Reseda luteola* (+) *Orchis mascula* subsp. *ichnusae* (+), *Micromeria graeca* subsp. *graeca* (+), *Orchis antropophora* (+), *Hypericum perfoliatum* (+), *Urospermum picroides* (+), *Teucrium flavum* subsp. *glaucum* (+); rel. 58: *Verbascum sinuatum* (+), *Brachypodium retusum* (+); rel. 59: *Lathyrus ochrus* (+), *Lathyrus cicera* (+), *Leontodon tuberosus* (+), *Cyclamen repandum* (+); rel. 61: *Taraxacum officinale* (+), *Orchis longicornu* (+), *Calicotome villosa* (+); rel. 57: *Smilax aspera* (+), *Phillyrea latifolia* (+), *Reichardia picroides* (+), *Melica arrecta* (+), *Asphodelus ramosus* subsp. *ramosus* var. *ramosus* (+); rel. 62: *Luzula forsteri* (+), *Galium scabrum* (+), *Cytisus villosus* (+), *Geranium purpureum* (+), *Centranthus calcitrapa* (+), *Corynephorus fasciculatus* (+)

Spot and date of relevés: rel. 58, 59, 60 after Angiolini & Bacchetta 2003; rel. 57, 61–62: Arenas (Fluminimaggiore) 26.06.1999; rel. 63: Tinnì (Fluminimaggiore) 27. 04. 1999

Table 11
Dorycnio suffruticosi-Genistetum corsicae ass. nova

Rel. number (with reference to Fig. 2)	63	64	65	66	67
Altitude (m a.s.l.)	205	250	130	255	285
Exposure	SE	ENE	ENE	NNE	WNW
Sloping angle (°)	–	5	5	5	20
Plot size (sq. meters)	20	100	100	50	100
Plant cover (%)	100	100	100	100	100
Mean vegetation height (m)	2,0	1,5	1,5	1,2	1,8
Char. association and Teucrion mari					
Genista corsica	5	5	5	5	5
Dorycnium pentaphyllum susp. *suffruticosum*	.	1	1	1	+
Char. Cisto-Lavanduletea					
Cistus eriocephalus	1	2	+	1	+
Cistus salvifolius	.	1	+	2	+
Cistus monspeliensis	1	+	2	.	.
Lavandula stoechas	+	.	+	.	.
Transgr. Scrophulario-Helichrysetea italici					
Helichrysum microphyllum	+	+	+	+	+
Ptilostemon casabonae	+	.	1	+	+
Euphorbia cupanii	+	.	.	+	+
Scrophularia canina subsp. *bicolor*	.	.	.	+	+
Anagallis monelli	.	.	.	.	+
Other species					
Daucus carota subsp. *maritimus*	+	+	1	+	.
Asparagus acutifolius	1	.	.	+	+
Dactylis hispanica	.	+	+	+	.
Rubia peregrina subsp. *peregrina*	+	.	+	.	.
Pistacia lentiscus	.	.	+	+	.
Carlina corymbosa	+	.	+	.	.
Oryzopsis miliacea subsp. *miliacea*	+	.	+	.	.
Urospermum dalechampii	+	+	.	.	.
Sixalix atropurpurea subsp. *maritima*	+	.	.	.	+
Convolvulus cantabrica	.	+	.	+	.
Reichardia picroides	.	.	.	+	+

Sporadic species: rel. 63: *Lonicera implexa* (+), *Quercus ilex* (+), *Osyris alba* (+), *Ferula communis* subsp. *communis* (+), *Geranium purpureum* (+), *Bituminaria bituminosa* (+), *Orchis antropophora* (+), *Clematis flammula* (+); rel. 65: *Arbutus unedo* (1); rel. 66: *Jasione montana* s.l. (+); rel. 67: *Bellium bellidioides* (+), *Sanguisorba minor* subsp. *muricata* (+); rel. 64: *Blackstonia perfoliata* (+)

Spot and date of relevés: rel. 63: Rio di Monteponi (Iglesias) 29. 04. 1999; rel. 65: S. Giovanni Miniera (Iglesias) 03. 06. 2001; rel. 64, 66, 67: Monteponi (Iglesias) 3. 06. 2001

Syndynamism: This association represents the most evolved stage of the special vegetation series of mining dumps, and it connects such series to the normal climatophilous ones.

Distribution: The association exclusively occurs in SW-Sardinia, and mainly on leached and acidified carbonatic substrata. It has been recorded for several sectors of the mining area of Monteponi. The Mediterranean chorologic element is numerically prevailing (83%), even if, due to the large prevalence of *Genista corsica*, the weighted average of the Sardo-Corsican element counts for the 81.2% in the chorologic spectrum (Fig. 4).

