THE VEGETATION ON THE BADLANDS OF "VARICOLORI" CLAYS IN THE MOLISE REGION (ITALY) - FRAMEWORK AND INTERPRETATION

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ABSTRACT - Vegetation on badlands on "varicolori" clays of Molise is studied. This vegetation is distributed in different sectors of the badland profile according to the prevalence of erosion or deposition: 1) the top of badland is usually flat and cultivated; 2) the stable but most intensively eroded zone is colonised by *Poo bulbosae-Camphorosmetum* ass. nova.; 3) the zone of accumulation of fine material is colonised by therophytic communities; 4) the zone of accumulation of landslides is colonised by *Cardopatetum corymbosi*; 5) in the same zone, but in more anthropized and humid sectors develops *Cynaro-Elytrigietum*. A discussion of phytogeographical features of badlands vegetation of Molise and nearby regions follows.

KEY WORDS – Badland, Camphorosmetum, Cardopatetum, Frankenion, Peganion, Agropyretea

INTRODUCTION

Molise (Fig. 1) is very rich in landslips and accelerated erosion, due to a powerful cover of clays all over the main river valleys: the "varicolori" (Miocenic chaotic complex) and the grey Pliocenic clays, with an altitudinal range up to 1000 m a.s.l. The morphology of badlands is very rough, and sharp slopes are a characteristic of this region. The badland flora and vegetation of Italy is rich in peculiar species, such as *Camphorosma monspeliaca*, *Cardopatum corymbosum*, etc. (Fig. 2). Since it is not suitable for agronomic exploitation this habitat has not been altered much and appears as large spots of natural biotopes in an anthropized landscape (crops). For that reason, it has become the object of study of many authors, also interested in setting up a model of correlation between vegetation and geomorphology (Biondi *et al.*, 1992), but they have dealt insofar only with the grey Pliocenic, not the "varicolori" clays.

Fig. 1 - Position of Molise region in Italy

CLIMATE

Details on climate can be found in Lucchese (1995), Lucchese & Paura (1996). Climate in the stations near to the study area can be referred to the Mediterranean macroclimate (mesomediterranean and superior-hilly type). The average yearly temperatures of Palata station (521 m asl) are 14,30 °C with 640 mm rainfall. There is a drought period from June to August. The climate is rather continental, with frequent and long snowfalls in winter; accordingly, strict Mediterranean species grow only along the coast (*Myrtus communis* and *Erica multiflora*), whereas only relatively cold-tolerant Mediterranean species can grow inland (*Phillyrea latifolia*, *Rhamnus alaternus*, *Pistacia lentiscus*). Due to such continental climate, species with Balcanic or eastern Mediterranean distribution are very representative of the flora of Molise (*Camphorosma monspeliaca, Cardopatum corymbosum, Catananche lutea*).

VEGETATION

Since 1988, 49 phytosociological relevés have been carried out using the Pignatti scale. These have been processed with the TWINSPAN software in order to emphasize the similarities and relationships among the types, as can be seen from the structured table (Tab. 1). Nomenclature follows Flora d'Italia (Pignatti, 1982).

A preliminar research (Fanelli & Lucchese, 1994), comparing the badlands vegetation of Molise with that of neighbouring areas, demonstrates that they belong to similar types, described from Basilicata, Calabria (Biondi et al.,1992; Brullo et al., 1990; Corbetta et al., 1991; Gentile & Di Benedetto, 1961) and Abruzzo (Biondi et al.,1990; Pirone, 1995). The situation in the upper part of Puglia, bordering Molise, is unknown. In this study some previously described associations are recognized, while populations of *Camphorosma monspeliaca* are referred to a different association.

PARAPHOLIDO STRIGOSAE-HORDEETUM MARINI Gehu & De Foucault 1977 hainardietosum Biondi & al. 1990 nomen corrigendum

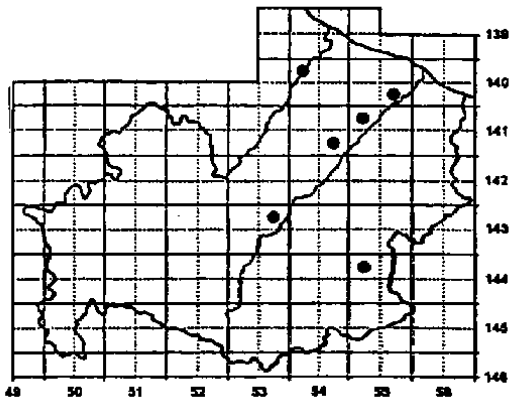
Therophytes often occur together with perennial species, so that they can be found in most of our relevés. Nonetheless, populations composed only by therophytes, mostly *Gramineae* (*Parapholis, Hainardia, Hordeum, Aegilops*), are found where fine, clayey materials pile up after erosion. *Geropogon glaber*, *Plantago psyllium*, *Scorpiurus muricatus*, *Hedypnois cretica*, *Catananche lutea*, *Senecio delphinifolius* distinguish this community from those described in literature. Possibly under higher nitrogen availability *Hordeetum marini* becomes richer in species belonging to syntaxa with more thermophilous and southern distribution (cfr. *Carthametalia lanati* Brullo 1985 and *Dauco-Catananchion* Brullo 1985).

