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Bogs and Mires in Mediterranean Areas: the Vegetation of the Marshlands of the Lacìna Plain (Calabria, S. Italy)

By

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With 8 Figures

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Summary

GARGANO D., PASSALACQUA N. G. & BERNARDO L. 2007. Bogs and mires in Mediterranean areas: the vegetation of the marshlands of the Lacìna Plain (Calabria, S. Italy). – Phyton (Horn, Austria) 47 (1–2): 161–189, with 8 figures. – English with German summary.

The vegetation of wet meadows and marshy zones of the Lacìna Plain (Calabria, Southern Italy) was investigated. This biotope is characterized by the presence of a residual bog which is one of the most southern in Italy. The aims of this paper are: i) describing the plant communities of the studied area, ii) underlining the role of relict elements and to highlight their value for biodiversity conservation. 89 phytosociological relevés from herbaceous vegetation (75) and wet woodlands (14) were taken in the field. The numerical classification and the comparison with data from literature lead to the identification of herbaceous communities of Potametea, Phragmition, Magnocaricion and Calthion. Noteworthy are the new associations Caricetum echinatae GARGANO, PASSALAQUA & BERNARDO ass. nova and Carici demissae-Potametum polygonifolii GARGANO, PASSALAQUA & BERNARDO ass. nova included in the Euro-Siberian alliances Caricion fuscae and Eleocharition acicularis, respectively. The phy-

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tosociological analysis and the ecological characterization of the woody vegetation allow to include the riparian communities into the alliance Alno-Ulmion, while we assigned the marshy woods to the Alnion glutinosae. Its presence is a further aspect underlining the biogeographic value of the Lacìna plain vegetation.

Zusammenfassung

GARGANO D., PASSALACQUA N. G. & BERNARDO L. 2007. Hoch- und Flachmoore im Mediterrangebiet: Die Vegetation der Sumpfgebiete der Lacina-Ebene (Calabrien, S-Italien). – Phyton (Horn, Austria) 47(1–2): 161–189, mit 8 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Die Vegetation der Feuchtwiesen und Sumpfgebiete der Lacina-Ebene (Calabrien, südliches Italien) wurde untersucht. Dieser Lebensraum ist durch einen der südlichst gelegenen Hochmoorreste Italiens ausgezeichnet. Das Anliegen dieser Studie ist: 1) Beschreibung der Pflanzengesellschaften des Gebietes. 2) Hervorheben der Rolle als Relikte und deren Wert für den regionalen Biodiversitäts-Schutz. 89 Vegetationsaufnahmen von krautiger Vegetation (75) und feuchten Gehölzen (14) wurden erhoben. Die numerische Klassifizierung und der Vergleich mit Literatur-Daten erlaubt die Unterscheidung von krautigen Pflanzengesellschaften der Potametea sowie des Phragmition, Magnocaricion und des Calthion. Bemerkenswert sind die neuen Assoziationen Caricetum echinatae GARGANO, PASSALACQUA & BERNARDO ass. nova und Carici demissae-Potametum polygonifolii GARGANO, PASSALACQUA & BERNARDO ass. nova, welche in die euro-sibirischen Verbände Caricion fuscae bzw. Eleocharition acicularis gehören. Die pflanzensoziologische Analyse und ökologische Charakterisierung der Gehölzvegetation erlaubt es, die Ufergesellschaften dem Verband Alno-Ulmion zuzuordnen, die Gehölze der Sümpfe dagegen dem Alnion glutinosae – ein weiterer Grund für den hohen biogeographischen Wert der Vegetion der Lacina-Ebene.

1. Introduction

The hygro-acidophilous plant communities show a boreo-arctic distribution (ROYER & al. 1979), and their occurrence in Southern Europe is restricted to sites showing a local climate as well as special hydrological and chemical conditions of the soils (BALÁTOVÁ-TULAČKOVÁ 1983). These sites are assumed to be relict stands from the last glaciation. However, in the Mediterranean the floristic characterization and the classification of these communities are difficult because of the cumulative loss of boreal and subboreal elements. Indeed, in a southward direction they are replaced by more competitive Mediterranean species (BARBERIS & MARIOTTI 1981). In Italy, hygro-acidophilous vegetation (e.g., Caricetum fuscae BR.-BL. 1915, Tofieldio-Schoenetum BR.-BL. 1971) mainly occurs in the Southern Alps and their foreland (BRAUN-BLANQUET 1971). Other examples of marshy vegetation were studied in the Padanian Plain (e.g., GERDOL 1987; SBURLINO & GHIRELLI 1994; SBURLINO & al. 1995b). In the Central-Southern Apennines these vegetation types are very rare because of the dominance of calcareous soils (TOMASELLI & BERNARDO 2006), and then restricted to the

bottom of karst planes (PEDROTTI 1985, PIRONE 1987, TOMASELLI & BERNARDO 2006). With respect to the region of Calabria, some examples are found in the granite complexes of the Sila Massif (VENANZONI 1988) and Aspromonte (BRULLO & al. 2001).

Human impact reduced the marshlands in a great part of the area considerably. By this their value for biography and conservation increased (SBURLINO & al. 1995a).

The Lacìna plain is characterized by flooded areas where different types of hygro-acidophilous plant communities occur. In the past, FERRARINI & PADULA 1969 carried out an unsuccessful palynological research. More recently BERNARDO & al. 2002 reported the presence of some extremely rare species for the Mediterranean area. However, detailed information about the vegetation of the locality is still lacking and, for this reason, we carried out a phytosociological study presented in this paper.

Unfortunately, the ecosystems which occur in the Lacìna plain are endangered too; indeed, the recent construction of a dike to create a reservoir within the next few years will cause the disappearance of most of the communities described here.

Hence, this work, by archiving information on the biodiversity of the area at specific and community level, aims to furnish a base for monitoring future habitat changes and for planning further conservation strategies like transplantation of the rarest communities.

2. Description of the Study Area

The Serre Calabre, a NE-SW orientated double chain represents the central part of the Calabrian Apennines (Fig. 1). Geologically these mountains are considered a horst whose lifting has been promoted by a fault system since the Lower Pliocene. The dominant bedrock type is granite.

The Lacìna plain (Fig. 1) forms a wide depression (about 4 square kilometers) with an altitudinal range from 950 to 1000 m a.s.l. The Alaco stream crosses the basin. The weathering of granites created the acidic sands which characterize the soils of this area together with lake sediments (clays and silts) of the Quaternary (CALCATERRA & al. 1993).

The local climate is greatly influenced by the geographical situation. Indeed, the proximity of two sea basins (Ionian and Thyrrenian) favours the transport of warm and humid air masses. Despite the strictly Mediterranean latitude of the study area, annual rainfall is high (1840 mm/year). However, a relatively short dry period occurs in the summer season (Fig. 2). Using the bioclimatic classification proposed by RIVAS-MARTINEZ 1982, the area is included in the upper colline belt of the temperate region, with a lower hyperhumid ombrotype.

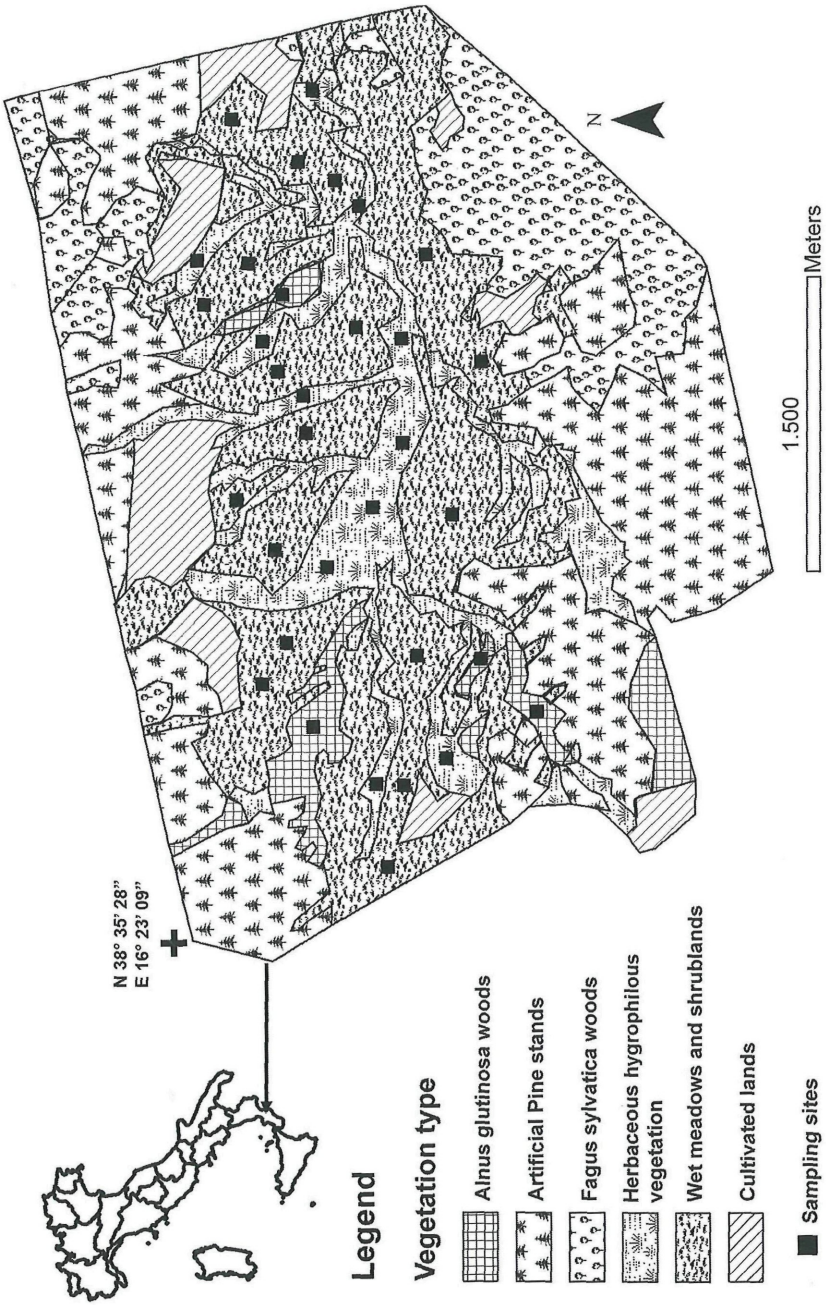

Fig. 1. Location of the Serre Calabre on the Italian peninsula and land use map of the study area.