B2) Polygalo sardoae-Linetum muelleri ANGIOLINI, BACCHETTA, BRULLO, CASTI, GIUSSO & GUARINO, ass. nova

Table 12

Holotypus: rel. 72, hoc loco.

Character species: *Linum muelleri*, *Polygala sardoa*, *Galium schmidii*.

Structure and synecology: Relatively dense vegetation (av. cover: 78%), on average 60 cm high, dominated by nanophanerophytes (weighted av.: 38.3%, Fig. 3) and chamaephytes (38%). It occurs in the vicinities of the mines, where it colonizes steep rocky slopes, mainly N-facing, formed by Paleozoic metalliferous limestones. The association ranges between 100 and 240 m a.s.l., within the upper-thermomediterranean upper-dry and the lower-mesomediterranean lower-subhumid bioclimatic units.

Syndynamism: This association is linked to natural habitats, where it represents a permanent community on the steepest rocky slopes. At present time, it also spreads as a consequence of the degradation of climatophilous holm-oak woods.

Distribution: *Linum muelleri* is endemic to Iglesiente. Out of the mining district it is only found on carbonatic screes in the area of Marganai (Domusnovas). The Polygalo sardoae-Linetum muelleri has been recorded for the mining areas of St. Giovanni and Cungiaus. In this association, the weighted percentage of Sardinian and Sardo-Corsican endemics (46.9%) feebly prevails over the Mediterranean element (40.3%, Fig. 4).

5. Conclusions

The vegetation of the mining dumps of Sulcis-Iglesiente, even if characterized by some exclusive species, is quite similar to the glareolus vegetation of non contaminated gravelly substrata, such as riverbeds and screes. Such similarity increases on the most aged dumps, where the meteoric agents reduced the concentration of phytotoxic elements, making the edaphic conditions suitable for species that do not tolerate heavily contaminated substrata. The Teucrion mari communities connect the special vegetation of mining dumps to the normal dynamic series of SW-Sardinia. Indeed, a neat gradient in the concentration of heavy metals is displayed in Table 13: from the most polluted substrata (samples 7–9), colonized by Resedo luteolae-Limonietum merxmuelleri, the concentration values are progressively decreasing on dumps colonized by Ptilostemono casabonae-Iberidetum integerrimae up to reaching the lowest values in the Dorycnio suffruticosi-Genistetum corsicae.

The plant communities presented in this paper largely contribute to the landscape diversity of the studied territories, and host some exclusive taxa, that are the result of a local evolution under the selective pressure of hostile edaphic conditions. Soils with high concentrations of heavy metals are known to force the differentiation of endemic, specialized floras (BROOKS 1987; BAKER et al. 1992; ROBERTS & PROCTOR 1992; CHIARUCCI et al. 1995). The studied dumps represent the last habitat, even if artificial, for these interesting species that have been heavily endangered by a millennial mining activity, that deeply modified the original milieu.

In the mining districts of SW-Sardinia, primary habitats are limited to the areas where the mining activity was not worthy, due to the scarcity of minerals. These contexts are covered by shrublands and woodlands where the interspecific competition disfavours the highly specialized pioneer character species of the Ptilostemono casabonae-Euphorbion cupanii and subordinated syntaxa. Among the species at issue, *Epipactis tremolsii* can be considered a homeless species, being smothered by the human activity from the primary biotopes: this W-Mediterranean orchid is indeed recorded from Sardinia only on from the calamines of Barraxiutta. *Limonium merxmuelleri* is likely to be a neoendemic closely related to *Limonium sulcitanum* ARRIGONI, that probably reached the mining districts from the coastal shipping terminals and whose further evolution was triggered by the peculiar edaphic conditions of mining dumps. *Iberis integerrima, Dianthus sardous, Coincya monensis* subsp. *recurvata* and *Anagallis monellii* still have their primary habitats in rocky sites, where they take part to pioneer communities belonging to the classes Asplenietea trichomanis (BR.-BL. in MEIER and BR.-BL. 1934) OBERDORFER 1977 and Carici-Genistetea lobelii KLEIN 1972.