In the structured table (Tab. 1) the species of subhalophilous therophytes of *Frankenietalia pulverulentae* form an obvious group, partially associated with *Camphorosma monspeliaca* and *Poa bulbosa*. In the field they are often found in mosaic with the populations of these two perennial species. These therophytes disappear in the basal zone of deposition colonized by *Cardopatum corymbosum* or *Cynara cardunculus*, where more common, often invasive annuals are present.

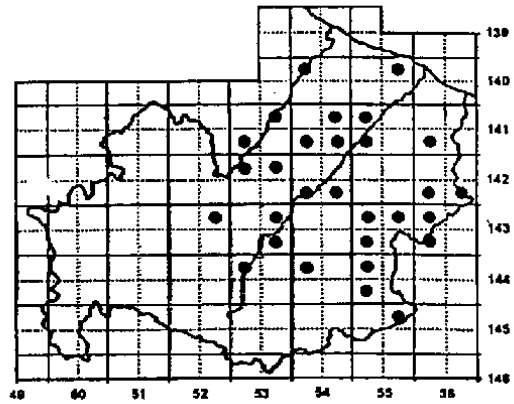
It is necessary to point out that in Molise badlands the species misnamed *Parapholis strigosa* (according to the systematics proposed in Flora d'Italia) is actually *Parapholis pycnantha* (Lucchese, 1996). The same is possibly true in southern Abruzzo, where *Parapholis strigosa* is reported as character species of *Parapholiso strigosae-Hordeetum marini* (Biondi et al,. 1990). This association, described from the coasts of northern France, probably doesn't occur in Central Italian badlands. The question deserves further study. It is likely that more therophyte communities should be described, since *Parapholis incurva* tends to prevail in the dryest stations, while *Parapholis pycnantha* is found in little more humid areas with higher vegetation cover.

PODOSPERMO LACINIATAE-CARDOPATETUM CORYMBOSI Biondi et al. 1990

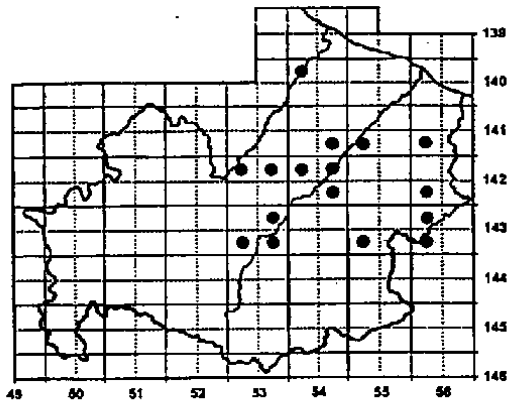
Although *Podospermo laciniatae-Cardopatetum corymbosi* often occurs in contact with *Parapholido-Hordeetum*, these two associations are not successionally related. In fact *Hordeetum marini* is unable to modify effectively the substratum, due to small biomass and ephemeral life-form of dominant species. According to our



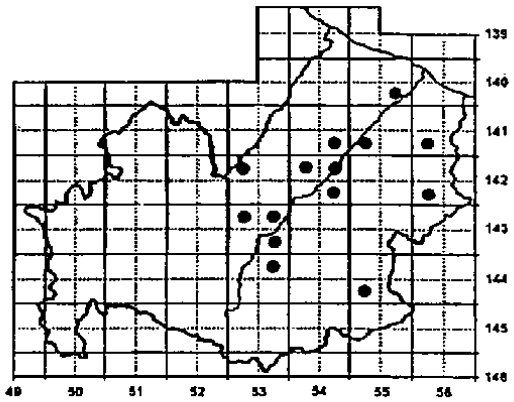
CAMPHOROSMA MONSPELIACA L.



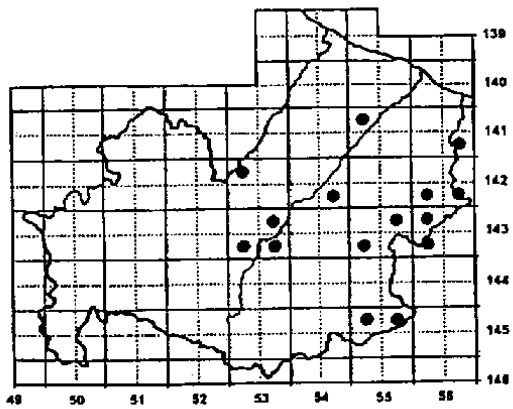
CARDOPATUM CORYMBOSUM (L.) PERS.