The surrounding woody vegetation is characterized by mixed woodlands of *Fagus sylvatica* and *Abies alba* belonging to Anemono apenninae-Fagetum (GENTILE 1969) BRULLO 1984 (BARBAGALLO & al. 1982 sub Aquifolio-Fagetum GENTILE 1969). In the degraded areas shrubby coenoses of *Cytisus scoparius* and *Pteridium aquilinum* occur, assigned to the Polygalo-Cytisetum scoparii BRULLO & FURNARI 1982 by BARBAGALLO & al. 1982.

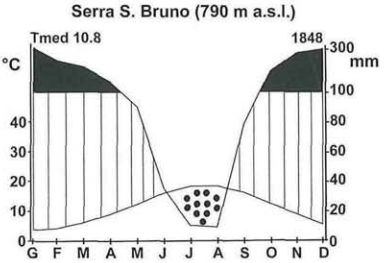

Fig. 2. Bagnoul-Gaussen climadiagram of Serra S. Bruno (Lacìna plain). The data refer to the station closest (4 km) to the study area.

3. Material and Methods

3.1.

Species were identified following TUTIN & al. 1964–1980, PIGNATTI 1982, HUBBARD 1984 and PRESTON 1995. Nomenclature follows PIGNATTI 1982. As vouchers 364 herbarium specimens have been collected in the field and deposited in the Herbarium of the University of Calabria (CLU).

3.2. Vegetation Sampling

The vegetation was studied using the phytosociological method (BRAUN-BLANQUET 1964). A systematic vegetation sampling was made taking 89 phytosociological relevés in the following formations (defined as in ELLENBERG & MUELLER-DOMBOIS 1967):

Dwarf shrub communities with *Genista anglica;*
Deschampsia caespitosa-Juncus effusus grasslands;
tall sedge communities, temperate reed-swamp on river banks, temperate herbaceous floating meadows (dominated by small helophytes);
temperate rooted floating-leaf communities (dominated by *Potamogeton natans*);
blanket bogs;
Alnus glutinosa woodlands.

The cover of the species was estimated using the BRAUN-BLANQUET scale as modified by PIGNATTI & MENGARDA 1962, so: r = rare species; + = cover < 1 %; 1 = 1 % < cover < 20 %; 2 = 20 % < cover < 40 %; 3 = 40 % < cover < 60 %; 4 = 60 % < cover < 80 %; 5 = 80 % < cover < 100 %.

Moreover, two transects were taken across bog- and aquatic vegetation and within the woodlands of *Alnus glutinosa* and the tall hygrophilous grasslands.

3.3. Data Analysis

The phytosociological relevés are presented in six floristic tables (Tab. 1–6, companion species with only one presence are omitted). The relevés with herbaceous

vegetation, after the exclusion of species with only one presence and the transformation of the cover values (VAN DER MAREEL 1979), were used to generate a matrix of 61 species × 75 relevés. This matrix was numerically classified by three methods based on the chord distance: incremental sum of squares (ISS), UPGMA and Global Optimization (GO). On the same data-set, we performed a principal components analysis (PCA) and a non metric multi-dimensional scaling (NMDS).

The vegetation units obtained from the numerical data analysis process were compared with the syntaxa from the literature, principally OBERDORFER 1977, 1983, VENANZONI 1988, BRULLO & al. 1994, BRULLO & al. 2001.

The syntaxonomic definition of the woody vegetation was obtained by comparing our data set with BARBAGALLO & al. 1982, DUMONT 1984, NOIRFALISE & DETHIOUX 1984, ROULIER 1984 and BRULLO & al. 2001.

4. Results

4.1. Vegetation Types

All applied classification methods identify 15 terminal groups of relevés (Fig. 3–5) which are roughly characterized by dominant species. However, in few cases relevés with the same dominant species are split into different groups and arranged in a different way depending on the agglomerative method.

The relevés dominated by *Deschampsia caespitosa* (L.) BEAUV. and *Juncus effusus* L. are all in the DESCH group (Fig. 3–5), characterized also by *Galium debile* DESV., *Lotus pedunculatus* CAV. and H*olcus lanatus* L. (Tab. 1). DESCH shows a high floristic correspondence with the communities studied by BRULLO & al. 2001 in the Aspromonte mountains, and described as Galio debilis-Deschampsietum caespitosae BRULLO, SCELSI & SPAMPINATO 2001. For this reason we include our relevés in this association. In our classification processes the DESCH group appeared related to *Carex vesicaria* L. formations, CARVE (UPGMA and ISS, Fig. 3–4), and to a group of relevés dominated by *Genista anglica*, GENIS1 (ISS, Fig. 4). The floristic composition of relevés of the GENIS1 group (Tab. 1) suggests that they can be considered as a variant of the Galio debilis-Deschampsietum caespitosae typicum.

The relevés included in CAREC1-2 (Fig. 3–5) show a dominance of *Carex echinata* MURRAY (Tab. 2), other characterizing species are *Epipactis palustris* (L.) CRANTZ, *Carex demissa* HORNEM. and *Carex distans* L.; moreover, in CAREC1, *Sphagnum fallax* H. KLINGGR. show a high frequency and high cover values. This group is always linked to GENIS2 (Fig. 3–5), representing stands with dominant *Genista anglica*, where some species of CAREC1-2 show high frequencies. Considering the grouping models and the floristic composition, we propose to include the relevés of the group CAREC1-2 into a new association:

Caricetum echinatae GARGANO, PASSALACQUA & BERNARDO, ass. nova hoc loco; Tab. 2, nomenclatural type: rel. 81 (holotypus).

