

## The badland vegetation of the northern-central Apennines (Italy)

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### Abstract

We present here a syntaxonomic revision of the vegetation of the badlands of the Northern-Central Apennines. Badlands are argillaceous-pelitic areas that are affected by processes of rapid soil erosion, caused by the surface water. After a summary of previous studies and of the syntaxonomic schemes used, we present the methodology used for this study, which provides comparisons between phytosociological tables. We conclude that the perennial vegetation of the calanchi should be referred to the class *Artemisietea*, of the order *Agropyretalia repentis* and the alliance *Inulo viscosae-Agropyrion repentis*, within which it is possible to recognise the suballiances *Inulo viscosae-Agropyrion repentis* of the non-halophilous aspects, and *Podospermo laciniati-Elytrigenion athericae* specifically for the more halophilous conditions of the more pioneering aspects of the vegetation. The annual vegetation can instead be included in the class *Saginetea maritimae*, of the order *Frankenietalia pulverulentae* and the alliance *Hordeion marini*. For each association, a brief description and a distribution map are included.

Key words: *Artemisietea*, badlands, Northern-Central Apennines, phytosociology, *Saginetea maritimae*, syntaxonomy.

### Riassunto

La vegetazione calanchiva degli Appennini centro-settentrionali (Italia). Viene presentata una revisione sintassonomica della vegetazione che si sviluppa sui calanchi presenti nell'Appennino centro-settentrionale. I calanchi sono territori a prevalente composizione argillosa e/o argilloso-pelitica, interessati da processi di erosione rapida del suolo dovuta all'azione dilavante delle acque superficiali. Dopo una sintetica presentazione dei precedenti studi e degli schemi sintassonomici utilizzati viene presentata la metodologia utilizzata nella ricerca che fa riferimento a confronti tra tabelle fitosociologiche. Si conclude che la vegetazione perenne dei calanchi sia da riferire alla classe *Artemisietea*, all'ordine *Agropyretalia repentis* e all'alleanza *Inulo viscosae-Agropyrion repentis* nell'ambito della quale si riconoscono le suballeanze *Inulo viscosae-Agropyrion repentis*, degli aspetti non alofili e *Podospermo laciniati-Elytrigenion athericae*, propria delle condizioni maggiormente alofile che riguardano negli aspetti di vegetazione maggiormente pionieri. La vegetazione annuale viene invece inquadrata nella classe *Saginetea maritimae*, ordine *Frankenietalia pulverulentae* e alleanza *Hordeion marini*. Di ogni associazione viene presentata una breve descrizione e una carta distributiva.

Parole chiave: Appennino centro-settentrionale, *Artemisietea*, calanchi, fitosociologia, *Saginetea maritimae*, sintassonomia.

### Introduction

The aim of the present study is to propose a syntaxonomic revision of the badland vegetation found in the Northern-Central Apennines. These badlands, which are known as "calanchi" in Italian, are argillaceous or argillaceous-pelitic areas that are affected by processes of rapid soil erosion caused by the surface water. These erosion processes result in the formation of mixed geomorphologies, made up of very deeply cut narrow valleys, organised in the form of a complex network of impluvium lines where the surface water runs off.

In the Italian peninsula, the badlands are mainly found in areas of the Northern Apennines (Piemonte, Lombardia, Emilia-Romagna, Tuscany-Romagna – including the Republic of San Marino – and Tuscany-Marche), the Central Apennines (Lazio, Marche and Abruzzo) and the Southern Apennines (Molise, Basilicata and Calabria). Badlands are also found in Sicily (Fig. 1).

The Apennines form the mountain chain that extends for more than 1,200 kilometres, forming the "backbone" of the Italian peninsula. The badland vegetation along

the Apennines is influenced by the different biogeographic and macrobioclimatic conditions, which themselves are dependent on the different longitudes at which they are found in the Italian peninsula. The microclimatic and micro-geomorphological conditions have a particular influence at the local level.

The area under consideration includes the badland territories between the valleys of Staffora and Curone (Piemonte and Lombardia), as far as the southern limits of the Region of Abruzzo. This territory is mainly influenced by the temperate macrobioclimate of the mesotemperate bioclimatic belt, and to a lesser extent, it is part of the Mediterranean macrobioclimate of the meso-Mediterranean bioclimatic belt (Fig. 1).

### The present syntaxonomic situation

There have been many studies into the badland vegetation of the Northern-Central sector of the Apennines, which have provided as many different syntaxonomic interpretations. These are summarised in Tab. 1.

## Materials and Methods

The data elaboration was carried out on a matrix of 23 columns that were collated from the same number of phytosociological tables of vegetal associations that have been described for the calanchi territories of the Apennine sector under consideration (Tab. 2).

The synoptic table, made up of a total of 206 species, was transformed into a numerical matrix that was ordered through the MATEDIT multivariate analysis programme, which uses the similarity ratio of the distance matrix and similarity by columns. The subsequent application of the algorithm of complete linkage (Anderberg, 1972) to the matrix obtained has revealed similar association clusters that have been visualised hierarchically in the dendrogram in Fig. 2. Moreover, the ordering of the groups was achieved with reference to the dispersion diagram produced through the fuzzy set procedure (Fig. 3).

## Results and Discussion

The dendrogram in Fig. 2 highlights the following five main clusters:

- Cluster I: This includes the pioneering associations of the sides of the badlands that have been included in the associations *Elytrigio athericae-Artemisietum caerulescentis*, *Podospermo laciniati-Cardopatetum corymbosi*, *Cynaro-Agrophyretum pungentis* and *Agropyro pungentis-Asteretum linostris*, which were previously included in the alliance *Podospermo laciniati-Elytrigio athericae* Pirone, 1995;
- Cluster II: This refers to the association *Agropyro-Artemisietum cretaceae*, which has attributed also to the alliance *Podospermo laciniati-Elytrigio athericae*;
- Cluster III: This includes the association *Podospermo canae-Plantaginetum maritima*, which, again, has also been attributed to the alliance *Podospermo laciniati-Elytrigio athericae*;

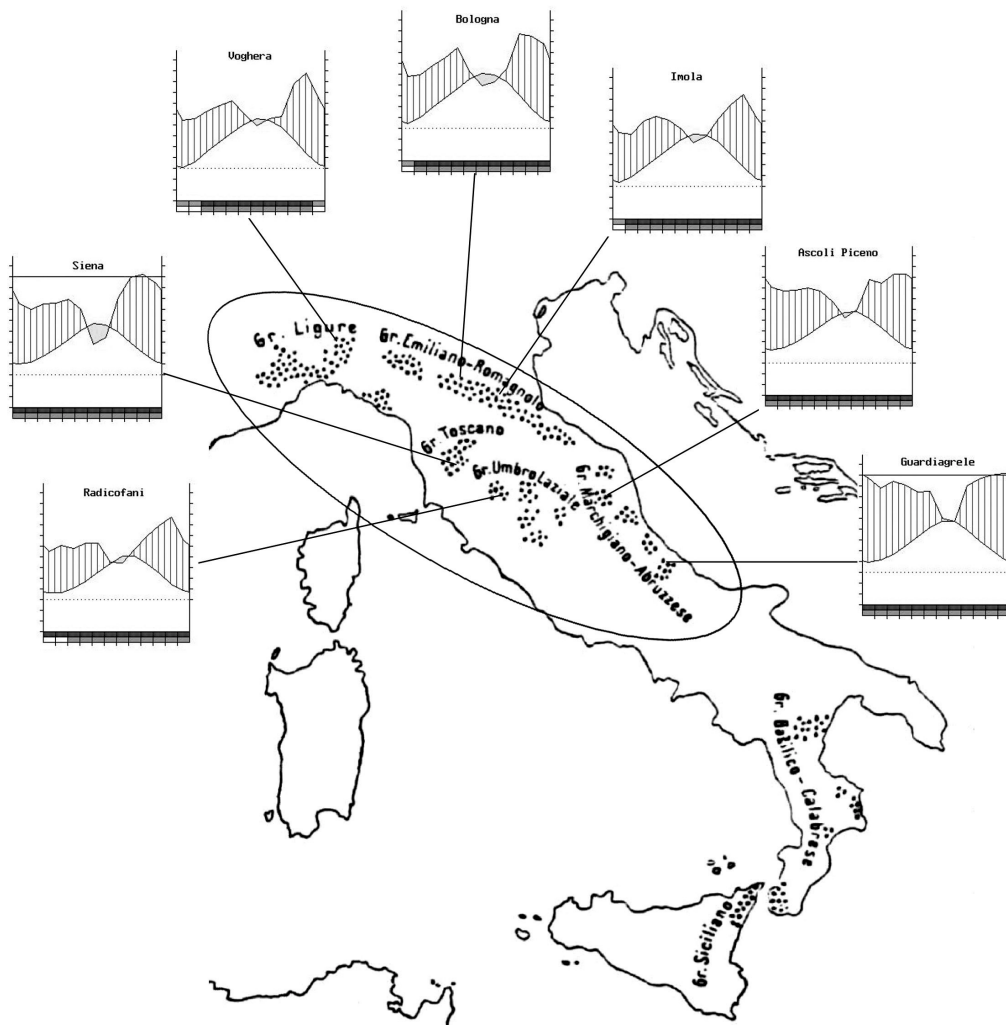


Fig. 1 – Distribution of the badlands (modified from Puglisi, 2002) and the main bioclimatic conditions of the Italian peninsula and Sicily. The oval line delineates the study area