Table 12
Polygalo sardoae-Linetum muelleri ass. nova

Rel. number (with reference to Fig. 2)	69	70	71	72	73
Altitude (m a.s.l.)	110	100	105	240	235
Exposure	N	NNW	NW	N	NNW
Sloping angle (°)	80	40	50	45	40
Plot size (sq. meters)	20	10	15	10	5
Plant cover (%)	80	80	80	70	80
Mean vegetation height (m)	1,2	0,5	0,6	0,4	0,3
Char. association					
Linum muelleri	2	3	3	3	3
Polygala sardoa	+	+	+	1	+
Galium schmidii	1	1	+	1	+
Char. Teucrion mari* and Cisto-Lavanduletea					
Cistus salvifolius	2	1	2	1	2
Cistus eriocephalus	1	2	2	+	2
*Genista corsica**	4	3	3	.	.
Lavandula stoechas	.	.	.	1	2
*Stachys glutinosa**	.	.	.	2	1
Transgr. Scrophulario-Helichrysetea italici					
Helichrysum microphyllum	1	.	+	1	1
Ptilostemon casabonae	+	+	+	.	+
Euphorbia cupanii	.	+	+	+	1
Dittrichia viscosa	.	+	+	+	+
Transgr. Quercetea ilicis					
Teucrium flavum subsp. *glaucum*	1	1	1	1	1
Rubia peregrina subsp. *peregrina*	1	1	+	1	+
Smilax aspera	+	+	1	.	+
Lonicera implexa	1	+	+	.	.
Osyris alba	.	+	+	.	+
Pulicaria odora	1	.	.	1	+
Daphne gnidium	+	.	1	.	.
Arbutus unedo	.	.	.	+	+
Pistacia lentiscus	.	.	.	+	.
Phillyrea angustifolia	.	.	.	+	.
Other species					
Daucus carota subsp. *maritimus*	1	+	+	+	+
Sixalix atropurpurea subsp. *maritima*	+	1	+	1	+
Eryngium tricuspidatum	2	+	+	+	+
Carlina corymbosa	.	+	+	+	+
Sanguisorba minor subsp. *muricata*	+	+	.	1	+
Anthyllis vulneraria subsp. *praepropera*	.	1	+	2	2
Brachypodium retusum	2	1	2	.	.
Dactylis hispanica	1	1	1	.	.
Allium subhirsutum	+	.	.	1	+
Foeniculum vulgare subsp. *piperitum*	.	+	+	.	.
Leontodon tuberosus	.	+	+	.	.
Orchis antropophora	.	+	+	.	.
Silene vulgaris subsp. *angustifolia*	1	+	.	.	.
Dorycnium pentaphyllum subsp. *suffruticosum*	.	.	.	2	2
Reichardia picroides	.	.	.	+	+
Centaurium erythraea	.	.	.	+	+
Convolvulus cantabrica	.	.	.	+	+

Sporadic species: rel. 70: *Dorycnium hirsutum* (+), *Chamaeleon gummifer* (+); rel. 71: *Jasione montana* s. l.; rel. 69: *Melica arrecta* (2), *Scorzonera callosa* (+); rel. 73: *Blackstonia perfoliata* (+), *Anthyrrhinum majus* subsp. *tortuosum* (+), *Tolpis virgata* (+)

Spot and date of relevés: rel. 69: S. Giovanni Miniera (Iglesias) 11. 06. 1998; rel. 70, 71: S. Giovanni Miniera (Iglesias) 6. VI. 2002; rel. 72–73: Monteponi (Iglesias) 03.06.2001

Table 13
Concentrations of heavy metals in the mining dumps of Monteponi. Samples 1–3: Dorycnio suffruticosi-Genistetum corsicae; samples 4–6: Ptilostemono casabonae-Iberidetum integerrimae; samples 7–9: Resedo luteolae-Limonietum merxmuelleri

Sample nr.	Depth (cm)	Pb (mg/Kg)	Zn (mg/Kg)	Cd (mg/Kg)	Cu (mg/Kg)	Cr (mg/Kg)	CrVI (mg/Kg)	As (mg/Kg)	Hg (mg/Kg)
1	0–30	1495	3263	22	15	17	<2	<5	1.82
	30–60	2069	3502	20	16	16	<2	8	2.30
2	0–30	870	2446	21	14	17	<2	<5	0.67
	30–60	1267	3342	23	13	15	6	<5	1.94
3	0–30	397	3684	29	7	39	4	7	3.39
	30–60	463	3977	29	12	36	6	<5	2.66
Average		**1094**	**3369**	**24**	**13**	**23**	**5**	**–**	**2.13**
4	0–30	5772	14400	102	44	32	<2	17	11.51
	30–60	3628	6386	48	42	53	<2	17	6.79
5	0–30	4444	20480	140	31	17	<2	11	9.45
	30–60	2023	4931	32	22	41	<2	15	3.15
6	0–30	2481	9253	65	15	23	<2	13	4.85
	30–60	1392	4460	29	13	32	<2	11	2.18
Average		**3290**	**9985**	**69**	**28**	**33**	**–**	**14**	**6.32**
7	0–30	9166	43300	202	139	38	6	67	23.23
	30–60	3618	17100	83	62	32	4	26	10.50
8	0–30	3508	15000	63	79	19	2	47	7.62
	30–60	3743	31100	97	417	30	4	253	7.50
9	0–30	577	4900	15	41	40	5	14	0.62
	30–60	6675	50200	224	122	18	2	64	37.42
Average		**4548**	**26933**	**114**	**143**	**30**	**4**	**79**	**14.48**

Santolina corsica, *Helichrysum microphyllum* subsp. *tyrrhenicum*, *Ptilostemon casabonae*, *Echium anchusoides* and *Euphorbia cupanii* have their primary habitats mainly on screes and gravels, from which they widely spread not only on mining dumps, but also in other synanthropic environments, such as road sides and dirts.