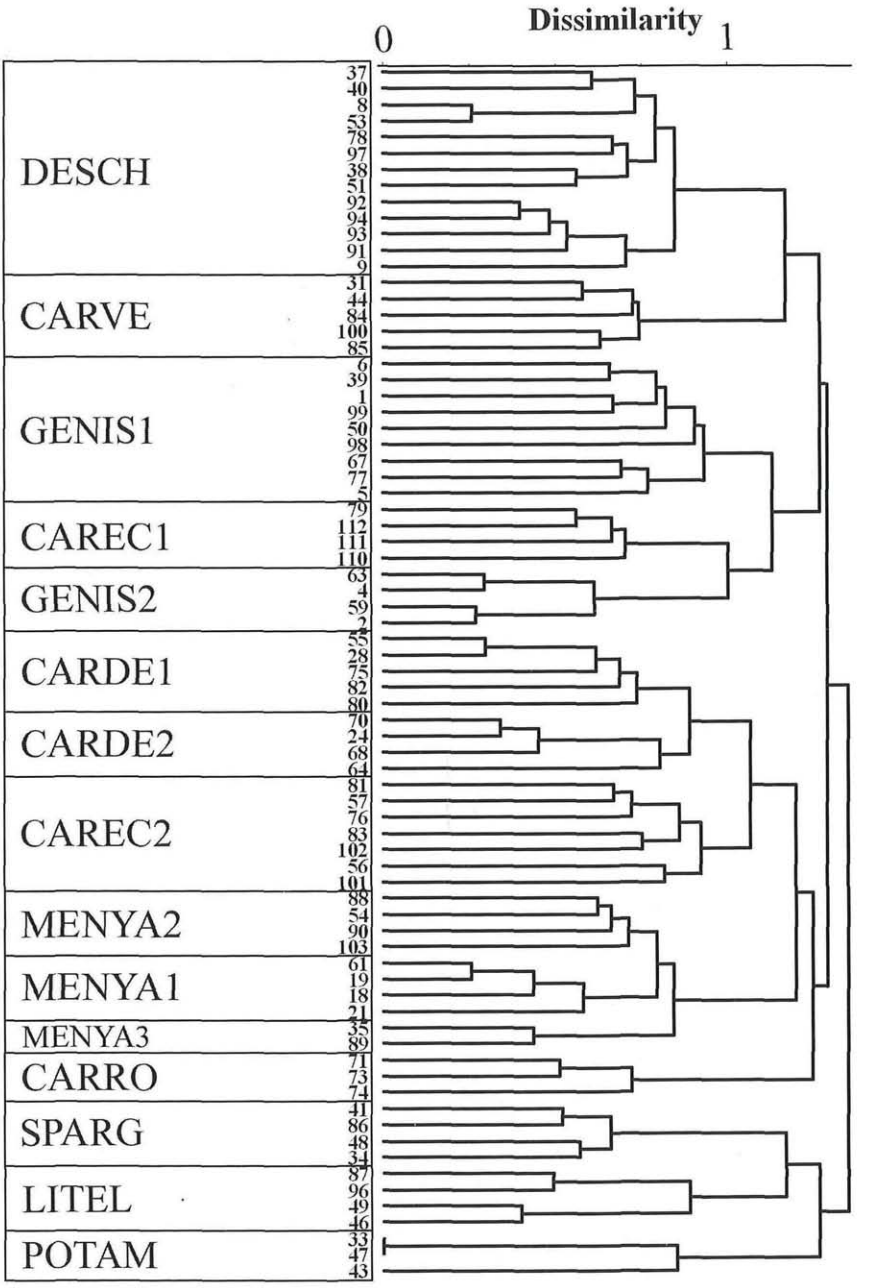

Fig. 3. Dendrogram produced by UPGMA.

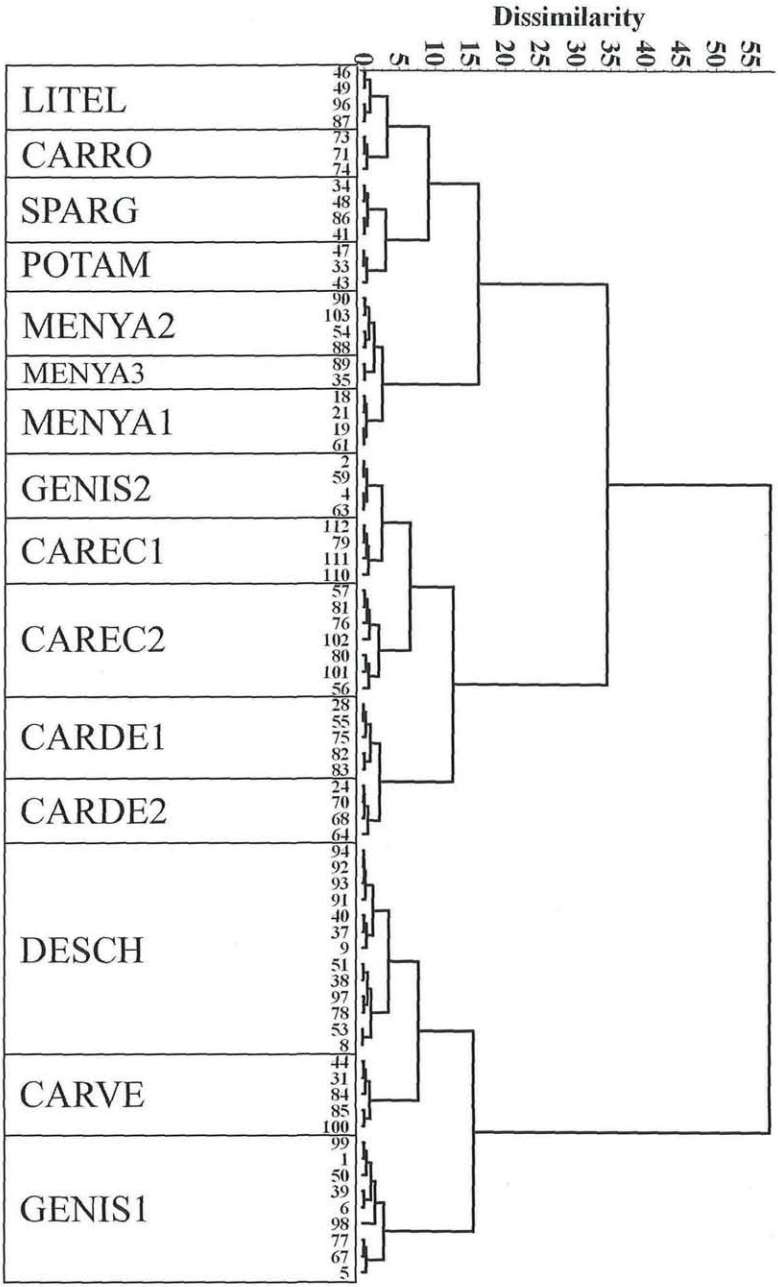

Fig. 4. Dendrogram produced by Incremental Sum of Squares (ISS).

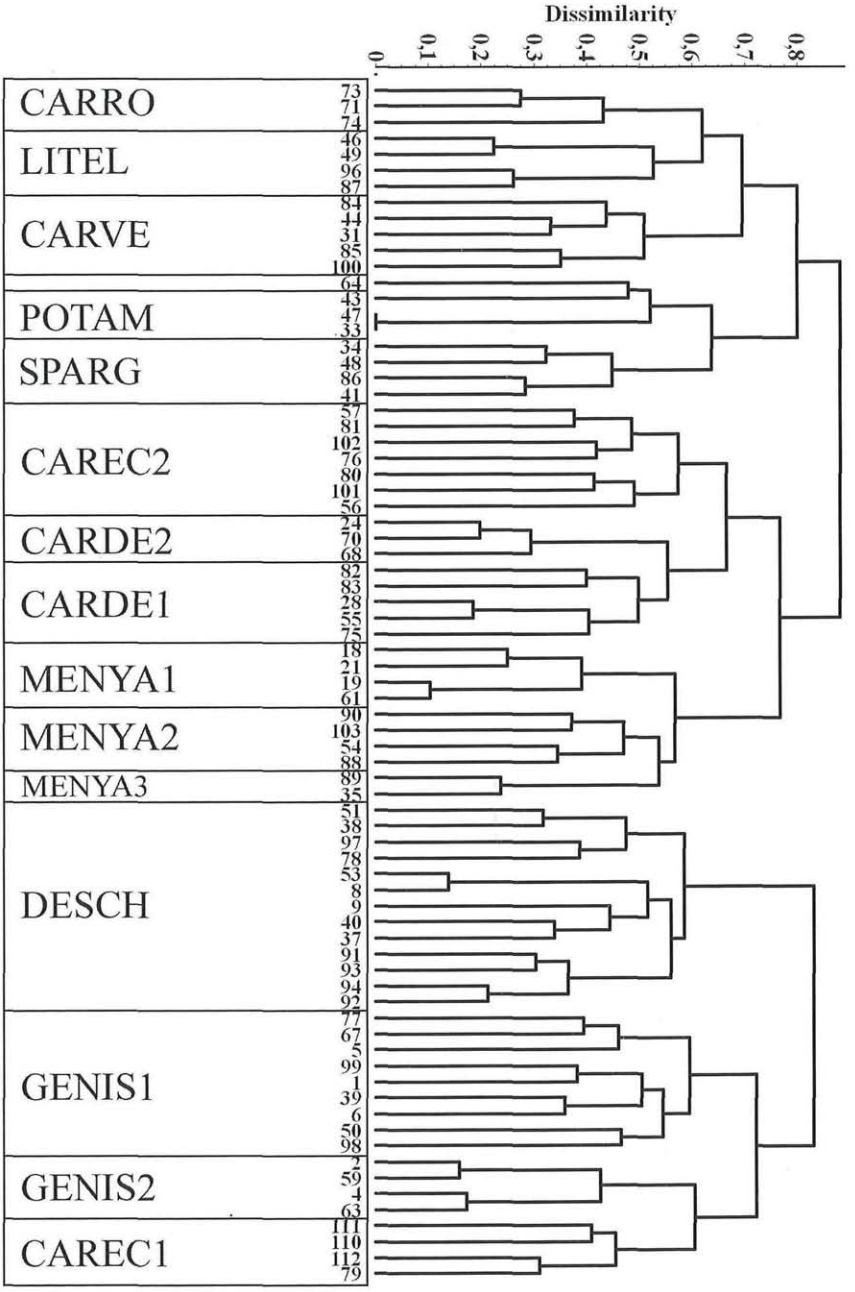

Fig. 5. Dendrogram produced by Global Optimizaztion (GO).