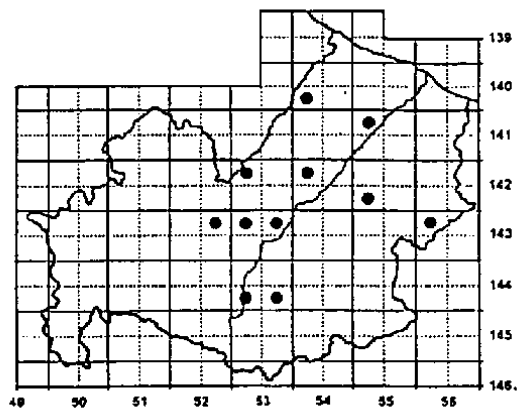
CATANANCHE LUTEA L. SUBSP. LUTEA



SCRIPARIA CAPITATA (L.) DESF.



MANTISALCA DURIAEI (SPACH) BRIQ. & CAVI



ONONIS OLIGOPHYLLA TEN.

Fig. 2 - Distribution of a few badland species in Molise according to Central European Flora grid

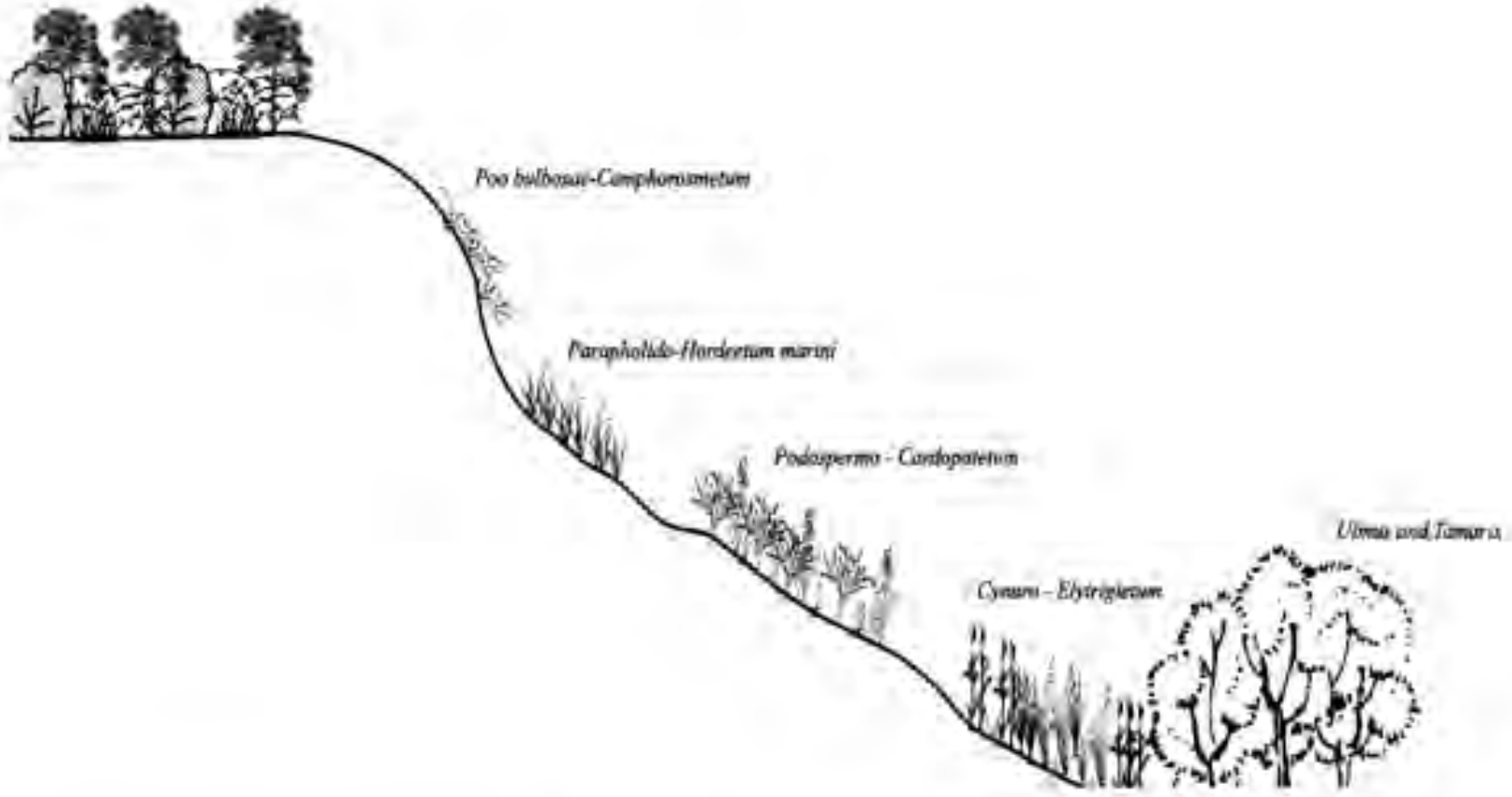


Fig. 3 - Schematic transect of badland vegetation in Molise

model the clayey depositions typically colonized by therophytes tend to glide gradually, with a consequent sedimentation downwards in a steadier position where also rough materials pile up. This chaotic but stable substratum enhances the growth of biennials and of species with long tapering roots: among them, *Podospermum laciniatum* and *Cardopatum corymbosum*. The presence of a few nitrophilous species confirms a relationship with the pioneer grassland associations of *Agropyretalia repentis* Oberd. 1969, as proposed by Pirone (1995) in opposition to previous classification (Ferrari et Gerdol, 1987; Biondi et al., 1990) in *Festuco-Puccinellietea* (halo-hygrophilous Central European vegetation dominated by perennials). It should be pointed out that in Molise some southern species lacking in Abruzzo are present, like *Mantisalca duriaei* and *Hedysarum glomeratum*.

CYNARO CARDUNCULI-ELYTRIGIETUM ATHERICAE (Pirone 1981) Ferrari & Gerdol 1987

This association is located lower than the former one, on wetter and less halophilous substratum. Tuft-forming species are also found, like *Dactylis hispanica*, which tend to get the substratum richer in humus. *Cynara cardunculus*, present also northwards in Abruzzo (Pirone, 1981), is a thermophilous species unable to tolerate low temperatures.

In the structured table (Tab. 1) the association with *Cynara cardunculus* is distinguished from a large group of ruderal species, enhanced by intensive sheep pasture at the base of the badlands. Under this disturbance regime *Cynara cardunculus* reaches high cover and forms compact populations.

POO BULBOSAE-CAMPHOROSMETUM MONSPELIACAE Fanelli & Lucchese ass. nova (holotypus, rel. 5)