Tab.1 – Summary of the syntaxonomic interpretations of the calanchi vegetation present in the Northern Apennines, from the main published studies

SYNTAXONOMIC LEVEL				
AUTORS	ASSOCIATIONS	ALLIANCES	ORDERS	CLASSES
Ferrari & Speranza (1975)	<i>Artemisietum cretaceae</i> (Pignatti, 1953) Ferrari 1975 <i>Agropyro-Asteretum linosyridis</i> Ferrari 1971 em. 1975	<i>Halo-Agropyron Ferrari</i> (1975), (characteristic species: <i>Agropyron litorale</i> , <i>Scorzonera laciniata</i> , <i>Hordeum maritimum</i> and <i>Atriplex patula</i> )	<i>Halo-Agropyretalia</i> Ferrari (1975)	<i>Puccinellio-Salicornietea</i> (Tzopa, 1939) Pign. 1953
Ferrari & Gerdol (1987)	<i>Artemisietum cretaceae</i> (Pignatti, 1953) Ferrari 1975; <i>Cynaro-Agropyretum pungentis</i> (Pirone, 1981) Ferrari & Gerdol 1987; <i>Cardopatetum corymbosi</i> Ferrari et Gerdol 1987	<i>Parapholido-Podospermion canisii</i> Ferrari & Gerdol (1987)	<i>Festuco-Puccinellietalia</i> Sòo 1968	<i>Festuco-Puccinellietea</i> Sòo 1968
	<i>Anthemido-Podospermetum resedifolii</i> Ferrari & Gerdol 1987 (Ferrari & Gerdol, 1987)	<i>Anthemido-Podospermion residifolii</i> Ferrari & Gerdol (1987)		
Biondi, Ballelli, Allegrezza & Manzi (1990)	<i>Podospermo laciniati-Cardopatetum corymbosi</i> (= <i>Cardopatetum corymbosi</i> di Ferrari & Gerdol 1987 <i>nomen invalidum</i> )	<i>Agropyron pungentis</i> Géhu (1968) 1973	<i>Festuco-Puccinellietalia</i> Sòo 1968	<i>Festuco-Puccinellietea</i> Sòo 1968
	<i>Epilobio tetragoni-Elymetum pycnanthi</i> Biondi et al., (1990)	<i>Convolvulo-Agropyron repentis</i> Gorz 1967	<i>Agropyretalia intermedii-repentis</i> Oberd., Th. Mull. et Gors 1967	<i>Agropyreteea intermedii-repentis</i> Oberd., Th. Mull. et Gors 1967
Pirone (1995)	<i>Elytrigio athericae-Artemisietum caerulescentis</i> Pirone, 1995; <i>Elytrigio athericae-Artemisietum cretaceae</i> Ferrari et Grandi 1974 corr. Allegrezza et al. 1993; <i>Podospermo laciniati-Cardopatetum corymbosi</i> Biondi et al., 1990; <i>Cynaro cardunculi-Elytrigetum athericae</i> (Pirone, 1981) Ferrari & Gerdol 1987 corr. Pirone 1995; <i>Elytrigio athericae-Asteretum linosyris</i> Ferrari 1971 corr. Allegrezza et al. 1993.	<i>Podospermo laciniati-Elytrigion athericae</i> Pirone 1995 (characteristic species: <i>Elytrigia atherica</i> , <i>Scorzonera laciniata</i> , <i>Aster linosyris</i> , <i>Plantago maritima</i> , <i>Scorzonera cana</i> and <i>Cardopatum corymbosum</i> ).	<i>Agropyretalia intermedii-repentis</i> Oberd., Th. Mull. et Gors 1967	<i>Agropyreteea intermedii-repentis</i> Oberd., Th. Mull. et Gors 1967
Biondi & Allegrezza (1996)	<i>Senecio erucifolii-Inuletum viscosae</i> Biondi & Allegrezza 1996; <i>Agrostio stoloniferae-Agropyretum repentis</i> Biondi & Allegrezza 1996 (corr. a <i>Elytrigio athericae-Asteretum linosyris</i> Ferrari 1971 corr. Allegrezza, Biondi, Brill-Cattarini & Gubellini 1993); <i>Arundinetum pliniana</i> Biondi, Brugiapaglia, Allegrezza & Ballelli 1992; <i>Agropyro repentis-Dactyletum glomeratae</i> Ubaldi 1976 em. Ubaldi, Puppi & Speranza 1983; <i>Epilobio tetragoni-Elytrigetum athericae</i> Biondi, Ballelli, Allegrezza & Manzi 1990 corr. Biondi & Allegrezza 1996; <i>Glycyrrhizo glabrae-Elytigitum athericae</i> Pirone & Tammaro 1981 corr.; <i>Dauco carotae-Tussilaginetum farfarae</i> Biondi, Brugiapaglia, Allegrezza & Ballelli 1989	<i>Inulo viscosae-Agropyron repentis</i> Biondi & Allegrezza 1996	<i>Agropyretalia repentis</i> Oberdorfer, Müller & Görs in Oberdorfer, Görs, Korneck, Lohmeyer, Müller, Philippi & Seibert 1967	<i>Artemisietea vulgaris</i> Lohmeyer, Preisung & Tüxen ex von Rochow 1951
	<i>Elytrigio athericae-Asteretum linosyris</i> Ferrari 1971 corr. Allegrezza, Biondi, Brill-Cattarini & Gubellini 1993; <i>Cynaro cardunculi-Elytrigetum athericae</i> (Pirone 1981) Ferrari & Gerdol 1987 corr. Pirone 1995; <i>Elytrigio athericae-Artemisietum caerulescentis</i> Pirone 1995; <i>Elytrigio athericae-Artemisietum cretaceae</i> Ferrari et Grandi 1974 corr. Allegrezza, Biondi, Brill-Cattarini & Gubellini 1993; <i>plantaginetosum maritima</i> Allegrezza, Biondi, Brill-Cattarini & Gubellini 1993; <i>Podospermo laciniati-Cardopatetum corymbosi</i> Biondi, Ballelli, Allegrezza & Manzi 1990;	<i>Podospermo laciniati-Elytrigion athericae</i> Pirone 1995		