Table 1. Galio debilis-Deschampsietum caespitosae typicum.

	var. typica (DESCH)													Genista anglica variant (GENIS1)								
Relevé Number	37	40	8	53	78	97	38	51	92	94	93	91	9	5	67	77	6	39	98	50	99	1
Elevation (dam a.s.l.)	105	99	99	99	99	99	99	99	99	99	99	105	100	99	99	99	99	100	99	99	99	99
Surface (m2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Cover (%)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
N° of Species	8	18	12	13	17	14	12	9	18	11	13	13	8	8	11	18	11	12	13	6	15	23
ASSOCIATION *(Galio debilis-Deschampsietum caespitosae)*																						Pr.(%)
Deschampsia caespitosa (L.) Beauv.	3	2	4	4	5	5	5	4	3	3	1	2	1	1	1	3	1	2	.	1	4	2	95
Galium debile Desv.(d)	+	+	+	+	+	.	.	+	+	+	1	+	1	.	.	.	+	.	.	.	.	.	55
Genista anglica variant																						
Genista anglica L.	.	.	.	.	+	r	1	.	.	.	.	.	.	4	3	2	5	5	4	3	5	5	55
ALLIANCE *(Calthion)*																						
Juncus effusus L.	4	4	2	2	1	1	2	3	4	5	5	5	5	.	.	.	.	.	.	.	+	.	64
Lotus pedunculatus Cav.	1	1	+	+	+	+	.	.	+	.	.	.	1	.	.	1	.	.	+	.	+	.	50
Holcus lanatus L.	.	.	.	.	.	1	.	.	1	1	1	1	.	.	.	.	.	.	2	.	1	.	32
Equisetum palustre L.	+	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
ORDER *(Molinietalia)* and CLASS *(Molinio-Arrhenatheretea)*																						
Potentilla reptans L.	.	1	.	.	1	1	+	1	.	.	.	.	.	.	1	+	2	1	+	.	+	1	55
Cirsium palustre (L.) Scop.	.	1	+	+	1	+	1	.	+	+	.	+	.	.	.	.	.	.	.	.	.	.	41
Hypericum tetrapterum Fries.	.	1	+	+	.	+	.	.	+	+	1	+	.	.	.	.	.	.	.	.	.	.	36
Carex distans L.	.	.	.	.	.	.	+	.	1	+	1	.	.	.	.	1	1	.	.	.	.	.	27
Cirsium vallis-demonis Lojac.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	r	.	.	+	1	+	+	27
Agrostis stolonifera L.	.	.	.	.	+	+	.	.	.	.	.	.	.	3	3	2	.	.	.	.	.	.	23
Prunella vulgaris L.	.	+	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	+	.	.	+	23
Cynosurus cristatus L.	+	1	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	18
Epilobium palustre L.	.	.	.	.	.	.	.	.	+	1	1	1	.	.	.	.	.	.	.	.	.	.	18
Thalictrum simplex L.	.	.	.	.	.	.	.	.	+	.	.	1	1	.	.	.	.	.	.	2	.	.	18
Carex ovalis Gooden.	.	.	.	.	1	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
Dactylorhiza maculata (L.) Soó subsp. saccifera (Brongn.) Diklic	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	14
Rumex acetosa L.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	14
Ajuga reptans L.	.	.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
Ranunculus repens L.	.	.	.	.	1	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	9
Trifolium dubium Sibth.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Trifolium pratense L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	5
Phragmito-Magnocaricetea																						
Mentha aquatica L.	.	1	.	.	.	+	.	1	2	2	2	+	1	.	.	.	+	.	.	.	.	.	41
Lycopus europaeus L.	.	.	+	+	.	.	.	.	+	1	+	.	.	.	.	.	.	.	.	.	.	.	23
Veronica scutellata L.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	14
Carex vesicaria L.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	9
Carex pseudocyperus L.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	5
Scheuchzerio-Caricetea fuscae																						
Carex echinata Murray	.	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	+	.	14
Carex demissa Hornem	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	14
Epipactis palustris (L.) Crantz	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Menyanthes trifoliata L.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	5

Table 1. Continuation

Relevé Number	37	40	8	53	78	97	38	51	92	94	93	91	9	5	67	77	6	39	98	50	99	1	
Companions																							
Holcus mollis L.	1	2	.	.	+	.	.	.	.	.	.	.	.	1	3	2	1	3	.	1	.	+	45
Cruciata laevipes Opiz	.	+	+	+	+	.	.	.	+	.	.	.	.	.	+	r	.	.	.	.	+	.	36
Potentilla erecta (L.) Raeusch.	.	.	.	.	+	1	1	.	+	+	.	.	.	3	.	+	.	.	.	.	.	.	32
Bromus erectus Huds.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	+	.	+	2	23
Festuca microphylla (St.-Yves ex Coste) Patzke	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	1	1	.	.	+	.	23
Ranunculus flammula L.	.	+	+	+	+	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	23
Aira caryophyllea L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	+	.	.	+	18
Bellis annua L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	14
Carex caryophyllea Latourr.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	.	.	+	14
Crepis leontodontoides All.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	1	.	.	.	.	14
Danthonia decumbens (L.) DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	+	14
Malva moschata L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	+	.	.	+	14
Oenanthe pimpinelloides L.	.	+	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	+	.	.	.	14
Ranunculus sardous Crantz	.	.	.	.	+	.	1	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	14
Anthemis arvensis L. subsp. arvensis	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	9
Arisarum cf. proboscideum (L.) Savi	.	.	.	.	.	.	.	.	+	.	.	r	.	.	.	.	.	.	.	.	.	.	9
Equisetum arvense L.	+	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
Hypochoeris radicata L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	9
Lotus corniculatus L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	+	.	.	.	.	9

Table 2. Caricetum echinatae GARGANO, PASSALACQUA & BERNARDO, ass. nova.

	typicum (CAREC2)							*sphagnetosum fallacis* subass. nova (CAREC1)								
								var. typica				*Genista anglica* variant (GENIS2)				
Relevé Number	102	81	57	76	101	83	56	110	111	112	79	4	63	2	59	
Elevation (m a.s.l.)	99	99	99	99	100	100	105	100	100	100	100	105	105	105	105	
Surface (m2)	80	80	80	80	80	80	90	80	90	90	90	90	90	100	100	
Cover (%)	100	90	90	100	90	90	100	100	100	100	100	100	100	100	100	
N° of Species	14	14	11	10	13	14	11	6	9	7	12	11	9	10	8	
ASSOCIATION ***(Caricetum echinatae)***																Pr.(%)
Carex echinata Murray	3	5	4	5	2	2	3	2	1	2	3	1	1	.	.	87
subass. ***sphagnetosum fallacis***																
Sphagnum fallax H. Klinggr.	.	.	.	.	.	.	1	5	5	5	3	.	.	+	.	40
***Genista anglica* variant**																
Genista anglica L.	.	.	.	2	+	.	+	1	1	1	1	4	4	4	4	73
ALLIANCE ***(Caricion fuscae)***																
ORDER ***(Caricetalia fuscae)*** **and CLASS**																
(Scheuchzerio-Caricetea fuscae)																
Carex demissa Hornem.	1	1	+	+	+	3	.	.	1	2	1	1	1	2	2	87
Carex distans L.	1	1	.	.	3	2	3	.	1	2	+	1	1	3	3	80
Dactylorhiza maculata (L.) Soó subsp. saccifera (Brongn.) Diklic	.	.	.	.	.	.	.	.	.	r	+	+	+	r	.	33
Ranunculus flammula L.	.	+	1	.	+	.	+	.	.	.	.	.	.	.	.	27
Epipactis palustris (L.) Crantz	+	.	.	.	r	.	.	.	.	.	.	.	.	.	.	13
Littorelletea																
Potamogeton polygonifolius Pourr.	1	+	1	+	.	3	.	.	+	.	.	.	.	.	.	40
Juncus bulbosus L.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	7
Phragmiti-Magnocaricetea																
Mentha aquatica L.	2	+	1	1	1	1	+	+	+	.	.	.	.	.	.	60
Lycopus europaeus L.	.	+	+	+	.	.	.	.	.	.	.	.	.	.	.	20
Sparganium erectum L.	.	+	.	.	.	1	.	.	.	.	.	.	.	.	.	13
Veronica scutellata L.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	7
Molinio-Arrhenatheretea																
Juncus effusus L.	.	+	.	1	1	.	.	2	.	.	+	2	2	+	+	60
Danthonia decumbens (L.) DC.	.	+	+	.	.	.	.	+	.	2	1	+	+	+	+	60
Festuca microphylla (St.-Yves ex Coste) Patzke	.	.	.	.	.	.	+	.	2	.	1	1	1	2	2	47
Galium debile Desv.	+	+	+	+	.	.	+	.	.	.	.	.	.	.	.	33
Holcus lanatus L.	1	1	.	.	1	+	.	.	+	.	.	.	.	.	.	33
Holcus mollis L.	.	.	1	.	.	.	2	.	.	.	1	1	1	.	.	33
Lotus pedunculatus Cav.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	20
Potentilla erecta (L.) Raeusch.	.	.	.	.	.	.	.	.	.	.	+	1	.	+	.	20
Cirsium palustre (L.) Scop.	+	.	.	.	.	+	.	.	.	.	.	.	.	.	+	20
Juncus fontanesii J.Gay	.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	13
Juncus articulatus L.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	.	13
Lysimachia vulgaris L.	+	.	.	.	.	.	+	.	.	.	.	.	.	.	.	13
Cynosurus cristatus L.	+	.	.	.	.	1	.	.	.	.	.	.	.	.	.	13
Deschampsia caespitosa (L.) Beauv.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	7
Carex ovata Gooden.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	7
Hypericum tetrapterum Fries	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Prunella vulgaris L.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Agrostis stolonifera L.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	7
Companions																
Crepis leontodontoides All.	.	.	.	.	.	+	+	.	.	.	.	+	.	+	+	33
Alnus glutinosa (L.) Gaertner	.	+	.	.	.	+	.	.	.	.	.	.	.	.	.	13

The group CAREC1 in this association we consider as a new subassociation:

Caricetum echinatae sphagnetosum fallacis GARGANO, PASSALACQUA & BERNARDO subass. nova hoc loco; Tab. 2, nomenclatural type: rel. 112 (holotypus), whereas GENIS2 can be considered as a variant of the subassociation sphagnetosum fallacis, mainly characterized by the dominance of *Genista anglica*.