Still it remains undetermined whether the Scrophulario-Helichrysetea italici vegetation described in this paper, with the exception of Euphorbio cupanii-Santolinetum insularis, once had natural habitats, where the erosion was so strong to impede the evolution of vegetation, or if the species characterizing the studied plant communities were assembled in other vegetation types, perhaps occurring in steep rocky slopes, like in the case of the Polygalo sardoae-Linetum muelleri. It remains, as well, undetermined, the time-scale of the biological succession on mining dumps. It is likely that, if set aside, the vegetation of mining dumps will sooner or later evolve into a *Quercus ilex* wood.

Further research is urgently needed, in order to ensure the survival of such an important part of the Sardinian biodiversity. The implementation of a model for the correct management of the mining areas of Sulcis-Iglesiente is certainly the main challenge for the recently instituted Geominerary Park of Sardinia.

Taxonomical remarks

Two taxa new to science, occurring in the surveyed vegetation are described here:

1) *Dianthus sardous* BACCHETTA, BRULLO, CASTI & GIUSSO, sp. nova, hoc loco

Differt a Diantho arrostii PRESL foliis planis vel laeviter canaliculatis, 1,5–3,5 mm latis,

4–15 mm longis, inflorescentia 1–4-flora, mucrone squamarum epicalicinorum 1,5–2,5 mm longo, limbo peralorum 8–12 mm lato.

Typus: Sardegna, discariche di S. Giovanni di Bindua (Iglesias), 06. 06. 2002, BACCHETTA, *BRULLO, CASTI & GIUSSO* (holotypus: CAT, isotypi: CAT, CAG, FI).

This species belongs to the group of *Dianthus sylvestris* WULFEN and shows close relationships with *D. arrostii* PRESL, ranging from Sicily to S-Calabria. The latter is characterized by canaliculate leaves 1–2.2 mm wide, 2–7 mm long, 1-flowered inflorescence (rarely 2–3-flowered), epicalyx-scales with mucro 0.5–1 mm long, limb of corolla 12–14 mm wide.

2) *Helichrysum microphyllum* (WILLD.) CAMB. subsp. *tyrrhenicum* BACCHETTA, BRULLO & GIUSSO, subsp. nova, hoc loco

A typo differt foliis laxe revolutis, 1,2–2,0 mm latis, adaxiali lamina foliari prominenti costa praedita, parte centrali squamarum capituli 0,5–1 mm lata, interioribus squamis 3–4 mm longis, corolla 3–4 mm longa, pappo 4 mm longo, achenio 0,6–0,8 mm longo.

Typus: Sardegna, Miniere di San Giovanni Binda (CA), 11. 06. 1998, *BACCHETTA & BRULLO* (holotypus: CAT, isotypi: CAT, CAG, FI).

Helichrysum microphyllum was described by WILLDENOW on a Cretan specimen collected by *TOURNEFORT* (B!). The plants from Crete, which were collected by us in several sites of the island, differ from those of the westmediterranean basin (Sardinia, Corsica and Baleares) in having leaves tightly revolute; leaf blades 1–1.2 mm wide with the adaxial face sulcate, without central rib; coriaceous central part of the capitulum scales 0.2–0.5 mm wide; innermost scales 4–4.5 mm long; corolla 3–3.5 mm long; pappus 3 mm long; achenes 0.8–1.2 mm long.

References

ANGIOLINI, C. & BACCHETTA, G. 2003: Analisi distributiva e studio fitosociologico delle comunità a Santolina insularis (GENNARI ex FIORI) Arrigoni della Sardegna meridionale (Italia). – Fitosociologia **40**(1): 109–127.

ARRIGONI, P. V. 1980: Le piante endemiche della Sardegna: 61–68. – Boll. Soc. Sarda Sci. Nat. **19**: 257–254.

ARRIGONI, P. V. 1983: Aspetti corologici della flora sarda. – Lav. Soc. Ital. Biogeogr. n.s. **8**: 83–109.

BACCHETTA, G. 2000: Flora, vegetazione e paesaggio dei Monti del Sulcis (Sardegna sud-occidentale). – Ancona Univ., Doctoral thesis.