Tab.2 - The perennial badland vegetation of northern-central Italy

		cluster I-II-III										cluster IV				cluster V							
Slope;		43	23	41	36	39	72	25	n.c	52	46	60	14	9	18	23	9	15	23	16	n.c	23	26
Coverage %		38	54	75	50	60	38	49	n.c	41	67	43	100	100	94	94	100	88	96	89	72	97	100
Col. N.		16	40	1	5	6	42	2	38	15	3	41	27	28	32	33	17	30	31	19	21	24	25
H scap	S-EUROP.-SUDSIB.	Charact. taxa of the Podospermo canae-Plantaginietum maritimae Scorzonera cana (C.A. Meyer) O. Hoffm. <span style="border: 1px solid black; padding: 2px;">V V</span> . . . . . IV . . . . .																					
Ch suffr	EURIMEDIT.	Charact. taxa of the Elytrigia-athericae-Artemisietum caerulescentis Artemisia caerulescens L. ssp. caerulescens . . . . . <span style="border: 1px solid black; padding: 2px;">V</span> . . . . . II . . . . .																					
H scap	NE-MEDIT.-MONT.	Charact. taxa of the Podospermo laciniati-Cardopatetum corymbosi Cardopatetum corymbosum (L.) Pers. . . . . <span style="border: 1px solid black; padding: 2px;">V IV</span> I . . . . . II . . . . .																					
H scap	STENOMEDIT.	Charact. taxa of the Cynaro-Agropyretum pungentis Cynara cardunculus L. . . . . <span style="border: 1px solid black; padding: 2px;">IV</span> . . . . . I I . . . . .																					
Ch suffr	ENDEM.	Charact. taxa of the Agropyro-Artemisietum cretaeae Artemisia caerulescens L. ssp. cretaeae (Fiori) Brilli-Catt. et Gubell. . . . . <span style="border: 1px solid black; padding: 2px;">V V V V</span> . . . . . I I . . . . . V . . . . .																					
G rhiz	EURIMEDIT.	Charact. taxa of the Agropyro-pungentis-Asteretum linosyris and of the Podospermo laciniati-Elytrigenion athericae suball.																					
H bienn	PALEOTEMP.	Elytrigia atherica . . . . . V V III V IV III I V V V V V V V V . . . . . V V . . . . . I . . . . .																					
H ros	S-EUROP.-SUDSIB.	Scorzonera laciniata L. . . . . V V II V V V V V V V V V V V V . . . . . I . . . . .																					
H ros	S-EUROP.-SUDSIB.	Plantago maritima L. . . . . <span style="border: 1px solid black; padding: 2px;">V V</span> . . . . . IV II II III . . . . .																					
T scap	MEDIT.ATL.	Diff. taxa of alofilia (Saginetea maritimae e Cakiletea maritimae)																					
H scap	EURIMEDIT.	Parapholis strigosa (Dumort.) Hubbard . . . . . II . . . . . V V V . . . . . II I . . . . .																					
T scap	EURIMEDIT.	Beta vulgaris L. ssp. maritima (L.) Arcang. . . . . III V I . . . . . I . . . . . I . . . . .																					
T scap	EURIMEDIT.	Hainardia cylindrica (Willd.) Greuter . . . . . II . . . . . I . . . . . I . . . . .																					
T scap	CIRCUMBOR.	Atriplex patula L. . . . . . . . . . . II I I . . . . . III . . . . .																					
T scap	W-EURIMEDIT.	Hordeum marinum Hudson . . . . . . . . . . . I I . . . . . IV . . . . .																					
T scap	MEDIT.ATL.(STENO)	Parapholis incurva (L.) Hubbard . . . . . I . . . . . I V V . . . . .																					
T scap	EURIMEDIT.	Plantago coronopus L. ssp. commutata (Guss.) Pilger . . . . . IV . . . . . I I . . . . .																					
T scap	CIRCUMBOR.	Atriplex prostrata DC. subsp. latifolia (Wahlenb) Rauschert . . . . . I . . . . .																					
T scap	PALEOTEMP.	Salsola soda L. . . . . . . . . . . II . . . . .																					
H bienn	EURIMEDIT.	Charact. taxa of the Epilobio tetragoni-Elymetum pycnanthi Tragopogon porrifolius L. . . . . . . . . . . I . . . . . III III II . . . . .																					
H scap	PALEOTEMP.	Epilobium tetragonum L. ssp. tetragonum . . . . . . . . . . . V IV . . . . . I . . . . .																					
H caesp	STENOMEDIT.	Charact. taxa of the Phalarido coerulescentis-Agropyretum Phalaris coerulescens Desf. . . . . . . . . . . II IV . . . . . I . . . . . <span style="border: 1px solid black; padding: 2px;">V V</span> . . . . .																					
H bienn	STENOMEDIT.	Galactites tomentosa Moench . . . . . . . . . . . I . . . . . <span style="border: 1px solid black; padding: 2px;">IV V</span> . . . . . I . . . . .																					
H caesp	EURASIAT.	Charact. taxa of the Senecio crucifolii-Inuletum viscosae Poa trivialis L. . . . . . . . . . . II II . . . . . <span style="border: 1px solid black; padding: 2px;">IV</span> . . . . .																					
G bulb	CENTRO-MEDIT.	Bellevialia romana (L.) Sweet . . . . . . . . . . . II II . . . . . <span style="border: 1px solid black; padding: 2px;">II</span> . . . . .																					
H bienn	SE-EUROP.	Cirsium italicum (Savi) DC. . . . . . . . . . . II II . . . . . <span style="border: 1px solid black; padding: 2px;">II</span> . . . . .																					
G rhiz	MEDIT.-TURAN.	Charact. taxa of the Glycyrrhizo glabrae-Elytrigetum athericae Cardaria draba (L.) Desv. . . . . . . . . . . IV . . . . . <span style="border: 1px solid black; padding: 2px;">IV</span> . . . . . I . . . . .																					
G rhiz	STENOMEDIT.	Glycyrrhiza glabra L. . . . . . . . . . . IV . . . . . <span style="border: 1px solid black; padding: 2px;">V</span> . . . . .																					
H caesp	CIRCUMBOR.	Charact. taxa of the Agrostio stoloniferae-Agropyretum repentis Phleum pratense L. . . . . . . . . . . IV III . . . . . I . . . . .																					
H scap	W-MEDIT.-MONT.	Knautia purpurea (Vill.) Borbas . . . . . . . . . . . III . . . . .																					
T scap	S-EUROP.-SUDSIB.	Charact. taxa of the Agropyro repentis-Dactyletum glomeratae Xeranthemum cylindraceum S. et S. . . . . I . . . . . III V IV I II . . . . . I <span style="border: 1px solid black; padding: 2px;">II</span> . . . . .																					
T scap	SE-EUROP.	Cephalaria transsylvanica (L.) Schrader . . . . . . . . . . . II . . . . . I <span style="border: 1px solid black; padding: 2px;">III</span> . . . . .																					
G rhiz	PALEOTEMP.	Charact. taxa of the Dauco carotae-Tussilaginetum farfarae Tussilago farfara L. . . . . III I . . . . . II . . . . . I . . . . . I <span style="border: 1px solid black; padding: 2px;">III</span> I . . . . .																					
G rhiz	STENOMEDIT.	Charact. taxa of the Arundinetum plinianae Arundo pliniana Turra . . . . . . . . . . . V V . . . . . <span style="border: 1px solid black; padding: 2px;">III II</span> . . . . .																					
P caesp	EURASIAT.	Cornus sanguinea L. . . . . . . . . . . III II . . . . .																					
H bienn	PALEOTEMP.	Charact. taxa of the Inulo viscosae-Agropyrion all. and of the Inulo viscosae-Agropyrion repentis suball. Daucus carota L. . . . . V II . . . . . II III . . . . . I I . . . . . V V V V V IV IV IV V III II V																					
H scap	W-STENOMEDIT.	Hedysarum coronarium L. . . . . III V IV I III III II III III V IV IV V III III IV I I I I																					
H scap	EURIMEDIT.	Inula viscosa (L.) Aiton . . . . . I . . . . . I I I I II . . . . . V I V I V IV V IV III III I																					
H scap	S-EUROP.-SUDSIB.	Aster linosyris (L.) Bernh. . . . . II . . . . . IV IV IV I II I V . . . . . III II . . . . . III I . . . . .																					
H scap	STENOMEDIT.	Reichardia picroides (L.) Roth . . . . . I II II IV . . . . . II I . . . . . III . . . . .																					
H caesp	STENOMEDIT.	Dactylis hispanica Roth . . . . . I V V IV III . . . . . V V . . . . . III . . . . .																					
T scap	EURIMEDIT.	Blackstonia perfoliata (L.) Hudson . . . . . . . . . . . II II IV . . . . . III II IV III II I III IV I III II																					
H bienn	STENOMEDIT.	Scabiosa maritima L. . . . . . . . . . . I I I . . . . . II II . . . . . II . . . . . I I II																					
H scap	EURASIAT.	Senecio crucifolius L. . . . . . . . . . . I I . . . . . IV III II IV . . . . . V I II																					
H scap	EURIMEDIT.	Pulicaria dysenterica (L.) Bernh. . . . . . . . . . . . . . . . . IV II IV II III V I II . . . . .																					
H scap	SUBCOSMOP.	Rumex crispus L. . . . . . . . . . . V IV . . . . . II I II . . . . . I . . . . .																					
T scap	EURIMEDIT.	Pallenis spinosa (L.) Cass. . . . . . . . . . . IV . . . . . IV . . . . . I . . . . . I																					
H rept	CIRCUMBOR.	Agrostis stolonifera L. . . . . . . . . . . I I V V . . . . . III . . . . .																					
H bienn	PALEOTEMP.	Centaurium erythraea Rafn . . . . . . . . . . . I II III I I . . . . .																					
H scap	PALEOTEMP.	Verbena officinalis L. . . . . I . . . . . III I . . . . . III . . . . .																					
H scap	EUROSIB.	Charact. taxa of the Agropyretalia repentis ord. and of the Artemisietea vulgaris class Pieris hieracioides L. . . . . I . . . . . II I I II . . . . . V V V V IV IV IV V II III III																					
H caesp	PALEOTEMP.	Dactylis glomerata L. . . . . I . . . . . I II I . . . . . I V V V . . . . . V IV IV V I I I . . . . .																					
G rhiz	PALEOTEMP.	Convulvulus arvensis L. . . . . V I . . . . . I I I I I . . . . . II II III V IV II I IV I . . . . .																					
H ros	EURASIAT.	Plantago lanceolata L. . . . . . . . . . . I I I . . . . . I II IV II III . . . . . IV . . . . .																					
H bienn	CENTRO-EUROP.	Anthemis tinctoria L. . . . . . . . . . . III IV . . . . . I II I IV . . . . . I . . . . .																					
G rhiz	CIRCUMBOR.	Agropyron repens (L.) Beauv. . . . . . . . . . . III . . . . . IV II V IV III . . . . . II																					
G bulb	S-EUROP.-SUDSIB.	Ornithogalum pyramidale L. . . . . . . . . . . II II III III . . . . . I . . . . . I . . . . .																					
T scap	EURIMEDIT.	Pieris echioides L. . . . . III . . . . . I I . . . . . I II . . . . .																					
H scap	PALEOTEMP.	Lotus glaber Miller . . . . . I . . . . . I . . . . . II II . . . . . I . . . . .																					
H scap	SUBCOSMOP.	Agrimonia eupatoria L. . . . . . . . . . . I I II III . . . . . I . . . . . II																					
H bienn	EURASIAT.	Melilotus officinalis (L.) Pallas . . . . . . . . . . . I . . . . . I . . . . . I . . . . . II																					
H bienn	EURIMEDIT.	Dipsacus fullonum L. . . . . . . . . . . II II . . . . . I I . . . . . I . . . . .																					
G rhiz	EUROSIB.	Melilotus altissima Thuill. . . . . . . . . . . I . . . . . I I . . . . . V . . . . .																					