Carex demissa, together with *Potamogeton polygonifolius* POURR., dominates the relevés of CARDE1-2 (Tab. 3). In all agglomerative methods

Table 3. Carici demissae-Potametum polygonifolii GARGANO, PASSALACQUA & BERNARDO ass. nova.

	typicum									menyanthetosum trifoliatae subass. nova (MENYA1)				
	var. typica (CARDE2)				*Carex echinata* variant (CARDE1)									
Relevé Number	24	70	68	64	82	75	55	28	80	21	18	19	61	
Elevation (m a.s.l.)	1000	1000	1000	1000	990	990	990	990	1000	1000	1000	1000	990	
Surface (m2)	40	50	50	50	80	80	80	80	80	50	60	50	60	
Cover (%)	60	60	60	60	100	100	100	90	100	80	80	80	80	
N° of Species	7	7	6	5	9	10	7	10	11	15	14	10	11	
ASSOCIATION (*Carici demissae-Potametum polygonifolii*)														Pr. (%)
Carex demissa Hornem (D)	3	4	2	1	4	5	4	4	3	+	+	+	+	100
Potamogeton polygonifolius Pourr. (TC)	4	3	3	4	2	1	2	2	.	+	+	2	2	92
subass. *menyanthetosum trifoliatae*														
Menyanthes trifoliata L.	.	.	+	.	.	.	.	.	.	4	5	5	5	38
***Carex echinata* variant**														
Carex echinata Murray	.	.	.	.	.	1	1	1	2	1	1	+	+	62
ALLIANCE (*Eleocarition acicularis*)														
Ranunculus flammula L. (D)	2	1	.	.	+	1	1	1	+	3	2	1	1	85
Juncus bulbosus L.	3	2	2	1	.	.	.	.	.	.	.	.	.	31
Veronica scutellata L. (D)	.	.	.	.	.	.	+	+	.	.	.	.	.	15
Scheuchzerio-Caricetea fuscae														
Carex distans L.	.	.	.	.	+	.	.	.	1	+	+	+	1	46
Dactylorhiza maculata (L.) Soó subsp. saccifera (Brongn.) Diklic	.	.	.	.	.	.	.	.	.	+	+	.	.	15
Epipactis palustris (L.) Crantz	.	.	.	.	.	.	.	.	.	+	.	.	.	8
Sphagnum fallax H. Klinggr.	.	.	.	.	.	.	.	.	.	.	+	.	.	8
Phragmito-Magnocaricetea														
Mentha aquatica L.	1	1	+	1	1	1	1	1	+	.	+	.	1	85
Lycopus europaeus L.	+	+	.	.	.	1	.	.	.	.	+	+	+	46
Molinio-Arrhenatheretea														
Juncus articulatus L.	.	1	+	+	.	1	.	.	.	1	1	+	+	62
Danthonia decumbens (L.) DC.	.	.	.	.	1	.	1	1	1	+	+	+	+	62
Lysimachia vulgaris L.	+	.	.	.	.	.	.	+	.	+	.	.	.	23
Cynosurus cristatus L.	.	.	.	.	.	.	.	.	.	.	+	+	+	23
Lotus pedunculatus Cav.	.	.	.	.	.	+	.	.	.	+	.	.	.	15
Juncus effusus L.	.	.	.	.	.	.	.	.	.	+	+	.	.	15
Juncus fontanesii J.Gay	.	.	.	.	2	.	.	.	+	.	.	.	.	15
Holcus lanatus L.	.	.	.	.	+	.	.	.	+	.	.	.	.	15
Hypericum tetrapterum Fries	.	.	.	.	.	+	.	.	.	.	.	.	.	8
Companions														
Genista anglica L.	.	.	.	.	.	.	.	+	+	.	.	.	.	15

Table 4. Stream bank and pond communities.

	Caricetum vesicariae (CARVE)					*Carex rostrata* community (CARRO)			Sparganietum erecti (SPARG)				*Ranunculus flammula-Juncus articulatus* community (LITEL)				*Menyanthes trifoliata* community (MENYA2-3)						
Relevé Number	44	84	31	100	85	71	73	74	41	86	34	48	46	49	96	87	35	89	88	54	103	90	
Elevation (dam a.s.l.)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	980	980	100	980	100	
Surface (m^2)	50	40	40	50	40	40	40	40	50	50	50	50	40	40	40	40	45	50	40	45	45	50	
Cover (%)	100	100	100	100	100	100	100	100	100	100	90	90	50	60	50	50	80	80	80	80	80	80	
N. of species	7	9	8	8	8	12	8	13	9	11	1	3	7	6	10	6	2	6	16	13	15	19	
ASSOCIATION (*Caricetum vesicariae*)																							Pr.(%)
Carex vesicaria L.	5	5	4	5	5	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	27
***Carex rostrata* community**																							
Carex rostrata Stokes	.	.	.	.	.	4	4	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	14
ASSOCIATION (*Sparganietum erecti*)																							
Sparganium erectum L.	1	.	.	.	.	.	.	.	5	5	5	5	.	.	1	1	.	.	.	.	.	1	36
***Ranunculus flammula-Juncus articulatus* community**																							
Ranunculus flammula L.	.	1	.	.	.	1	+	+	1	+	.	.	3	3	2	.	.	1	1	+	.	+	59
Juncus articulatus L.	.	.	.	+	.	1	.	+	.	.	.	.	1	2	3	3	.	1	2	+	1	1	55
***Menyanthes trifoliata* community**																							
Menyanthes trifoliata L.	.	2	.	1	.	.	.	.	.	.	.	.	.	.	.	.	3	5	5	5	4	5	36
ALLIANCE (*Magnocaricion*)																							
Lysimachia vulgaris L. (D)	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	14
Galium debile Desv.	+	+	.	.	.	.	.	+	.	+	.	.	.	.	.	.	.	+	+	+	+	1	41
ALLIANCE (*Phragmition*)																							
ORDER (*Phragmitetalia*) and CLASS (Phragmito-Magnocaricetea)																							
Mentha aquatica L.	2	1	2	1	.	+	1	1	2	+	.	2	2	2	1	1	.	.	1	+	1	2	82
Lycopus europaeus L.	.	+	+	.	+	+	+	+	.	+	.	.	.	.	+	+	.	.	.	.	.	.	41
Carex pseudocyperus L.	.	.	.	.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	r	+	1	+	27
Glyceria fluitans (L.) R. Br.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	2	2	.	.	.	.	.	.	18
Alisma plantago-aquatica L.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	5

Table 4. Continuation

Relevé Number	44	84	31	100	85	71	73	74	41	86	34	48	46	49	96	87	35	89	88	54	103	90	
Scheuchzerio-Caricetea fuscae																							
Carex echinata Murray	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	+	18
Epipactis palustris (L.) Crantz	.	.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	14
Carex demissa Hornem (D)	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	+	9
Carex distans L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	9
Sphagnum fallax H. Klinggr.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Littorelletea																							
Veronica scutellata L.	.	.	.	.	.	1	+	+	.	+	.	.	.	+	.	.	.	.	.	+	.	+	32
Potamogeton polygonifolius Pourr.	.	.	.	.	.	1	2	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1	18
Molinio-Arrhenatheretea																							
Juncus effusus L.	2	1	1	.	+	+	+	1	.	.	.	.	.	.	.	.	.	.	+	+	2	1	50
Lotus pedunculatus Cav.	1	.	1	+	1	1	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	+	41
Hypericum tetrapterum Fries	.	+	.	.	.	.	.	+	+	+	.	.	.	.	.	.	.	.	.	+	+	+	32
Deschampsia caespitosa (L) Beauv.	.	.	1	1	+	.	.	.	.	.	.	.	.	.	.	.	.	.	r	.	.	.	18
Epilobium palustre L.	.	.	.	+	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	+	.	18
Equisetum palustre L.	.	.	.	.	.	.	.	.	1	.	.	.	1	.	+	.	.	.	.	.	+	.	18
Ranunculus repens L.	.	r	.	.	.	+	.	.	.	+	.	.	.	.	.	.	.	.	r	.	.	.	18
Holcus lanatus L.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1	18
Ajuga reptans L.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
Carex ovata Gooden.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	r	+	.	.	9
Companions																							
Potamogeton natans L.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	+	+	1	2	.	.	.	.	23
Ludwigia palustris (L.) Elliott	.	.	.	.	.	.	.	.	1	+	.	.	1	2	.	.	.	.	.	.	.	.	18
Holcus mollis L.	.	.	1	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	r	.	.	6	14

the groups CARDE1-2 appear together (Fig. 3–5), linked to *Carex echinata* (CAREC2 in Fig. 3 and Fig. 5; CAREC1-2 in Fig. 4) and to *Menyanthes trifoliata* L. formations (MENYA1-3 in Fig. 3 and Fig. 5). We consider CARDE1-2 as a new association:

Carici demissae-Potametum polygonifolii GARGANO, PASSALACQUA & BERNARDO ass. nova hoc loco; Tab. 3, nomenclatural type: rel. 70 (holotypus).