BACCHETTA, G.; BRULLO, S. & SELVI, F. 2000: *Echium anchusoides* (Boraginaceae), a new species from Sardinia (Italy). – Nordic J. Bot. **20**(3): 271–278.

BAKER, A. J. M.; PROCTOR, J. & REEVES, R. D. 1992: The vegetation on ultramafic (serpentine) soils. – Andover, UK.

BIONDI, E.; BALLELLI, M.; ALLEGREZZA, M.; TAFFETANI, F. & FRANCALANCIA, C. 1994: La vegetazione delle fiumare del versante ionico lucanocalabro. – Fitosociologia **27**: 51–66.

BIONDI, E.; VAGGE, I.; FOGU, C. & MOSSA, L. 1996: La vegetazione del letto ciottoloso dei fiumi della Sardegna meridionale (Italia). – Coll. Phytosoc. **24**: 813–825.

BROOKS, R. R. 1987: Serpentine and its vegetation. A multidisciplinary approach. – Portland.

BRULLO, S. 1984: Contributo alla conoscenza della vegetazione delle Madonie (Sicilia settentrionale). – Boll. Acc. Gioenia Sci. Nat. **16**(322): 351–420.

BRULLO, S.; GRILLO, M. & GUGLIELMO, A. 1998: Considerazioni fitogeografiche sulla flora iblea. – Boll. Acc. Gioenia Sci. Nat. **29**(352): 45–111.

BRULLO, S.; SCELSI, F. & SPAMPINATO, G. 1998: Considerazioni sintassonomiche sulla vegetazione perenne pioniera dei substrati incoerenti dell'Italia meridionale e Sicilia. – Itinera Geobot. **11**: 403–424.

BRULLO, S. & SPAMPINATO, G. 1990: La vegetazione dei corsi d'acqua della Sicilia. – Boll. Acc. Gioenia Sci. Nat. **23**(336): 119–252.

CARMIGNANI, L. 2001: Geologia della Sardegna. Note illustrative della Carta Geologica della Sardegna a scala 1:200.000. – Memorie descrittive della Carta Geologica d'Italia **60**: 1–283.

CHIARUCCI, A.; FOGGI, B. & SELVI, F. 1995: Garigue plant communities of ultramafic outcrops of Tuscany (Italy). – Webbia **49**: 179–192.

CIDU, R.; BIAGINI, C.; FANFANI, L.; LA RUFFA, G. & MARRAS, I. 2001: Mine closure at Monteponi (Italy): Effect of the cessation of dewatering on the quality of shallow groundwater. – Appl. Geochemistry **16**: 489–502.

DI GREGORIO, F. & MASSOLI-NOVELLI, R. 1988: Impatto ambientale delle attività minerarie in Sardegna. – Boll. Soc. Sarda Sci. Nat. **26**: 17–42.

ERBEN, M. 1980: Eine neue *Limonium*-Art aus dem Inneren Südwest-Sardiniens. – Mitt. Bot. Staatssamml. München **16**: 1–5.

MAZZOLENI, S.; RICCIARDI, M. & APRILE, G. G. 1989: Aspetti pionieri della vegetazione del Vesuvio. – Ann. Bot. (Roma) **47**(6): 97–110.

MEZZOLANI, S. & SIMONCINI, A. 2001: Storia, Paesaggi, Architetture. Il Parco Geominerario della Sardegna. – Sardegna da Salvare **13**: 1–430.

NOEST, V.; VAN DER MAAREL, E.; VAN DER MEULTEN, F. & VAN DER LOAN, D. 1989: Optimum-transformation of plant species cover abundance values. – Vegetatio **83**: 167–178.

PIGNATTI, S. 1982: Flora d'Italia, vol. 1–3. – Bologna.

PODANI, J. 1997: SYN-TAX 5.10-pc. – Budapest.

RIVAS-MARTÍNEZ, S.; SÁNCHEZ-MATA, D. & COSTA, M. 1999: North American boreal and western temperate forest vegetation (Syntaxonomical synopsis of the potential natural plant communities of North America, II). – Itinera Geobot. **12**: 5–316.

RIVAS-MARTÍNEZ, S.; FERNÁNDEZ-GONZÁLEZ, F.; LOIDI, J.; LOUSÃ, M. & PENAS, Á. 2001: Syntaxonomical checklist of vascular plant communities of Spain and Portugal to association level. – Itinera Geobot. **14**: 5–341.

RIVAS-MARTÍNEZ, S.; DÍAZ, T. E.; IZCO, J.; FERNÁNDEZ-GONZÁLEZ, F.; LOIDI, J.; LOUSÃ, M. & PENAS, Á. 2002: Vascular plant communities of Spain and Portugal. Addenda to the syntaxonomical checklist of 2001. – Itinera Geobot. **15**(1, 2): 5–922.