*Agropyrenion* suball. nova (type association: *Senecio erucifolii-Inuletum viscosae* Biondi & Allegrezza 1996).

The ordering of the phytocoenoses along the fuzzy sets of Cluster I and of Cluster V of the dispersion diagram (Fig. 3) reveals the pioneering capacities of the various vegetal communities.

Clusters I, II and III represent the sub-halophilous, halophilous and xerophilous phytocoenoses with a low level of coverage, and that are exclusively present on the sides of the badlands; Cluster IV includes instead the sub-halophilous and hydrophytic phytocoenoses that have an almost continuous coverage, and that are found on the deposits of the erosion sediment and in low-slope situations; Cluster V includes the non-halophilous meso-hydrophilous phytocoenoses that have a high coverage particular of the argillaceous soils.

### Pioneering communities of the suballiance *PODOSPERMO-ELYTRIGENION ATHERICAE*

ARTEMISIETEA VULGARIS Lohmeyer, Preising & Tüxen ex von Rochow 1951

*Agropyretalia repentis* Oberdorfer, Müller & Görs in Oberdorfer, Görs, Korneck, Lohmeyer, Müller, Philippi & Seibert 1967

*Inulo viscosae-Agropyron repentis* Biondi & Allegrezza 1996

*Podospermo laciniati-Elytrigenion athericae* (Pirone 1995) Biondi & Pesaresi 2004 *stat. nov.*

[*Halo-Artemision* Pignatti 1953 (syntax. syn), *Elytrigion athericae* Géhu 1968 nom. mut. propos. (art. 45), *Halo-Agropyron* Ferrari 1975 (syntax. syn.), *Parapholido-Podospermion caniis* Ferrari & Gerdol 1987 (syntax. syn.), *Podospermo laciniati-Elytrigion athericae* Pirone 1995

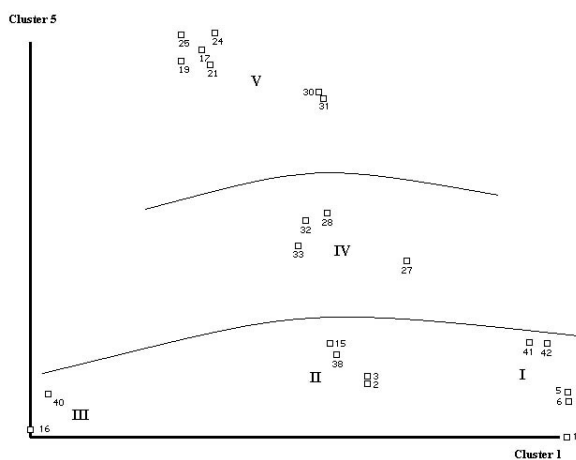


Fig. 3 – Dispersion diagram showing the distribution of the Clusters in relation to the variations in the salt and humidity gradients of the substrata

(syntax. syn.)]

A suballiance of the pioneering perennial grasslands of the badland morphologies that is distributed along the Northern-Central Apennines in sub-Mediterranean temperate bioclimate conditions on weakly salty lime-clay substrata *Elytrigia atherica* dominates from a physiognomic point of view. This syntaxon reaches its southern limits in the Italian peninsula at the border between Abruzzo and Molise (Pirone, 1995).

CHARACTERISTIC AND DIFFERENTIAL SPECIES: *Artemisia coerulescens* subsp. *cretacea*, *Elytrigia atherica*, *Scorzonera laciniata*, *Plantago maritima*, *Scorzonera cana* and *Cardopatum corymbosum*.

*PODOSPERMO CANAE-PLANTAGINETUM MARITIMAE* Biondi, Allegrezza, Guitian & Taffetani 1986

A perennial pioneering association described for the calanchi on the “varicolori” Cretaceous clays found in Sasso Simone and Simoncello (Marche and Tuscany) (Fig. 4).

CHARACTERISTIC AND DIFFERENTIAL SPECIES OF THE ASSOCIATION: *Plantago maritima* and *Scorzonera cana*.

*AGROPYRO-ARTEMISIETUM CRETACEAE* Ferrari & Grandi 1974

[*Artemisietum cretaceae* Pignatti 1953 n. n. (syntax. Syn), *Parapholido-Artemisietum cretaceae* Branconi, De Dominicis, Boscagli & Boldi 1979 (syntax. syn), *Elytrigia athericae-Artemisietum cretaceae* Ferrari et Grandi 1974 corr. Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993 (syntax. Syn)]

*subass. artemisietosum cretaceae* subass. nova (corr. of the type. Lectotype n. 7, Tab. 1 in Ferrari & Grandi 1974)

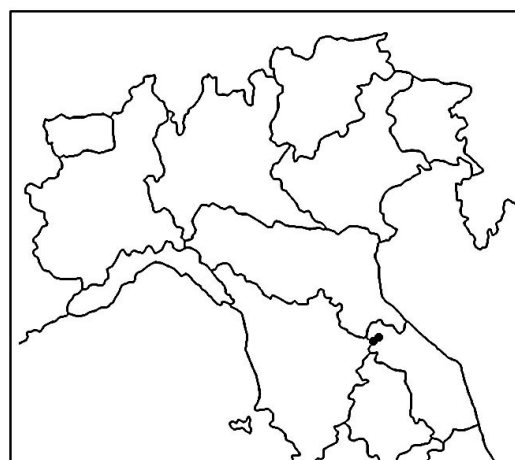


Fig. 4 – Distribution of the association *Podospermo canae-Plantaginetum maritimae* of the Northern-Central Apennines

*subass. plantaginetosum maritimae* Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993

This association represents the nomenclature type of the suballiance. It was initially described by Pignatti (1953) on the basis of the studies conducted by Zangheri (1942) on the badlands of Pliocene clays of Romagna, and later described by Ferrari & Grandi (1974) for the badlands of the valley of Santerno (Emilia-Romagna) that are on Pliocene clays of marine origins.

It is the typical badland vegetation of slightly salty Pliocene clays.