Camphorosma monspeliaca and *Poa bulbosa* are the only perennials growing on the steepest slopes over strongly eroded clays, the most difficult habitat to colonise. In some cases *Camphorosma monspeliaca* occurs together with *Cardopatum corymbosum* on more developed substrata, where it competes poorly with other perennials because of its creeping growth form. In the structured table these two perennial species - together with *Bromus molliformis* and an annual form with little divided leaves of *Plantago coronopus* (*P. weldenii*) - form a distinctive group, partially overlapping on that of *Cardopatetum corymbosi*. It is thus possible to distinguish a core of relevés, where *Camphorosma monspeliaca* grows alone and *Anacyclus tomentosus* is abundant, and transitional relevés where *Camphorosma* and *Cardopatum* are growing together.

Due to its floristic impoverishment this association is of difficult syntaxonomical classification. It is possibly an extrazonal expression of *Pegano-Salsoletea*, a southern syntaxon here in its northern limit.

SYNTAXONOMICAL SCHEME

SAGINETEA MARITIMAE Westhoff, V.Leuuw., Adriani 1961
FRANKENIETALIA PULVERULENTAE Rivas-Mart. in Rivas-Mart. & Costa 1976
FRANKENION PULVERULENTAE Rivas-Mart. & Costa 1976
Parapholido strigosae-Hordeetum marini Géhu & De Foucault 1977
hainardietosum Biondi et al. 1990 nomen corrigendum

PEGANO-SALSOLETEA Br.-Bl. & O.Bolos 1957?
SALSOLO-PEGANETALIA Br.-Bl. & O.Bolos 1957?
SALSOLO-PEGANION Br.-Bl. & O. Bolos 1957?
Poo bulbosae-Camphorosmetum monspeliacae Fanelli & Lucchese ass.nova

AGROPYRETEA INTERMEDII-REPENTIS Oberd et al. 1967
AGROPYRETALIA REPENTIS Oberd 1969
PODOSPERMO LACINIATI-ELYTRIGION ATHERICAE Pirone 1995
Podospermo laciniati-Cardopatetum corymbosi Biondi et al. 1990
Cynaro-cardunculi-Elytrigietum athericae (Pirone 1981) Ferrari & Gerdol 1987

MODEL OF BADLANDS VEGETATION

In order to understand the ecology and dynamics of badlands vegetation a schematic model (Fig. 3) is proposed, illustrating different belts of erosion and deposition.

In the upper belt the erosion is continuous but the substratum is never removed or submerged, which helps this sector to become a stable base for a slow colonisation of mostly perennial plants. This sector is very dry in summer and, in more southern regions, where rainfalls are insufficient, it is likely to become completely barren (cfr. Corbetta et al., 1991).