It is characterized by *Carex demissa* and *Potamogeton polygonifolius*. While in CARDE2 the cover of *Juncus bulbosus* L. is important, in CARDE1 and in MENYA1 it is missing. In these relevé groups *Carex echinata, Ranunculus flammula* L. and *Veronica scutellata* L. are the differentiating species. According to the considerations reported above, the Carici demissae-Potametum polygonifolii appears floristically connected to the Caricetum echinatae through the relevés of the CARDE1. It represents a variant inside the Carici demissae-Potametum polygonifolii subass. typica.

The groups MENYA1-3 are characterized by the dominance of *Menyanthes trifoliata*, which can be accompanied by many elements of the previous group. The position of these units varied in the classification and ordinal processes. In fact, in two cases MENYA1-3 appeared connected to CARDE1-2 (Fig. 3 and Fig. 5), while the ISS method (Fig. 4) presents a relation to the context which includes helophytic and aquatic vegetation. We consider MENYA1 as a subassociation of the Carici demissae-Potametum polygonifolii:

Carici demissae-Potametum polygonifolii menyanthetosum trifoliatae GARGANO, PASSALACQUA & BERNARDO subass. nova hoc loco; Tab.3, nomenclatural type: rel. 19 (holotypus),

for the constant presence of *Carex demissa, Potamogeton polygonifolius* and *Ranunculus flammula;* while the groups MENYA2-3, here defined as *Menyanthes trifoliata* communitiy, appear closer to the vegetation types including POTAM, SPARG, CARRO and LITEL (Tab. 4).

The relevés which compose CARRO (Tab. 4) are dominated by *Carex rostrata* STOKES. Species like *Mentha aquatica* L., *Lycopus europaeus* L., *Potamogeton polygonifolius, Ranunculus flammula, Veronica scutellata* and *Juncus effusus* play a prominent role. Beside *Carex rostrata*, we could not identify any characterizing element; for this reason we defined this unit as *Carex rostrata* community.

In CARVE (Tab. 4) *Carex vesicaria* is the dominant *Carex* species. It is accompanied by *Lysimachia vulgaris* L., *Lycopus europaeus, Sparganium erectum* L., *Juncus effusus* and others. We consider this unit referable to the Caricetum vesicariae BR.-BL. & DENIS 1926, (probably a jounger synonym of Caricetum vesicariae CHOUARD 1924), although its definition is prevalently based on physiognomic characters.

The relevés included in SPARG (Tab. 4) are dominated by *Sparganium erectum*, while other species (i.e. *Carex pseudocyperus* L., *Mentha aquatica* and *Lycopus europaeus*) show notable lower cover values. This vegetation type is probably referable to the helophytic Sparganietum erecti described by PHILIPPI 1973.

LITEL (Tab. 4) represents a vegetation dominated by small helophytes like *Ranunculus flammula, Juncus articulatus* L. and by *Mentha aquatica*. In this heterogeneous and semi-floating vegetation, defined as *Ranunculus flammula-Juncus articulatus* community, characteristic elements are lacking. Therefore a precise phytosociological definition is difficult.

POTAM (Tab. 5) includes very poor formations, mostly dominated by *Potamogeton natans* L. We define this aquatic vegetation as *Potamogeton natans* community.

Table 5. *Potamogeton natans* community.

	POTAM			
Relevé Number	47	33	43	
Elevation (dam a.s.l.)	100	100	100	
Surface (m^2)	20	20	20	
Cover (%)	40	40	40	
N° of Species	1	2	3	
***Potamogeton natans* community**				Pr.(%)
Potamogeton natans L.	4	5	1	100

The relevés with *Alnus glutinosa* are reported in Tab. 6. Besides *Alnus glutinosa*, the most frequent species are *Juncus effusus, Crataegus monogyna* JACQ. *Carex remota* L., *Sambucus nigra* L., *Solanum dulcamara* L., and *Arisarum proboscideum* (L.) SAVI. Most of the relevés have the typical floristic structure of the mountainous riparian woods of the Alno-Ulmion BR.-BL. & R. TX. ex TCHOU 1948. BARBAGALLO & al. 1982 assigned the riparian woods of the Serre mountains to the association Euphorbio-Alnetum glutinosae BRULLO & FURNARI in BARBAGALLO & al. 1982. However, probably because of the floristic poorness, our relevés do not allow an assignation to the Alno-Ulmion alliance. In Tab. 6 four relevés (15, 12, 14 and 13) are floristically well differentiated by *Poa palustris* L., *Ranunculus flammula, Lysimachia nemorum* L., and *Veronica scutellata*; they show the highest frequencies of *Carex remota* and of the Molinietalia species (e. g., *Epilobium palustre* L. and *Galium debile*) and, finally, a reduced importance of the Querco-Fagetea species. This leads to the assumption, that these relevés should be included in the alliance Alnion glutinosae (MALC. 1929) MEIJER DREES 1936, although most of the typical species are lacking.

Table 6. *Alnus glutinosa* woods.

Relevé Number	9	2	8	3	4	5	6	7	10	11	15	12	14	13	
Elevation (dam a.s.l.)	97	100	100	99	97	98	98	100	100	100	99	99	99	100	
Surface (m^2)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Tree layer cover (%)	85	90	85	95	90	80	80	90	90	90	90	90	90	90	
Elevation (m)	10	25	20	18	5	6	5	6	6	6	14	18	12	12	
Shrub layer cover (%)	10	30	5	10	10	10	10	10	10	10	50	25	25	25	
Elevation (m)	1,5	4	2	1,5	4	4	1,5	1,5	1,5	1,5	1,5	1,5	1,5	1,5	
Herb layer cover (%)	100	85	5	90	90	100	100	100	75	75	90	85	90	90	
ALLIANCE (*Alnion glutinosae*), ORDER (*Alnetalia glutinosae*) and CLASS (*Alnetea glutinosae*)															Pr.(%)
Lycopus europaeus L.	+	.	.	.	.	+	.	.	.	.	.	1	+	r	36
Poa palustris L.	.	.	.	.	.	.	.	.	.	.	+	2	3	1	29
Ranunculus flammula L.	.	.	.	.	.	.	.	.	.	.	.	1	3	3	21
Lysimachia nemorum L.	.	.	.	.	.	.	.	.	.	.	.	3	1	2	21
Veronica scutellata L.	.	.	.	.	.	.	.	.	.	.	.	1	.	+	14
ALLIANCE (*Alnion-Ulmion*) and ORDER (*Populetalia albae*)															
Alnus glutinosa (L.) Gaertner	5	5	5	5	5	5	5	5	5	5	5	5	5	5	100
Carex remota L.	.	.	.	3	+	1	1	1	2	3	5	4	5	5	79
Sambucus nigra L.	.	.	+	2	.		.	1	2	1	3	+	+	+	71
Arisarum proboscideum (L.) Savi	+	.	.	.	2	2	.	1	+	1	.	1	1	+	64
CLASS (*Querco-Fagetea*)															
Crataegus monogyna Jacq.	.	2	+	+	.	+	+	1	+	1	+	+	+	+	86
Hedera helix L.	.	+	+	1	.	.	.	.	.	1	1	1	+	+	57
Rosa canina L. group.	.	.	1	.	.	+	.	+	1	+	.	+	.	+	50
Poa nemoralis L.	.	+	.	+	4	.	+	+	.	.	.	.	.	.	36
Lonicera etrusca Santi	.	.	+	1	.	.	+	+	.	.	.	.	+	.	36
Stellaria media (L.) Vill.	.	.	+	.	.	.	.	.	.	.	.	+	1	+	29
Euonymus europaea L.	.	.	.	.	.	+	.	.	.	.	.	+	+	.	21
Brachypodium sylvaticum (Huds.) P. Beauv.	.	+	1	1	.	.	.	.	.	.	.	.	.	.	21
Fragaria vesca L.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	14
Equisetum telmateia Ehrh.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	7
Lamium flexuosum Ten.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	7
Lactuca muralis (L.) Gaertn.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	7
Nitrophylous species															
Galium aparine L.	.	.	.	+	.	+	.	+	.	+	.	.	.	.	29
Urtica dioica L.	.	.	.	.	+	.	.	+	.	.	.	.	.	r	21
Chaerophyllum temulum L.	.	.	.	.	.	.	.	.	.	.	1	+	.	.	14
Urtica membranacea Poir. ex Savigny	.	+	+	.	.	.	.	.	.	.	.	.	.	.	14
Geranium versicolor L.	.	1	+	.	.	.	.	.	.	.	.	.	.	.	14
Chaerophyllum hirsutum L.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	7
Molinio-Arrhenatheretea															
Juncus effusus L.	4	.	+	+	1	2	2	1	2	1	+	r	r	r	93
Ranunculus repens L.	.	.	.	.	1	.	+	1	.	+	1	2	1	1	57
Deschampsia caespitosa (L.) Beauv.	3	.	.	.	+	2	+	1	2	1	.	.	.	.	50
Holcus lanatus L.	1	.	.	.	+	.	+	1	+	+	.	+	.	.	50
Myosotis nemorosa Besser	.	.	.	.	+	+	+	+	1	1	.	.	.	.	43