ROBERTS, B. A. & PROCTOR, J. 1992: The ecology of areas with serpentinized rocks. A world view. – Geobotany **17**: 1–440.

VAN DER MAAREL, E. 1979: Transformation of cover-abundance values in phytosociology and its effects on community similarity. – Vegetatio **39**: 97–114.

VALSECCHI, F. 1986: Le piante endemiche della Sardegna: 188–189. – Boll. Soc. Sarda Sci. Nat. **25**: 193–202.

WEBER, H. E.; MORAVEC, J. & THEURILLAT, J. P. 2000: International code of phytosociological nomenclature. 3rd ed. – J. Veg. Sci. **11**: 739–768.

Appendix

Taxonomic nomenclature, chorologic groups, life and growth forms of the observed taxa

Sa: Sardinia; Co: Corsica; Si: Sicily; TA: Tuscan Archipelago; Bl: Balearic Islands; H: Iles d'Hyère; Itc: Central Italy

Achillea ligustica ALL.	H scap	Circum-Medit.
Allium roseum L.	G bulb	Circum-Medit.
Allium subhirsutum L.	G bulb	Circum-Medit.
Allium triquetrum L.	G bulb	W-Medit.
Anagallis monelli L.	H scap	S-Medit.
Andryala integrifolia L.	T scap	W-Medit.
Anthyllis vulneraria L. subsp. *praepropera* (KERNER) BORNM.	H bienn	Circum-Medit.
Antirrhinum majus L. subsp. *tortuosum* (BOSC) ROUY	Ch suffr	S-Medit.
Arabis verna (L.) R.BR.	T scap	Circum-Medit.
Arbutus unedo L.	P	Circum-Medit.
Arisarum vulgare TARG.-TOZZ.	G rhiz	Circum-Medit.
Asparagus acutifolius L.	NP	Circum-Medit.
Asphodelus fistulosus L.	H scap	Circum-Medit.
Asphodelus ramosus L. subsp. *ramosus* var. *ramosus*	G rhiz	Circum-Medit.
Avena fatua L.	T scap	Cosmop.
Bellardia trixago (L.) ALL.	T scap	Circum-Medit.
Bellium bellidioides L.	H ros	Sa-Co-Bl-Endem.
Biserrula pelecinus L.	T scap	Circum-Medit.
Bituminaria bituminosa (L.) STIRTON	H scap	Circum-Medit.
Blackstonia perfoliata (L.) HUDSON	T scap	Euro-Medit.
Borago officinalis L.	T scap	Circum-Medit.
Brachypodium retusum (PERS.) BEAUV.	H caesp	Circum-Medit.
Brachypodium rupestre (HOST) ROEM. & SCHULT.	H caesp	Circum-Medit.
Calamintha nepeta (L.) SAVI subsp. *glandulosa* (REQ.) P.W.BALL	H scap	Sa-Co-Endem.
Calicotome villosa (POIR.) LINK	NP	Circum-Medit.
Carex distachya DESF.	H caesp	Circum-Medit.