Because of the transportation of fine material and the sudden detachment of unsteady sides, a zone of deposition is forming where the clayey cover is a mobile mass, continuously reshuffling. From this material a steady, harder to erode, more or less homogenous, deep substratum eventually forms downhill; this soil is subjected to deep-cracking, a limiting factor tolerated only by tap rooting perennials and a few annuals.

Summing up the question, the following habitats can be observed along a transect from the head to the feet of the slope: 1) upper belt: usually flat and stable, formed by rather compact sandstone, making a roof on the badland, with a submediterranean vegetation of *Phillyrea latifolia*, *Rhamnus alaternus*, *Pistacia lentiscus* (*Pistacio-Rhamnetalia alaterni* Rivas-Martinez 1975); 2) head of the badland: very steep, easily subjected to erosion but never submerged by flows of clay or sandstone (*Poo-Camphorosmetum*); 3) recent depositions of clay masses (associations of therophytes); 4) basal zone of older deposition (*Podospermo-Cardopatetum corymbosi* and *Elytrigio-Cynaretum*) 5) riparian zone with *Ulmus minor* and *Tamarix africana* (often with *Glycyrrhiza glabra*). The morphological types of this model correspond to the groups of relevés detected by multivariate analysis. We have to add to these habitats the sides of ancient slides widely colonised by *Arundo pliniana* and *Agropyron pycnanthum*.

Thermophilous species (*Catananche lutea, Senecio delphinifolius, Geropogon glaber, Mantisalca duriaei, Hedysarum glomeratum, Hedypnois cretica*) are widespread from Southern Italy (Calabria, Basilicata, Puglia) to Molise, not reaching Abruzzo. The presence of *Atractylis gummifera* close to a surveyed station (rel. 5) is worth remarking and represents the first certain finding in Molise; it adds evidence to the special phytogeographical meaning of this habitat.

The phytogeographical and ecological role of *Camphorosma monspeliaca*, a steppic element also present in Mediterranean coastal halophilous stations, requires further research. Because of this situation it is difficult to settle its syntaxonomical position.

RIASSUNTO

Viene studiata la vegetazione dei calanchi su argille varicolori del Molise. Questa vegetazione è distribuita in settori differenti del profilo del calanco, ora di accumulo, ora di erosione: 1) la parte più alta del calanco è abitualmente piatta e coltivata; 2) la zona più stabile ma con maggior erosione è colonizzata dal *Poo bulbosae-Camphorosmetum* ass. nova; 3) la zona di accumulo di materiali fini è colonizzata da comunità di terofite; 4) la zona di accumulo delle frane è colonizzata dall'associazione *Cardopatetum corymbosi*; 5) nella stessa zona, ma in situazioni più umide e antropizzate, si sviluppa l'associazione *Cynaro-Elytrigietum*. Segue una discussione sulle caratteristiche fitogeografiche della vegetazione dei calanchi del Molise e regioni limitrofe.

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APPENDIX I: DATES AND SITES OF RELEVÉS

1: 23/6/92, Valle del Biferno, red clays.
2: 4/6/99, Valle del Biferno, Liscione (Palata).
3: 4/6/99, Valle del Biferno, Liscione (Palata); badland top.
4: 4/6/99, Valle del Biferno, Liscione (Palata); badland top, downward with naked clays.
5: 4/6/99, Valle del Biferno, Liscione (Larino); small badland; on border *Atriplex halimus*.
6: 23/6/88, S. Angelo Limosano; red clays.
7: 23/6/88, S. Angelo Limosano; very arid red clays with limonite nodules.
8: 13/5/92, Palata.
9: 5/6/99, Valle del Biferno, Lucito.
10: 5/6/99, Valle del Biferno, Lucito; black-red clays.
11: 23/6/99, Valle del Biferno; brown clays with iron nodules.
12: 22/6/92, Vallone di S. Simone.
13: 22/6/99, Vallone di S. Simone; red clays.
14: 23/6/88, Limosano; very arid red clays.
15: 23/6/99, Valle del Biferno; red clays.
16: 23/6/88, S. Angelo Limosano; red clays.
17: 23/6/88, Civitacampomarano; red clays.
18: 12/6/92, Monte Gessaro.
19: 4/6/99, Valle del Biferno, Defenza plant.
20: 2/7/89, under Pietracatella; red clays.
21: 22/6/92, Vallone di S. Simone; brown clays with iron nodules.
22: 22/6/92, Vallone di S. Simone;
23: 22/5/99, Vallone di S. Simone; grey clays.
24: 23/6/92, Vallone di S. Simone.
25: 13/5/92, Palata.
26: 23/6/88, Civitacampomarano; red clays.
27: 22/6/99, Vallone di S. Simone; grey clays.
28: 13/5/92, Palata.
29: 14/5/92, Valle del Biferno, Guardialfiera; close to M. Peloso; red clays.
30: 13/5/92, Palata.
31: 14/5/92, Valle del Biferno, Guardialfiera;sotto M. Peloso.
32: 4/4/94, Valle del Trigno, between Lentella e Fresagrandinara; red clays.
33: 23/6/99, Valle del Biferno; red clays.
34: 4/6/99, Valle del Biferno, Liscione (Palata); on the top of badland, in a stable situation, close to a crop.
35: 23/6/92, Valle del Biferno; chaotic clays.
36: 13/6/92, Valle del Biferno, Guglionesi; clays with pebbles.
37: 15/5/92, Valle del Biferno, under the dam.
38: 13/5/92, Palata.
39: 2/5/92, Morrone del Sannio, Serra Guardiola.
40: 1/5/92, Lucito.
41: 2/7/89, Val Tappino, crossroad to Pietracatella.
42: 2/7/89, Val Tappino, crossroad to Pietracatella; pioneer recolonizing stage with *Arundo pliniana*.