Table 6. Continuation

Relevé Number	9	2	8	3	4	5	6	7	10	11	15	12	14	13	
Ajuga reptans L.	.	.	.	.	+	.	.	+	.	1	.	+	1	+	43
Prunella vulgaris L.	.	4	+	.	.	.	.	.	.	.	.	+	+	+	36
Dactylorhiza maculata (L.) Soó subsp. saccifera (Brongn.) Diklic	.	.	.	.	.	.	.	+	+	+	.	+	.	.	29
Cirsium palustre (L.) Scop.	.	.	+	.	.	.	.	+	.	+	.	+	.	.	29
Galium debile Desv.	.	.	.	.	.	.	.	.	.	.	+	+	+	+	29
Epilobium palustre L.	.	.	.	.	.	.	.	.	.	.	+	r	+	.	21
Myosotis laxa Lehm. subsp. caespitosa (Schultz) Hyl. ex Nordh.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	21
Ranunculus reptans L.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	14
Equisetum palustre L.	.	.	.	.	.	.	.	.	.	.	+	+	.	.	14
Potentilla reptans L.	.	+	.	.	.	.	.	.	.	.	.	.	+	.	14
Juncus articulatus L.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	7
Phragmito-Magnocaricetea															
Mentha aquatica L.	.	.	.	.	.	.	.	.	.	.	+	1	+	1	29
Apium nodiflorum (L.) Lag.	.	.	.	.	.	.	.	.	.	.	.	2	r	+	21
Sparganium erectum L.	1	.	.	.	+	.	.	.	.	.	.	.	.	.	14
Carex pseudocyperus L.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	7
Companions															
Lapsana communis L.	+	.	.	+	.	.	.	.	.	.	1	.	+	+	36
Cardamine flexuosa With.	.	.	.	.	.	.	.	+	.	1	.	+	r	+	35
Oenanthe pimpinelloides L.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	14
Bellis annua L.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	14
Cruciata laevipes Opiz	.	+	.	.	+	.	.	.	.	.	.	.	.	.	14
Epilobium cfr. tetragonum L.	.	.	.	.	.	+	+	.	.	.	.	.	.	.	14
Pteridium aquilinum (L.) Kuhn	.	.	+	+	.	.	.	.	.	.	.	.	.	.	14
Ranunculus fontanus C. Presl	.	.	.	.	.	.	1	1	.	.	.	.	.	.	14
Viola alba Besser	.	2	+	.	.	.	.	.	.	.	.	.	.	.	14
Rubia peregrina L.	.	.	.	.	.	.	.	.	+	+	.	.	.	.	14

4.2. Syntaxonomy

BRULLO & al. 2001 assigned the Galio debilis-Deschampsietum caespitosae in the alliance Dactylorhizo-Juncion striati BRULLO & GRILLO 1978, of the order Holoschoenetalia BR.-BL. ex TCHOU 1948. However, this association includes many species (e. g. *Cirsium palustre, Lotus pedunculatus, Trifolium dubium* SIBTH., *Equisetum palustre, Deschampsia caespitosa, Rumex acetosa* L., *Holcus lanatus, Juncus effusus*) characteristic for the alliance Calthion TÜXEN 1937 (OBERDORFER 1983). As consequence, we retain the Galio debilis-Deschampsietum caespitosae referable to this alliance within the Molinietalia W. KOCH 1937. Noteworthy, associations of the Calthion alliance already were reported by VENANZONI 1988 for the transition meadows of the nearby Sila highland.

The Caricetum echinatae shows a very poor species composition. We assign this association to the Caricion fuscae W. KOCH 1926 em. KLIKA

1934, for the presence of *Epipactis palustris, Menyanthes trifoliata*, and *Ranunculus flammula*. These species several authors (MONTANARI & GUIDO 1980; ROYER & al. 1979; WATTEZ & GEHU 1982) consider as characteristic for this alliance.

The Carici demissae-Potametum polygonifolii is assigned to the Eleocharition acicularis PIETSCH 1966 em. DIERSS. 1975, within the Littorelletalia W. KOCH 1926, because the species characterizing this association (e. g., *Juncus bulbosus, Ranunculus flammula, Veronica scutellata*) are connected with this alliance (OBERDORFER 1977; WATTEZ & GEHU 1982; BRULLO & al. 2001).

The tall sedge communities (Caricetum vesicariae and the *Carex rostrata* community) represent the alliance Magnocaricion W. KOCH. 1926, for the dominant species. Species characterizing the higher syntaxonomic units are extremely rare (Tab. 4).

On the other hand, the vegetation belonging to the Phragmition W.KOCH 1926 appears to be well represented (Tab. 4). According to BRULLO & al. 1994, 2001, in the study area we have detected many species which characterize this alliance (e. g., *Mentha aquatica, Lycopus europaeus, Glyceria fluitans, Alisma plantago-aquatica, Carex pseudocyperus, Ludwigia palustris*). In the study area the Phragmition includes the Sparganietum erecti, the *Menyanthes trifoliata* community and the *Ranunculus flammula-Juncus articulatus* community.

Following BRULLO & al. 1994, we refer the *Potamogeton natans* community to the Nymphaeion albae OBERD. 1957. As in the case of the tall sedges communities, also in this case the community is dominated by a single species.

The Alno-Ulmion is referable to the order Populetalia albae BR.-BL. ex TCHOU 1948 of the Querco-Fagetea BR.-BL. & VLIEGER in VLIEGER 1937. This attribution coincides with the floristic composition of the riparian woodland studied on the Lacìna Plain (Tab. 6), wheras the Alnion glutinosae belongs to the Alnetalia glutinosae TÜXEN 1937 within the Alnetea glutinosae BR.-BL. & TÜXEN 1943. This class includes boreal woodlands of marshy and peaty areas. This vegetation type appears characterized by few species. Indeed, only *Solanum dulcamara* and *Lycopus europaeus* can be considered locally related to the Alnion glutinosae (NOIRFALISE & DETHIOUX 1984). However, the occurrence of some acidophilous species and the different ecological context indicate the transition from riparian to marshy *Alnus*-woods.

4.3. Synecology

The ordination analysis showed a lower resolution for defining the groups than the classification methods; however it is useful to identify ecological gradients. The multi-dimensional scaling (Fig. 6) proposes less

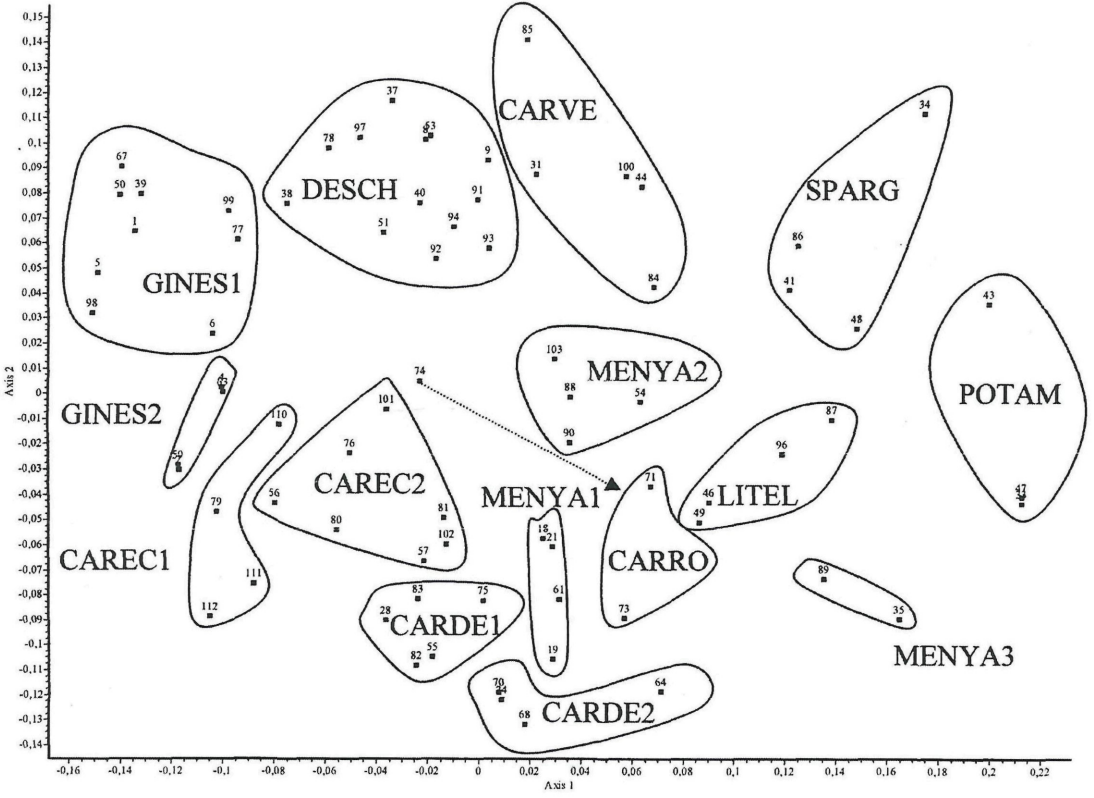

Fig. 6. Scatter plot referred to the Non Metric Multi-Dimensional Scaling (NMDS). Arrow indicates the group including the réléve in the classification.