Carlina corymbosa L.	H scap	Circum-Medit.
Centaurium erythraea RAFN	T scap	Euro-Medit.
Centranthus calcitrapa (L.) DC.	T scap	Circum-Medit.
Chamaeleon gummifer (L.) CASS.	H ros	S-Medit.
Cistus eriocephalus VIV.	NP	Circum-Medit.
Cistus monspeliensis L.	NP	Circum-Medit.
Cistus salvifolius L.	NP	Medit.-Irano-Turan.
Clematis cirrhosa L.	NP	Circum-Medit.
Clematis flammula L.	NP	Medit.-Irano-Turan.
Clematis vitalba L.	P	Euro-Medit.
Coincya monensis (L.) GREUTER & BURDET subsp. *recurvata* (ALL.) LEADLAY	H scap	Sa-Co-endem.
Convolvulus althaeoides L. subsp. *althaeoides*	H scand	Circum-Medit.
Convolvulus cantabrica L.	H scap	Euro-Medit.
Corynephorus fasciculatus BOISS. & REUTER	T scap	W-Medit.
Crepis bellidifolia LOISEL.	H caesp	Sa-Co-TA-Itc-Endem.
Cyclamen repandum SIBTH. & SM.	G bulb	W-Medit.
Cytinus hypocistis (L.) L.	Mmm	mmm
Cytisus villosus POURR.	NP	Circum-Medit.
Dactylis hispanica ROTH	H caesp	Circum-Medit.
Daphne gnidium L.	NP	Circum-Medit.
Daucus carota L. subsp. *maritimus* (LAM.) BATT.	H bienn	W-Medit.
Dianthus sardous BACCHETTA, BRULLO, CASTI & GIUSSO	Ch suffr	Sa-Endem.
Dipsacus ferox LOISEL.	H bienn	Sa-Co-Endem.
Dittrichia viscosa (L.) GREUTER	Ch suffr	W-Medit.
Dorycnium hirsutum (L.) SER.	Ch suffr	Circum-Medit.
Dorycnium pentaphyllum SCOP. subsp. *suffruticosum* (VILL.) ROUY	Ch suffr.	W-Medit.
Echium anchusoides BACCHETTA, BRULLO & SELVI	H ros	Sa-Endem.
Echium vulgare L.	H bienn	Europ.
Epipactis tremolsii Pau	G rhiz	W-Medit.
Erica arborea L.	P	Medit.-Trop.
Eryngium tricuspidatum L.	H scap	S-W-Medit.
Euphorbia characias L.	NP	Circum-Medit.
Euphorbia cupanii GUSS. ex BERTOL.	Ch suffr	Sa-Co-Si-Endem.
Ferula communis L. subsp. *communis*	H scap	Circum-Medit.
Foeniculum vulgare L. subsp. *piperitum* (UCRIA) COUTINHO	H scap	Circum-Medit.
Galactites tomentosa MOENCH	T scap	Circum-Medit.
Galium scabrum L.	H scap	W-Medit.
Galium schmidii ARRIGONI	H scap	Sa-Endem.
Galium verrucosum HUDSON	T scap	Circum-Medit.
Genista corsica (LOISEL.) DC.	NP	Sa-Co-Endem.
Genista sulcitana VALS.	NP	Sa-Endem.
Genista valsecchiae BRULLO & DE MARCO	NP	Sa-Endem.
Geranium purpureum L.	T scap	Paleotemp.
Glaucium flavum CRANTZ	H scap	Circumbor.
Helichrysum microphyllum (WILLD.) CAMB. subsp. *tyrrhenicum* BACCHETTA, BRULLO & GIUSSO	Ch suffr	Sa-Co-Bl-Endem.
Hyparrhenia hirta L. subsp. *hirta*	H caesp	Medit.-Trop.
Hypericum perfoliatum L.	H scap	Circum-Medit.
Hypochaeris achyrophorus L.	T scap	Circum-Medit.
Iberis integerrima MORIS	Ch suffr	Sa-Endem.
Jasione montana s.l.	H bienn	Euro-Medit.
Juniperus oxycedrus L. subsp. *oxycedrus*	P	Medit.-Irano-Turan.
Lathyrus aphaca L.	T scap	Euro-Medit.
Lathyrus cicera L.	T scap	Circum-Medit.
Lathyrus ochrus (L.) DC.	T scap	Circum-Medit.
Lavandula stoechas L.	Ch frut	Circum-Medit.