43: 4/6/99, Valle del Biferno, Defenza plant.
44: 4/6/99, Valle del Biferno, Defenza plant; accumulation zone at the base of badland.
45: 5/6/99, Valle del Biferno, Lucito.
46: 5/6/99, Valle del Biferno ss 87, crossroad to Fossalto (Castropignano); pastured.
47: 5/6/99, Valle del Biferno ss 87, crossroad to Fossalto (Castropignano); pastured.
48: 5/6/99, Valle del Biferno ss 87, crossroad to Fossalto (Castropignano); small humid valley.
49: 5/6/99, Valle del Biferno, Lucito.

APPENDIX II

Sporadic species

ril. 5: *Ligustrum vulgare*; ril. 9: *Vulpia ciliata*; ril. 10: *Sonchus oleraceus*; ril. 15: *Ecballium elaterium*; ril. 18: *Torilis nodosa*; ril. 19: *Centaurium tenuiflorum*; ril. 20: *Asperula aristata*; ril. 21: *Lactuca saligna*; ril. 22: *Picris hieracioides*; ril. 30: *Ranunculus bulbosus* ssp. *aleae*; ril. 33: *Bupleurum tenuissimum, Atriplex patula*; ril. 34: *Lathyrus ochrus, Phalaris truncata*; ril. 35: *Eryngium amethystinum, Helianthemum salicifolium, Notobasis syriaca, Onobrychis aequidentata, Petrorhagia saxifraga, Pistacia lentiscus, Stipa austroitalica*; ril. 36: *Atriplex halimus* (2), *Dasypyrum villosum*; ril. 37: *Convolvulus pentapetaloides, Ononis spinosa* ssp. *antiquorum, Ophrys fusca*; ril. 39: *Bellis perennis, Cerastium glomeratum, Cichorium intybus, Ranunculus flabellatus, Urospermum dalechampi, Veronica arvensis*; ril. 40: *Astragalus monspessulanus* (2); ril. 41: *Allium sphaerocephalon, Bellis perennis, Dorycnium hirsutum, Lotus ornithopodioides*; ril. 42: *Silene bellidifolia*; ril. 43: *Anacamptis pyramidalis*; ril. 44: *Asparagus acutifolius, Thymelaea passerina*; ril. 45: *Cephalaria transsylvanica, Lophochloa cristata, Podospermuam canum, Romulea columnae*; ril. 47: *Achillea ageratum, Melica ciliata*; ril. 48: *Geranium purpureum, Plantago lanceolata, Trifolium echinatum*; ril. 49: *Carduus corymbosus* (2), *Lotus corniculatus, Malope malacoides, Prunella laciniata, Serapias vomeracea, Teucrium chamaedrys*.

TABLE 1 A: POO BULBOSAE-CAMPHOROSMETUM; B: TRANSITION BETWEEN CARDOPATETUM AND CAMPHOROSMETUM; C: CARDOPATETUM CORYMBOSI; D: CYNARO-ELYTRIGIETUM