This association is distributed (Fig. 5) on the badlands of the Northern-Central Apennines: in Emilia-Romagna from the valley of Santerno near Imola and Castel Bolognese (Ferrari & Grandi, 1974), near Faenza, Castrocaro and Forlì (Zangheri, 1942), in the medium and low Marecchia Valley in Marche and Romagna, between Pennabilli and Verucchio (Allegrezza *et al.*, 1993) and in the Republic of San Marino (Biondi & Vagge, 2004) and in Tuscany, in Cecina (Livorno), Volterra, Siena, Asciano, the river Orcia valley, Pienza, Radicofani, to the borders between Lazio and Umbria (Branconi *et al.*, 1979; Chiarucci *et al.*, 1995; Maccherini *et al.*, 1997).

For Tuscany, Branconi *et al.* (1979) described a pioneering association of *Artemisia cretacea* (*Parapholido-Artemisietum cretaceae*) that is thought to be synonymous with *Agropyro-Artemisietum cretaceae*. The same authors described a certain similarity between these two vegetal associations, although in the Tuscany association they are differentiated by the presence of *Parapholis incurva*, *Parapholis strigosa*, *Plantago coronopus*, *Hordeum marinum* and *Plantago maritima*. These species are therophytes, with the exception of *Plantago maritima* which is believed to be differential for the subassociation *Plantaginetosum maritimae* of the

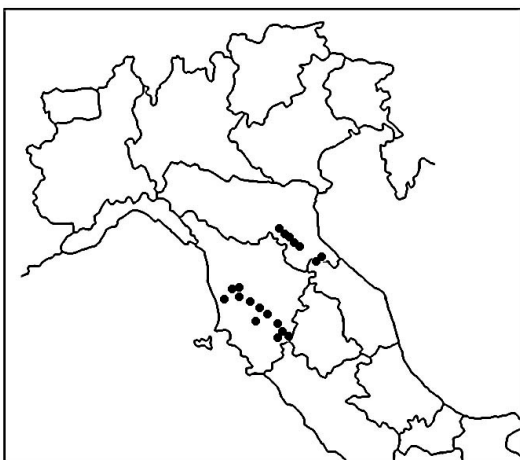


Fig. 5 – Distribution of the association *Agropyro-Artemisietum cretaceae* of the Northern-Central Apennines

association *Agropyro-Artemisietum cretaceae*, thus they cannot be considered as characteristic of an association of perennial vegetation.

The therophyte species in the badland areas actually occupy a different ecological niche, which is mainly determined by the specific edaphic factors of the unstable and superficial substrata. They are able to colonise because they have a great adaptive capacities, which is linked to their brief vegetative cycle that frequently allows the alternation of seasonal communities.

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Artemisia coerulescens* subsp. *cretacea*.

DIFFERENTIAL SPECIES OF THE SUBASSOCIATION *plantaginetosum maritimae*, described for the medium and low valley of Marecchia: *Plantago maritima*.

**AGROPYRO-ASTERETUM LINOSYRIS** Ferrari 1971

[*Elytrigio athericae-Asteretum linosyris* Ferrari 1971 corr. Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993 (syntax. syn)]

*subass. asteretosum linosyris* subass. nova

(corr. of the type in Ferrari 1975. Lectotype n. 28, Tab. 1 in Ferrari 1971)

*subass. poetosum bulbosae* Ferrari 1971

(Lectotype n. 5, Tab. 1 in Ferrari 1971)

*subass. carthametosum lanati* Taffetani 2000

A perennial pioneering association described by Ferrari (1971) for the badlands on the clays of the heterogeneous chaotic “scaly clays” of Mount Paderno (Emilia-Romagna). Initially the association was thought to be exclusive to chaotic scaly clays (Ferrari, 1971; Ferrari & Speranza, 1974). Later phytosociological studies showed that it can also be found on Pliocene clay soils (De Dominicis *et al.*, 1979; 1995).

The association is found in the Northern-Central Apennines (Fig. 6): the valleys of Staffora and Curone (Piemonte and Lombardia) (Gentile & Sartori, 1975) on Eocene and Miocene clays; the badlands of Emilia-Romagna to the east of the river Sillaro, in the medium and low valley of Marecchia; on the badlands of Pliocene clays of the eastern slopes of Mount Ascensione (Marche); from Northern Umbria to part of Tuscany (around Siena and Val d’Orcia) in the Tyrrhenian side.

For the badlands of Mount Ascensione (Ascoli Piceno), the subassociation *carthametosum lanati* had been described (Taffetani, 2000), with mediterranean therophytic differential species. The presence of some perennial xero-termophytic species such as *Dactylis hispanica* and *Reichardia picroides* is significant because they are never found in the typical aspect of *Agropyro-Asteretum linosyris*.



The subassociation *poetosum bulbosae* describes instead the contact situation where the sides of the badlands meet the top of the badlands, where the slopes are less steep and the typical species of *Brometalia* are found, such as *Ononis masquilleri*, *Poa bulbosa* and *Brachypodium rupestre*.

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Elytrigia atherica* and *Scorzonera laciniata*.

DIFFERENTIAL SPECIES OF THE SUBASSOCIATION *poetosum bulbosae*: *Poa bulbosa*, *Ononis masquilleri*, *Brachypodium rupestre* and *Hedysarum coronarium*.

DIFFERENTIAL SPECIES OF THE SUBASSOCIATION *carthametosum lanati*: *Linum corymbulosum*, *Pallenis spinosa*, *Malope malacoides*, *Carthamus lanatus ssp. Lanatus*.

**CYNARO-AGROPYRETUM PUNGENTIS** (Pirone 1981) Ferrari & Gerdol 1987

[corr. a *Agropyro-Asteretum linosyris* Ferrari 1971 *subass. dactyletosum hispanicae* Pirone 1981, *Cynaro cardunculi-Elytrigetum athericae* (Pirone 1981) Ferrari & Gerdol 1987 corr. Pirone 1995 (syntax. syn) ]

A perennial pioneering association found in the basins of the seasonal rivers Calvano and Piomba (Teramo) and of the rivers Alento and Faro (Pescara and Chieti), always on Pliocene clays (Fig. 7).

*Cynara cardunculus*, *Dactylis hispanica*, *Reichardia picroides* and *Cardaria draba* are the characteristic species of this association and describe more thermophilic characteristics than *Agropyro-Asteretum linosyris* association.

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Cynara cardunculus*, *Dactylis hispanica*, *Reichardia picroides* and *Cardaria draba*.

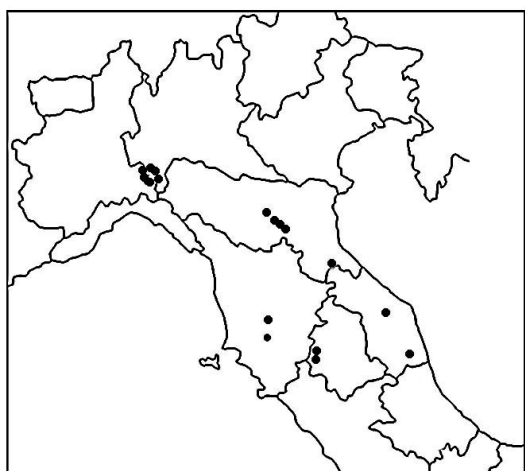


Fig. 6 – Distribution of the association *Agropyro-Asteretum linosyris* of the Northern-Central Apennines

**PODOSPERMO LACINIATI-CARDOPATETUM CORYMBOSI** Biondi, Ballelli, Allegrezza & Manzi 1990 (*Cardopatetum corymbosi* Ferrari & Gerdol 1987 *nom. nud.*)

A perennial pioneering association found on the badlands of Atessa and Gessopalena (Southern Abruzzo) on the “varicolori” clays of the Oligocene (Biondi *et al.*, 1990; Pirone, 1995) (Fig. 8).

It represents the most southern perennial pioneering association of the suballiance *Podospermo laciniati-Elytrigenion athericae*.

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Scorzonera laciniata* and *Cardopatetum corymbosum*.

**ELYTRIGIO ATHERICAE-ARTEMISIETUM CAERULESCENTIS** Pirone 1995

A perennial pioneering association that is considered to be the substitute for the association *Agropyro-Artemisietum cretaceae* (Pirone 1995).