Lavatera arborea L.	H bienn	Circum-Medit.
Lavatera olbia L.	NP	W-Medit.
Leontodon tuberosus L.	G bulb	Circum-Medit.
Limonium merxmuelleri ERBEN	Ch suffr	Sa-Endem.
Linum bienne MILL.	T scap	Medit.-Atl.
Linum muelleri MORIS	Ch suffr	Sa-Endem.
Lobularia maritima (L.) DESV.	H caesp	Circum-Medit.
Lonicera implexa AITON	NP	Circum-Medit.
Lotus corniculatus L.	H scap	Paleotemp.
Luzula forsteri (SM.) DC.	H caesp	Euro-Medit.
Melica arrecta KUNTZE	H caesp	Circum-Medit.
Mentha pulegium L.	H scap	Euro-Medit.-Irano-
Mercurialis annua L.	T scap	Paleotemp.
Micromeria graeca (L.) BENTH. subsp. *graeca*	Ch suffr	Circum-Medit.
Misopates orontium (L.) RAFIN.	T scap	Paleotemp.
Nerium oleander L.	P	Circum-Medit.
Oenanthe pimpinelloides L.	H scap	Medit.-Atl.
Olea europaea L. var. *sylvestris* BROT.	P	Circum-Medit.
Ophrys fusca LINK subsp. *fusca*	G bulb	Circum-Medit.
Orchis anhtropophora (L.) ALL.	G bulb	Medit.-Atl.
Orchis intacta LINK	G bulb	Medit.-Atl.
Orchis longicornu POIR.	G bulb	W-Medit.
Orchis mascula (L.) L. subsp. *ichnusae* CORRIAS	G bulb	Sa-Endem.
Ornithogalum biflorum JORD. & FOURR.	G bulb	Sa-Endem.
Orobanche canescens C.PRESL	T par	W-Medit.
Orobanche purpurea JACQ.	T par	Europ.
Oryzopsis miliacea (L.) ASCH. & SCHWEINF. subsp. *miliacea*	H caesp	Medit.-Irano-Turan.
Osyris alba L.	NP	Circum-Medit.
Oxalis pes-caprae L.	G bulb	Adventitious
Phillyrea angustifolia L.	P	Circum-Medit.
Phillyrea latifolia L.	P	Circum-Medit.
Pistacia lentiscus L.	P	Circum-Medit.
Plantago coronopus L.	H ros	Paleotemp.
Polygala sardoa CHODAT	H scap	Sa-Endem.
Polygonum scoparium REQ. ex LOISEL.	Ch suffr	Sa-Co-Endem.
Prasium majus L.	NP	Circum-Medit.
Ptilostemon casabonae (L.) GREUTER	H scap	Sa-Co-TA-Endem.
Pulicaria odora (L.) RCHB.	H scap	Circum-Medit.
Pyrus spinosa FORSSK.	P	Circum-Medit.
Quercus ilex L.	P	Circum-Medit.
Reichardia picroides (L.) ROTH	H scap	Circum-Medit.
Reseda luteola L.	T scap	Euro-Medit.
Rhamnus alaternus L.	P	Circum-Medit.
Rubia peregrina L. subsp. *peregrina*	NP	Circum-Medit.
Rubus ulmifolius SCHOTT	NP	Euro-Medit.
Rumex bucephalophorus L.	T scap	Medit.-Irano-Turan.
Rumex scutatus L. subsp. *glaucescens* (GUSS.) BRULLO, SCELSI & SPAMPINATO	Ch suffr	Centre- Medit.
Sanguisorba minor SCOP. subsp. *muricata* (GREMLI) BRIQ.	H scap	Circum-Medit.
Santolina insularis (GENNARI ex FIORI) ARRIGONI	NP	Sa-Endem.
Scirpoides holoschoenus (L.) SOJÁK subsp. *holoschoenus*	G rhiz	Euro-Medit.
Scorzonera callosa MORIS	H ros	Sa-Endem.
Scrophularia canina L. subsp. *bicolor* (SIBTH. & SM.) GREUTER	Ch suffr	Centre-Medit.
Sedum sediforme (JACQ.) PAU	Ch succ	Circum-Medit.
Selaginella denticulata (L.) SPRING	H rept	Circum-Medit.
Serapias parviflora PARL.	G bulb	Circum-Medit.
Sesleria insularis SOMMIER subsp. *morisiana* ARRIGONI	H caesp	Sa-Endem.
Silene vulgaris (MOENCH) GARCKE subsp. *angustifolia* HAYEK	H scap	Circum-Medit.

Sixalix atropurpurea (L.) GREUTER& BURDET subsp. *maritima* GREUTER & BURDET	H bienn	Circum-Medit.
Smilax aspera L.	NP	Circum-Medit.
Sonchus oleraceus L.	T scap	Subcosmop.
Stachys glutinosa L.	Ch frut	Sa-Co-TA-Endem.
Stipa bromoides (L.) DÖRFL.	H caesp	Circum-Medit.
Tamus communis L.	G rad	Medit.-Atl.
Taraxacum officinale WEBER	H ros	Circumbor.
Teucrium capitatum L.	Ch suffr	Circum-Medit.
Teucrium flavum L. subsp. *glaucum* (JORDAN & FOURR.) RONN.	Ch frut	Circum-Medit.
Teucrium marum L.	Ch suffr	Sa-Co-TA-Bl-H-
Teucrium massiliense L.	Ch suffr	W-Medit.
Thapsia garganica L.	H scap	Circum-Medit.
Theligonum cynocrambe L.	T scap	Circum-Medit.
Thymelaea hirsuta (L.) ENDL.	NP	Circum-Medit.
Tolpis virgata (DESF.) BERTOL.	H scap	Circum-Medit.
Urginea maritima (L.) BAKER	G bulb	Circum-Medit.
Urospermum dalechampii (L.) SCOP. ex F.W.SCHMIDT	H ros	Circum-Medit.
Urospermum picroides (L.) SCOP.	T scap	Circum-Medit.
Verbascum sinuatum L.	H bienn	Circum-Medit.
Veronica cymbalaria BODARD	T scap	Circum-Medit.
Vicia bithynica (L.) L.	T scap	Circum-Medit.
Vicia hybrida L.	T scap	Circum-Medit.
Vicia sativa L. subsp. *sativa*	T scap	Subcosmop.

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Manuscript received: November 29th, 2004/revised version March 30th, 2005.