	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	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Association	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	D	D
Slope, degrees	40	15	10	40	30	10	10	25	10	20	30	40	30	60	30	10	30	15	20	40	45	45	45	40	45	60	30	25	35	35	25	30	40	3	5	40	5	40	5	45	40	45	3	5	20	5	5	5	5
Aspect, degrees	W	S	S	E	S	S	S	S	SE	SE	S	N	W	E	SE	S	E	E	S	E	SW	W	NE	NE	SW	S	W	S	S	SW	S	SE	SE	S	N	S	SE	SE	SW	S	S	E	S	S	SE	S	W	N	E
Sample area, square metres	50	10	50	10	100	100	100	50	50	50	100	100	50	50	100	80	150	100	200	80	50	100	250	80	150	100	80	150	70	150	100	200	200	30	80	200	300	150	200	50	200	200	200	200	80	100	80	50	100
Herb cover, %	40	50	50	50	50	30	20	80	40	60	40	70	20	20	70	30	40	50	30	20	40	40	40	40	80	25	30	60	40	50	70	40	80	90	60	70	100	100	90	70	50	35	100	90	90	60	100	100	80
Number of species per sample	6	8	7	7	16	14	15	17	11	14	20	14	9	13	12	14	21	18	14	14	12	20	17	14	21	11	18	18	9	20	27	18	22	18	35	13	29	15	25	16	21	11	29	36	36	23	19	22	34
Poo bulbosae-Camphorosmetum																																																	
Camphorosma monspeliaca	1	.	3	3	3	4	3	3	2	2	1	1	1	3	2	3	4	3	2	2	1	2	1	1	+	3	1	1	2	2	2	2	.	+	1	.	.	+	.	.	.	.	1	.	.	.	.	.	.
Poa bulbosa	.	+	2	2	2	3	2	+	1	2	2	1	.	.	.	1	.	.	2	.	1	1	1	1	.	2	+	+	.	+	+	1	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.
Bromus molliformis	.	1	+	+	+	1	1	+	+	+	+	+	4	+	1	.	+	+	1	.	.	.	+	.	.	.	1	.	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Plantago weldenii	.	+	.	.	+	.	.	+	+	+	.	2	+	+	.	.	+	+	+	.	.	1	1	+	.	.	+	+	+	+	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Anacyclus tomentosus	2	+	+	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.
Cardopatetum corymbosi, Elytrigion atherica																																																	
Cardopatum corymbosum	.	.	.	.	.	.	.	.	.	.	.	.	+	2	.	+	+	2	.	1	2	+	+	1	1	2	1	2	.	2	1	+	.	1	2	.	2	1	3	3	1	2	2	1	2	.	.	.	.
Aster linosyris	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	1	.	.	.	+	.	.	2	.	+	1	1	.	.	.	.	.	.	.
Hedysarum coronarium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	+	.	.	.	.	+	.	.	.	+	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.
Catananche lutea	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	r	1	.	.	+	.	2	.	+	.	.	.	.	1	.	.	.	.	+
Mantisalca duriaei	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus lanceolatus	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Salvia verbenaca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	+	+	+	+	+	.	.	.	.	.
Plantago serraria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	1	1	+	+	3	+	.	.	.	.	1
Podospermum laciniatum	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.	+	+	+	+	+	+	+	+	+	+	.	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	+	.
Agropyron pycnanthum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	3	2
Anthemis tinctoria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.
cynaro-Elytrigietum																																																	
Cynara cardunculus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	+	.	+	.	.	.	+	2	.	4	5	4	+
Gaudinia fragilis	.	.	.	.	.	.	1	.	.	.	+	+	.	+	+	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	1	1	1	+	+	1	1
Senecio delphinifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	+
Sherardia arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	+	+	+	+
Blackstonia perfoliata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+
Carthamus lanatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.
Dactylis glomerata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	3	+	.	+	.	1	2
Foeniculum vulgare ssp. piperitum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	+	.	+	.	+	.
Crepis pulchra	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Carlina corymbosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.
Cynosurus echinatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.
Eryngium campestre	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	+	.
Linum corymbulosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Micromeria graeca	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	1
Rhagadiolus stellatus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.
Frankenietalia pulverulentae																																																	
Hordeum marinum	1	1	1	+	2	.	1	.	.	+	+	1	1	1	+	3	1	.	.	+	.	+	1	+	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parapholis pycnantha	.	.	.	.	2	2	1	.	.	+	2	+	+	2	2	2	2	1	+	.	.	+	.	+	1	2	+	.	.	1	1	+	.	1	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.
Hainardia cylindrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	+	.	+	2	1	+	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Parapholis incurva	+	2	1	.	1	.	.	+	.	.	.	.	.	.	.	.	.	1	.	+	+	1	1	1	+	.	+	1	1	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Thero-Brachypodietea, Thero-Brachypodietalia																																																
Trifolium scabrum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hippocrepis unisiliquosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Hedypnois rhagadioloides	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	+	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.
Aegilops geniculata	.	.	.	.	.	.	+	+	.	1	1	+	+	+	.	.	.	.	+	.	.	.	.	.	2	.	+	1	1	1	1	.	5	.	+	.	1	1	.	.	.	.	1	+	.	1	+	.	.
Polygala monspeliaca	.	.	.	.	.	.	+	+	+	1	1	.	.	.	.	.	+	.	.	+	.	.	r	.	+	.	.	.	.	.	+	.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	+
Filago germanica	.	.	.	.	.	+	+	+	.	.	1	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.
Xeranthemum inapertum	.	.	.	.	.	2	1	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	.	.	.
Hypochoeris achyrophorus	.	+	.	.	+	1	2	+	+	+	+	.	.	+	.	.	+	.	+	+	.	.	.	.	+	+	+	+	.	.	+	.	.	.	.	+	+	1	+	.	.	.	.	.	1	+	+	.	.	.
Melilotus sulcatus	.	1	+	.	+	1	1	+	.	.	.	.	.	.	+	.	+	.	+	+	.	.	.	.	+	.	.	+	+	.	+	.	.	1	+	.	1	.	.	.	.	.	1	+	+	.	.	.	.