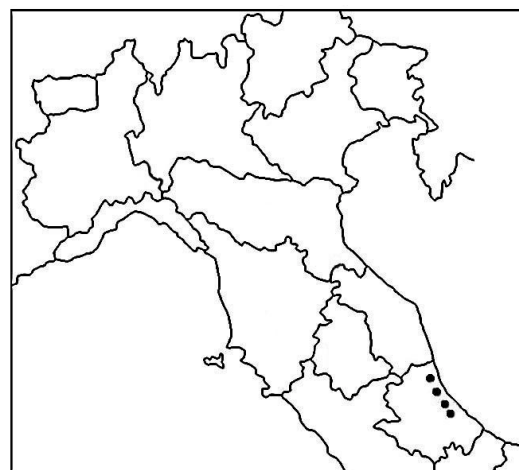


Fig. 7 – Distribution of the association *Cynaro-Agropyretum pungentis* of the Northern-Central Apennines

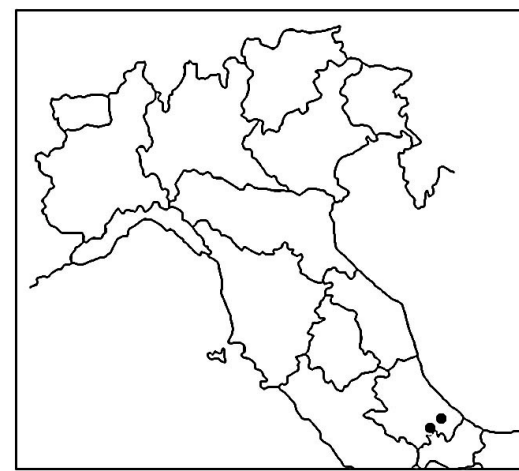


Fig. 8 - Distribution of the association *Podospermo laciniati-Cardopatetum corymbosi* of the Northern-Central Apennines

With respect to this latter association, *Elytrigia athericae*-*Artemisietum caerulescentis* is found on soils with higher concentrations of sodium and with higher pH values (Pirone 1995).

On the calanchi of Atessa (Fig. 9), *Artemisia caerulescens* ssp. *caerulescens* substitutes *Artemisia caerulescens* subsp. *cretacea*, which is itself found on the badlands of Tuscany, Emilia-Romagna and Marche. These two floristic entities can be separated at the level of subspecies (Brilli-Cattarini & Gubellini, 1991). This has also been confirmed through analyses of the essential oils of some of the sub-halophyte and halophyte species of the genus *Artemisia* L. (Biondi *et al.*, 2000).

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Artemisia caerulescens* subsp. *caerulescens*.



Fig. 9 – Distribution of the association *Elytrigia athericae*-*Artemisietum caerulescentis* of the Northern-Central Apennines

### Syntaxonomic scheme of the perennial badlands vegetation of northern-central Italy

In the syntaxonomic scheme of the calanchi vegetation of Northern-Central Italy presented here, we indicate the associations are believed to be valid, along with their relative synonymous syntaxa.

The lectotypes of the non-typified associations are also indicated, and the wrongly corrected names of the associations in Allegrezza *et al.* (1993) are also returned to the original names. In Allegrezza *et al.* (1993), the role of a floristic substitute of *Agropyron pungens* was attributed to *Elytrigia atherica*, while these two are believed instead believed to be synonymous (Conert *et al.*, 1998; Rivas-Martinez *et al.*, 2002).

#### ARTEMISIETEA VULGARIS Lohmeyer, Preising & Tüxen ex von Rochow 1951

*Agropyretalia repentis* Oberdorfer, Müller & Görs in Oberdorfer, Görs, Korneck, Lohmeyer, Müller, Philippi & Seibert 1967

*Inulo viscosae*-*Agropyron repentis* Biondi & Allegrezza 1996

*Inulo viscosae*-*Agropyrenion repentis* Biondi & Pesaresi *suball. nova hoc. loco*

*Daucu carotae*-*Tussilaginietum farfarae* Biondi, Brugiapaglia, Allegrezza & Ballelli 1989

*Epilobio tetragoni-Elymetum pycnanthi* Biondi, Ballelli, Allegrezza & Manzi 1990

[*Epilobio tetragoni-Elytrigietum athericae* Biondi, Ballelli, Allegrezza & Manzi 1990 corr. Biondi & Allegrezza 1996 (syntax. syn.)]

*Agropyro repentis-Dactyletum glomeratae* Ubaldi 1976 em. Ubaldi, Puppi & Speranza 1983

*subass. dactyletosum hispanicae* Ubaldi 1976

*Arundinetum pliniana* Biondi, Brugiapaglia, Allegrezza & Ballelli 1992

*Phalarido coerulescentis-Agropyretum* Loppi & De Dominicis 1990

[*Phalarido coerulescentis-Elytrigietum athericae* Loppi & De Dominicis 1990 corr. (syntax. syn.)]

*subass. inuletosum* Loppi & De Dominicis 1990

*subass. brachypodietosum* Loppi & De Dominicis 1990

*Agrostio stoloniferae-Agropyretum repentis* Biondi & Allegrezza 1996

(corr. a *Elytrigia athericae-Asteretum lynosyris* Ferrari 1971 corr. Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993 *festucetosum arundinaceae* Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993)

*Senecio erucifolii-Inuletum viscosae* Biondi & Allegrezza 1996

*subass. festucetosum arundinaceae* Taffetani 2000

*Podospermo laciniati-Elytrigenion athericae* (Pirone 1995) Biondi & Pesaresi 2004 *stat. nov.*

[*Halo-Artemision* Pignatti 1953 (syntax. syn.), *Halo-Agropyron* Ferrari 1975 (syntax. syn.), *Parapholido-Podospermion canisii* Ferrari & Gerdol 1987 (syntax. syn.), *Podospermo laciniati-Elytrigion athericae* Pirone 1995 (syntax. syn.)]

- Podospermo laciniati-Cardopatetum corymbosi* Biondi, Ballelli, Allegrezza & Manzi 1990  
(*Cardopatetum corymbosi* Ferrari & Gerdol 1987 nom. nud.)  
*Elytrigio athericae-Artemisietum caeruleo-virescentis* Pirone 1995  
*Agropyro-Artemisietum cretaceae* Ferrari & Grandi 1974  
[*Artemisietum cretaceae* Pignatti 1953 n. n. (syntax. syn.), *Parapholido-Artemisietum cretaceae* Branconi, De Dominicis, Boscagli & Boldi 1979 (syntax. syn.), *Elytrigio athericae-Artemisietum cretaceae* Ferrari et Grandi 1974 corr. Allegrezza, Biondi, Brillì-Cattarini & Gubellini 1993 (syntax. syn.)]  
subass. *artemisietosum cretaceae* subass. nova  
(corr. al tipo. Lectotipo n.7 Tab.1 in Ferrari & Grandi 1974)  
subass. *plantaginetosum maritimae* Allegrezza, Biondi, Brillì-Cattarini & Gubellini 1993  
*Agropyro-Asteretum linosyris* Ferrari 1971  
[*Elytrigio athericae-Asteretum linosyris* Ferrari 1971 corr. Allegrezza, Biondi, Brillì-Cattarini & Gubellini 1993 (syntax. syn.)]  
subass. *asteretosum linosyris* subass. nova  
(corr. al tipo in Ferrari 1975. Lectotipo n. 28 Tab. 1 in Ferrari 1971)  
subass. *poetosum bulbosae* Ferrari 1971  
(Lectotipo n.5 Tab. 1 in Ferrari 1971)  
subass. *carthametosum lanati* Taffetani 2000  
*Cynaro-Agropyretum pungentis* (Pirone 1981) Ferrari & Gerdol 1987  
[corr. a *Agropyro-Asteretum linosyris* Ferrari 1971 subass. *dactyletosum hispanicae* Pirone 1981, *Cynaro cardunculi-Elytrigetum athericae* (Pirone 1981) Ferrari & Gerdol 1987 corr. Pirone 1995 (syntax. syn.) ]  
*Podospermo canae-Plantaginetum maritimae* Biondi, Allegrezza, Guitian & Taffetani 1986

### The therophytic vegetation of the badlands of northern-central Italy

Up to the early 1900s, the pioneering vegetation of the badlands was described without any distinctions being made between the perennial and therophytic communities. This thus described a mosaic of vegetation conditions. Later studies paid more attention to the individuation of the area in which the phytosociological relevés were made, and therefore to the floristic uniformity and to the physiognomy of the vegetation. In this way, the perennial communities were defined as being separate from the therophytic communities, which themselves are linked to the particular edaphic conditions of the calanchi soils.

The annual phytocoenoses so far described for the badlands of Northern-Central Italy are *Parapholiso strigosae-Hordeetum marini* (Géhu & De Foucault 1977) subass. *hainardietosum cylindrica* (Biondi *et al.*, 1990), *Hainardio cylindrica-Salsoletum sodae* (Allegrezza *et al.*, 1993), *Anacyclo tomentosii-Hainardietum cylindrica* Pirone 1995 subass. *parapholietosum incurvae* Pirone 1995, and they have been attributed to the alliance *Frankenion pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976, the order *Frankenietalia pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976, and the class *Sagineteta maritimae* Westhoff, Van Leeuwen & Adriani 1962.

From a comparison between the phytosociological tables in Géhu & De Foucault (1977), Biondi *et al.*,

(1990,1992) and Pirone (1995), the vegetal community of *Parapholiso strigosae-Hordeetum marini* (Géhu & De Foucault, 1977) subass. *hainardietosum cylindrica* (Biondi *et al.*, 1990) can be attributed to a new association, which has the name of *Hainardio cylindrica-Parapholidetum strigosae*. This is differentiated from *Parapholiso strigosae-Hordeetum marini* (Géhu & De Foucault, 1977) in its typical aspect by the presence of Mediterranean species, such as: *Hainardia cylindrica*, *Centaureum maritimum*, *Melilotus sulcata*, *Hypochoeris achrophorus* and *Scorpiurus muricatus*. Moreover, from the collated data in Tab. 4, it is possible to see a constant and significant presence of the species *Hordeum marinum* and *Hainardia cylindrica*, which justify the attribution of the vegetal associations *Hainardio cylindrica-Parapholidetum strigosae* ass. nova, *Anacyclo tomentosii-Hainardietum cylindrica* Pirone 1995 subass. *parapholietosum incurvae* Pirone 1995 and *Hainardio cylindrica-Salsoletum sodae* (Allegrezza *et al.*, 1993) to the alliance *Hordeion marini* Ladero, F. Navarro, C.J. Valle, Marcos, Ruiz Téllez & M.T. Santos 1984. This alliance has been described for the alo-sub-nitrophyle graminaceous coenoses of the internal areas that are subjected to brief salt-water stagnation, and it is therefore ecologically related to the calanchi environment. Instead, the alliance *Frankenion pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976 describes the coastal environments, and those more internal that have long-standing stagnant salt water.

### Therophytic communities of the alliance *Hordeion marini*

SAGINETEA MARITIMAE Westhoff, Van Leeuwen & Adriani 1962

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

*Hordeion marini* Ladero, F. Navarro, C.J. Valle, Marcos, Ruiz Téllez & M.T. Santos 1984

An alliance of the alo-sub-nitrophyle, pioneering, therophytic, graminaceous communities of the internal areas, in a Mediterranean bioclimatic environment, with brief water stagnation (Rivas-Martínez *et al.*, 2002).

#### HAINARDIO CYLINDRICAЕ-PARAPHOLIDETUM STRIGOSAE ass. nova

(corr. a *Parapholis strigosae-Hordeetum marini* Géhu & De Foucault 1977 subass. *hainardietosum cylindricae* Biondi, Ballelli, Allegrezza & Manzi 1990)

This vegetation colonises the more active areas of the badlands and the small clay-lime landslips where it is distributed in a mosaic with the hemicryptophytic perennial vegetation (Biondi *et al.*, 1990).

It has been found on the Abruzzo badlands of Gessopalena and Atessa on “scaly” Oligocene clays (Biondi *et al.*, 1990; Pirone, 1995) (Fig. 10), and on the badlands of Pliocene clays of Basilicata near the localities of Ferrandina, Grottole and Tricarico (Biondi *et al.*, 1992). CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Parapholis strigosa*, *Hainardia cylindrica* and *Hordeum maritimum*.

#### ANACYCLO TOMENTOSI-HAINARDIETUM CYLINDRICAЕ Pirone 1995

subass. *parapholietosum incurvae* Pirone 1995

A therophytic pioneering community of the badlands on the very steep sides with a southern exposure; it is often in a mosaic with the vegetation of *Artemisia caerulescens* subsp. *caerulescens*. It has been described for the calanchi of Atessa (Abruzzo) (Pirone, 1995) (Fig. 11).

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Hainardia cylindrica*, *Anacyclus tomentosus* and *Plantago coronopus* ssp. *commutata*.

DIFFERENTIAL SPECIES OF THE SUBASSOCIATION *parapholietosum incurvae*: *Parapholis incurva* and *Hordeum maritimum*.

#### HAINARDIO CYLINDRICAЕ-SALSOLETUM SODAE Allegrezza, Biondi, Brilli-Cattarini & Gubellini 1993

As described for the badlands of the valley of Marecchia (Marche and Emilia-Romagna) and in the Republic of S. Marino (Biondi & Vagge, 2004) (Fig. 12), this represents

a therophytic pioneering vegetation that is in a mosaic with the perennial *Agropyro-Artemisietum cretaceae* (Allegrezza *et al.*, 1993).

CHARACTERISTIC SPECIES OF THE ASSOCIATION: *Salsola soda*.

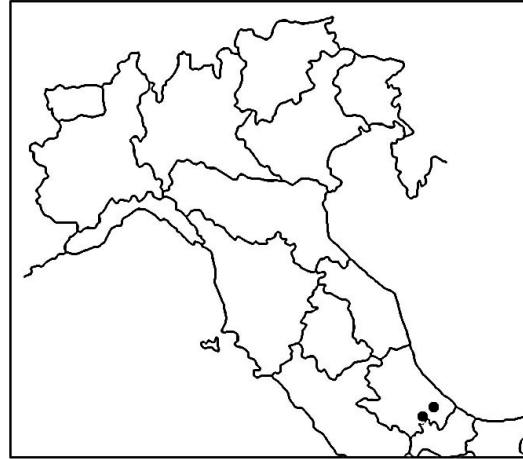


Fig. 10 – Distribution of the association *Hainardio cylindricae-Parapholietum strigosae* of the Northern-Central Apennines



Fig. 11 – Distribution of the association *Anacyclo tomentosii-Hainardietum cylindricae* of the Northern-Central Apennines

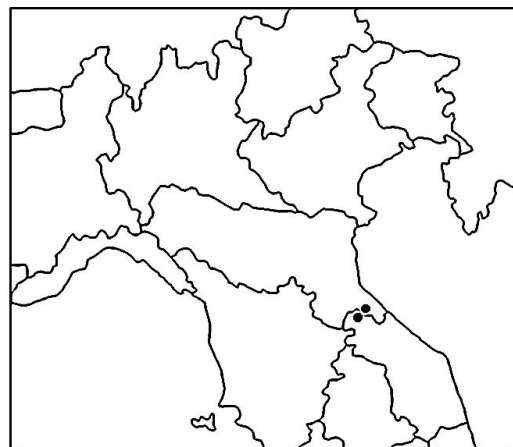


Fig. 12 – Distribution of the association *Hainardio cylindricae-Salsoletum sodae* of the Northern-Central Apennines