TABLE 1 B

	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	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49
Association	A	A	A	A	A	A	A	A	A	A	A	A	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	B	C	C	C	C	C	C	C	C	C	C	D	D	D	D	D	D	D
Hedypnois cretica	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	.	.	.	+	.	.	.	.
Trifolium stellatum	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Ononis oligophylla	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Ononis mitissima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Briza maxima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Tetragonolobus purpureus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.
Hedysarum glomeratum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	4	.	.	+	.	1	3	.	.	.	.	+	.	3	4	.	.	.	.	.	.	.	.	.	.	.
Scabiosa maritima	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.
Scorpiurus muricatus	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	+	.	+	.	+	.	.	.	+	.	.	.	1
Brachypodium distachyum	.	.	.	.	.	.	1	.	+	.	+	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	.	+	.	.	1	+	+	+	.	.	1	+	.	.	.	+	.	.	.	+
Plantago psyllium	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	+	+	.	+	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	.
Medicago intertexta	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	1	.	.	.	.
Trifolium campestre	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1	1	.	.	.	.	.
Trifolium lappaceum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	+	.	.	.	.
Onobrychis caput-galli	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	+	1	+	.	.	.	1
Bellardia trixago	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	1	.	.	.	.	.
Trifolium angustifolium	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.
Linum strictum ssp. strictum	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	+	.	.	+	.	.	1	1	+	+	.	.	.
Convolvulus cantabrica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	+	.	.	.	1
Sideritis romana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+
Urospermum picroides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+
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Tordylium apulum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.
Linum trigynum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Ononis pusilla	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.
Echinaria capitata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.
companions																																																	
Allium tenuiflorum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	r	.	.	.	r	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Catapodium rigidum	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Trifolium maritimum	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.
Phalaris paradoxa	+	.	.	1	1	.	.	+	+	+	+	1	+	1	1	.	2	+	+	.	.	.	.	.	.	+	+	+	+	.	.	.	.	.	1	.	.	.	+	.	.	.	.	+	1	.	.	.	.
Avena barbata	+	.	.	.	.	.	.	.	.	.	+	+	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	.	.	+	.	.	.	.	.
Centaurium pulchellum	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Picris echioides	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Hordeum leporinum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.
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Melilotus indica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Scabiosa cretata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Melilotus altissimus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leontodon villarsii	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus asper	.	.	.	.	.	.	+	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	+	+	+	+	.	+	+	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	.
Allium ampeloprasum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Tyrimnus leucographus	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	+	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Bromus madritensis	.	.	.	.	.	.	.	+	+	.	+	.	.	.	+	.	.	.	.	.	.	.	r	+	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.
Euphorbia exigua	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Anagallis arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	+	.	+	.	.	.	.	.	.	.	.	.	.	.	.
Reichardia picroides	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	+	+	+	+	.	+	.	+	.	.	.	.	.	+	.	+	+	.	.	.	+	.	1	.	+	.	+	.	+
Dactylis hispanica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	+	+	.	.	1	.	1	2	3	.	+	1	.	2	.	.	+	.	.	+
Rapistrum rugosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	+	.	2	1	.	.	.	.	.	.	.	.	.	.
Galactites tomentosa	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.
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Crepis vesicaria ssp. vesicaria	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	+	+	+	.	.	+	.	.	.	.	.	+
Bromus hordeaceus	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	.	.	+	+	.	1	.
Romulea bulbocodium	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.
Daucus carota	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.
Nigella damascena	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	.	.	.	.	.	.	.	+	+	.	+	.	.	+
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Carex flacca ssp. serrulata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	.	.	.	.	.
Carlina lanata	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	.	.	.	.	+	.	+	.	.	.	+
Avena sterilis	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3	+	3	.	.	.	.	.	.	1	1	1	.	.	.	+
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Pallenis spinosa	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	.	.	.	.	.	+	.	.	.	.
Vicia bithynica	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.
Ornithogalum brevistylum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Arundo pliniana	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2	+	.	.	.	.	.	.	.	.
Sesleri tortuosum	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.
sporadic species					1				1	1					1			1	1	1	1	1							1			2	2	7	2	3		6	1	5		2	2	5		2	3	8