Tab.3 - The pioneer therophytic badland vegetation of northern-central Italy

		Col. N.	4	12	3	18
		Rel. N.	8	9	8	6
		Charact. taxa of the Hainardio cylindricae-Salsoletum sodae				
T scap	PALEOTEMP.	Salsola soda L.	V			
		Charact. and diff. taxa of the Hainardio cylindricae-Parapholidetum strigosae				
T scap	MEDIT.ATL.	Parapholis strigosa (Dumort.) Hubbard	V			
		Charact. and diff. taxa of the Anacyclo tomentosi-Hainardietum cylindricae				
T scap	STENOMEDIT.	Anacyclus tomentosus (All.) DC.		V	IV	
T scap		Plantago coronopus L. ssp. commutata (Guss.) Pilger		V	IV	
		Charact. and diff. taxa of the Hordeion marini all.				
		Frankenietalia pulverulenta, Saginetea maritimae				
T scap	EURIMEDIT.	Hainardia cylindrica (Willd.) Greuter	IV	III	V	V
T scap	W-EURIMEDIT.	Hordeum maritimum With.	III	V	-	V
T scap	MEDIT.ATL.(STENO)	Parapholis incurva (L.) Hubbard	-	-	-	V
T scap	EURIMEDIT.	Plantago coronopus L. ssp. coronopus	-	II	-	-
T scap	CIRCUMBOR.	Atriplex latifolia Wahlenb.	II	II	-	-
T scap	PALEOTEMP.	Centaurium tenuiflorum (Hoffm. et Link) Fritsch	-	II	-	-
T scap	STENOMEDIT.	Centaurium maritimum (L.) Fritsch	-	I	-	-
		Charact. taxa of the Brachypodietalia distachyi, Helianthemetea guttati				
T scap	S-EUROP.-SUDSIB.	Xeranthemum cylindraceum S. et S.	-	II	II	-
T scap	S-MEDIT.	Melilotus sulcata Desf.	-	-	II	-
T scap	STENOMEDIT.	Hypochoeris achyrophorus L.	-	II	-	-
T scap	EURIMEDIT.	Euphorbia exigua L.	-	I	-	-
		Charact. species of the Thero-Brometalia ord. and of the Stellarietea mediae class				
T scap	STENOMEDIT.	Phalaris paradoxa L.	-	I	IV	III
T scap	STENOMEDIT.-TURAN.	Aegilops geniculata Roth	-	III	-	I
T scap	MEDIT.-TURAN.	Crepis sancta (L.) Bab.	-	-	IV	I
T scap	SUBCOSMOP.	Bromus hordeaceus L.	I	I	-	-
T scap	EURIMEDIT.	Rapistrum rugosum (L.) All.	III	-	IV	-
T scap	EURASIAT.	Sonchus asper (L.) Hill	-	I	-	-
T scap	EURASIAT.	Sonchus oleraceus L.	-	-	III	-
T scap	EURIMEDIT.	Avena barbata Potter	II	-	-	-
T scap	EURIMEDIT.	Bellardia trixago (L.) All.	-	I	-	-
T scap	EURIMEDIT.	Bromus madritensis L.	I	-	-	-
T rept	COSMOP.	Polygonum aviculare L.	II	-	-	-
		Other species				
H bienn	PALEOTEMP.	Podospermum laciniatum (L.) DC.	-	II	II	III
G rhiz	EURIMEDIT.	Agropyron pungens (Pers.) R. et S.	III	II	III	-
H scap		Beta vulgaris L. ssp. maritima (L.) Arcang.	-	II	III	-
H caesp	PALEOTEMP.	Poa bulbosa L.	-	II	-	I
T scap	EURIMEDIT.	Picris echioides L.	-	-	III	I
Ch suffr	EURIMEDIT.	Artemisia coerulescens L. subsp. caer.	-	-	IV	III
H bienn	PALEOTEMP.	Daucus carota L.	-	II	-	-
H caesp	STENOMEDIT.	Phalaris coerulescens Desf.	-	II	-	-
H scap	PALEOTEMP.	Lotus tenuis W. et K.	-	II	-	-
T scap	MEDIT.-TURAN.	Melilotus indica (L.) All.	-	II	-	-
H scap	EUROSIB.	Picris hieracioides L.	-	I	-	-
H scap	W-STENOMEDIT.	Hedysarum coronarium L.	-	-	III	-
H scap	S-EUROP.-SUDSIB.	Podospermum canum C. A. Meyer	I	-	-	-
Ch suffr	ENDEM.	Artemisia cretacea (Fiori) Pign.	II	-	-	-
H scap	NE-MEDIT.-MONT.	Cardopatum corymbosum (L.) Pers.	-	I	-	-
T scap	NE-EURIMEDIT.	Crepis neglecta L.	-	I	-	-
T scap	EURASIAT.	Geranium dissectum L.	-	I	-	-

### Syntaxonomic scheme of the annual calanchi vegetation of northern-central Italy

SAGINETEA MARITIMAE Westhoff, Van Leeuwen & Adriani 1962

[*Frankenietea pulvulentae* Rivas-Martínez in Rivas-Martínez & Costa 1976 (art. 8), *Frankenietea pulverulentae* Rivas-Martínez ex Castroviejo & Porta 1976 (syntax. syn.)]

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

[*Frankenietalia pulverulentae* Rivas-Martínez in Rivas-Martínez & Costa 1976 (art. 2b)]

*Hordeion marini* Ladero, F. Navarro, C.J. Valle, Marcos, Ruiz Téllez & M.T. Santos 1984

*Hainardio cylindricae-Parapholidetum strigosae* (Biondi, Ballelli, Allegrezza & Manzi 1990)  
Biondi & Pesaresi *stat. nov.*

(corr. a *Parapholiso strigosae-Hordeetum marini* Géhu & De Foucault 1977 *subass.*)

*hainardietosum cylindricae* Biondi, Ballelli, Allegrezza & Manzi 1990)

*Hainardio cylindricae-Salsoletum sodae* Allegrezza, Biondi, Brillì-Cattarini & Gubellini 1993

*Anacyclo tomentosi-Hainardietum cylindricae* Pirone 1995

*subass.parapholietosum incurvae* Pirone 1995

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### Addenda

#### Reference of the relevés in Tab. 2

- Col.1 *Elytrigio athericae-Artemisietum caerulescentis* Pirone 1995 Atesa Val di Sangro (Abruzzo) scaly clays; altit. 350-450m; 6 relevés (Tab.1: 3,5,8,9,10,13).
- Col.5 *Podospermo laciniati-Cardopatetum corymbosi* Biondi et al. 1990 Gessopalena (Abruzzo), scaly clays; altit. 450-610m; 7 relevés (Tab. 4: rel.1-7).
- Col.6 *Podospermo laciniati-Cardopatetum corymbosi* Pirone 1995 Atesa (Abruzzo) scaly clays; altit. 350-450m; 4 relevés (Tab.2: rel. 1-4).
- Col.41 *Agropyro-Asteretum linosyris* Ferrari 1971. M. Paterno (Bologna); 6 relevés (Tab.1: rel.16,17,25,28,30,34).
- Col.42 *Cynaro-Agropyretum pungentis* Pirone 1981 Atri (Abruzzo) pliocene clays. 15 relevés (Tab.1: rel. 1-15).
- Col.2 *Agropyro-Artemisietum cretaceae* Branconi et al. 1979. Southern Tuscany, pliocene clays; altitud. 70-620m; 15 relevés (Tab. 1: rel. 1-8,11-16,19).
- Col.38 *Agropyro-Artemisietum cretaceae* Maccherini et al. 1997 pliocene clays (Tuscany); 44 relevés (Tab.2 group 1).
- Col.15 *Agropyro-Artemisietum cretaceae* Maccherini et al. 1997. Radicofani southern Tuscany; altitud. 514-610m; 12 relevés (Tab. 2: rel.1-12).
- Col.3 *Agropyro-Artemisietum cretaceae* Allegrezza et al. 1993 Val Marecchia scaly clays 420-470m; 10 relevés (Tab.2: rel.1-10).
- Col.16 *Podospermo canae-Plantaginetum maritimae* Biondi et al. 1986 Sasso Simone-Simoncello; altit. 980-985m; 2 relevés (Tab.1: rel.1-2).
- Col.40 *Podospermo canae-Plantaginetum maritimae* var. *Ononis masquilleri* Biondi et al. 1986. Sasso Simone-Simoncello; altit. 970-1060m; 6 relevés (Tab.1: rel.3-8).
- Col.27 *Epilobio tetragoni-Elymetum pycnanthi* Biondi et al. 1990 Gessopalena (Abruzzo) scaly clays; altit. 590-610m; 4 relevés (Tab. 5: rel.1-4).

Col.28 *Epilobio tetragoni-Elymetum pycnanthi* var. a *Festuca arundinacea* Biondi *et al.* 1990 Gessopalena (Abruzzo) scaly clays; altit. 570-590m; 5 relevés (Tab. 5: rel.5-9).

References of the relevés in Tab. 3

Col.4 *Hainardio cylindricae-Salsoletum sodae*, Allegrezza *et al.* 1993 Val Marecchia; altit. 420-460m. 8 relevés (Tab. 1: rel. 1-8).

Col.12 *Hainardio cylindricae-Parapholidetum strigosae* Biondi *et al.* 1990 Gessopalena (Abruzzo); altit. 550-600m. 9 relevés (Tab. 3: rel. 1-9).

Col.3 *Anacyclo tomentosi-Hainardietum cylindricae* Pirone 1995. Atessa (Abruzzo); altit. 350-450m. 8 relevés (Tab.4: rel. 1-8).

Col.18 *Anacyclo tomentosi-Hainardietum cylindricae parapholisetosum incurvae* Pirone 1995. Atessa (Abruzzo); altit. 350-450m. 6 relevés (Tab.4: rel. 9-14).