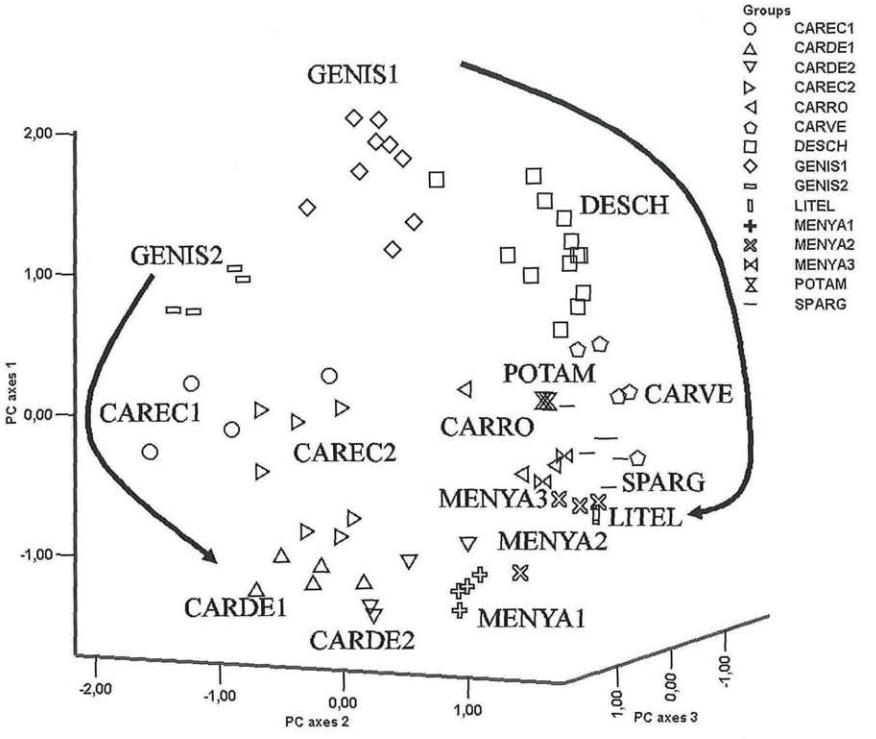

Fig. 7. Scatter plot referred to the Principal Components Analysis (PCA); arrows show two gradients (more details in the text).

evident gradients, while in the PCA (Fig. 7) the group resolution was lower, but the gradients are better defined.

Nevertheless, both numerical methods produced the same two gradients which appeared related to the spatial and ecological relationships among the different community types. A first gradient starts from GENIS1 and, through DESCH and CARVE, ends with SPARG and POTAM (Fig. 6, increasing values of first axis and positive values of the second one; Fig. 7, right arrow). This situation describes the dislocation along the stream sides of different vegetation types in function of the soil humidity. The community of *Potamogeton natans* is the starting point of a spatial succession which includes the bank vegetation (represented by the Sparganietum erecti and the Caricetum vesicariae). The driest component of the transition meadows (Galio debilis-Deschampsietum caespitosae variant with *Genista anglica*) is the last term of such a succession. Indeed, this vegetation type characterizes the intermediate space between the dry habitats of the Citysetea striato-scoparii RIVAS MARTINEZ 1974 and the per-

ennially flooded ones of the Phragmito-Magnocaricetea KLIKA in KLIKA & NOVAK 1941.

The second gradient begins in correspondence of GENIS2 and CAREC1 and, through CAREC2 and CARDE1-2, it ends with a confused group (including MENYA1-3, CARRO and LITEL) which is very close to SPARG and POTAM (Fig. 6, increasing values of the first axis and negative values of the second one; Fig. 7, left arrow). This situation represents the relationships among communities which depend both to the soil humidity and to its acidification. As in the previous case, the *Potamogeton natans* community and the Sparganietum erecti represent the initial terms of this chain which involves successively the small helophytes, the *Carex rostrata* community and the Carici demissae-Potametum polygonifolii. The Carici demissae-Potametum polygonifolii (through its variant with *Carex echinata*) is followed by the Caricetum echinatae, the typical term of bog vegetation. At the end, the variant with *Genista anglica* connects the Caricetum echinatae with the transition meadows of this area (Fig. 8A).

As indicated also by their floristic composition (Tab. 6), the woods of the Alno-Ulmion characterize the sides of the stream in the basin and, under low disturbance rates, they are close to *Fagus sylvatica* woods. Instead, the vegetation of the Alnion glutinosae occurs in marshy areas which are prone to flooding. From a spatial point of view, these woods are contiguous to the communities of *Carex rostrata* and to the vegetation of the Calthion. Consequently, they show a low presence of nitrophilous species and the tendency to include the hygro-acidophilous species of bogs and Molinietalia communities (Tab. 6 and Fig. 8B).

4.4. Conservation

The preservation of marsh ecosystems represents a worldwide concern. Such communities must face detrimental aspects mainly related to the loss of suitable habitat availability, because rising human impact on land use, and to a decline of habitat quality due to excessive nutrient loading (e. g., BEDFORD & al. 1999; SCHEFFER & al. 2001).

Beside this general assumption, the importance for conservation of the studied vegetation types is highlighted by their phytogeographic value. From this viewpoint the communities of the Caricion fuscae, Eleocharition acicularis, Magnocarion and Alnion glutinosae can be considered as the most relevant. These coenoses are connected to peaty environments, whose occurrence at Mediterranean latitudes must be retained a result of the glaciations of the Pleistocene. Dealing with the bog vegetation of France and Suisse, ROYER & al. 1979 and WATTEZ & GEHU 1982 already stated the relict role of such vegetation in central S. Europe. The rarity of marsh and bog communities as well as the concerns for their conservation become more evident southwards; in particular, for sites located in areas with a

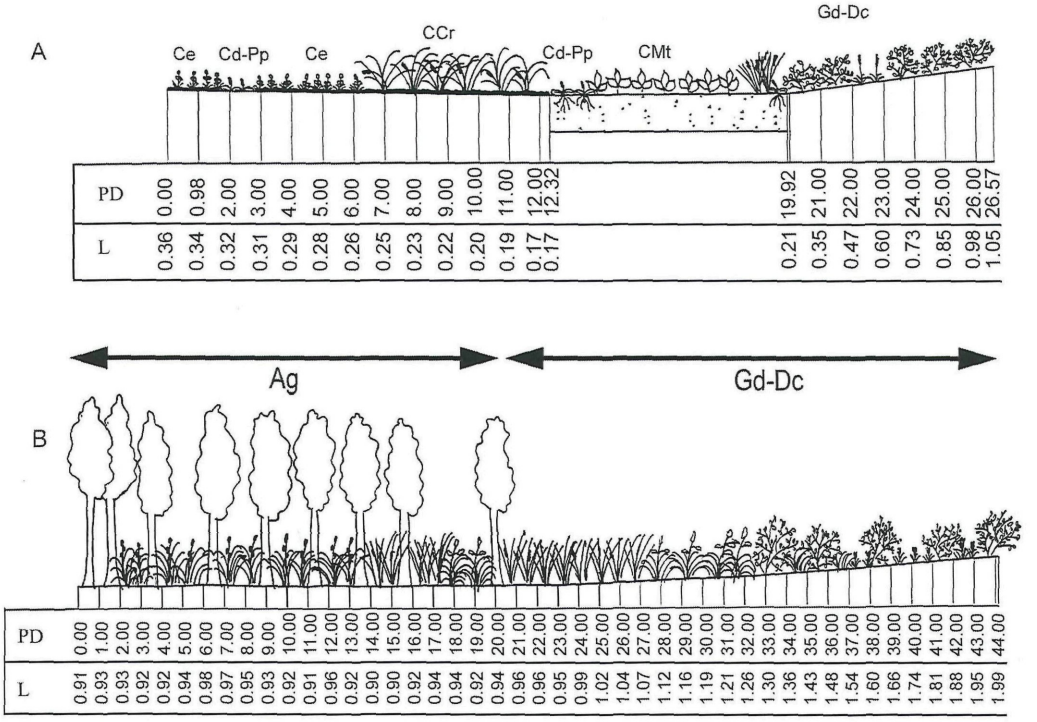

Fig. 8. Transect across the bog and aquatic vegetation. – A: Caricetum echinatae (Ce), Carici demissae-Potametum polygonifolii (Cd-Pp); *Carex rostrata* community (CCr), *Menyanthes trifoliata* community (CMt), Galio debilis-Deschampsietum caespitosae (Gd-Dc). Transect through: *Alnus glutinosa* woodland and communities of tall hygrophilous grassland. – B: Alnion glutinosae (Ag), Galio debilis-Deschampsietum caespitosae (Gd-Dc). Vertical lines indicate topographic relevé points (about every meter); PD: progressive distances from the first topographic relevé point (left side); L: relative elevation of the topographic relevé points.

large extent of human presence as the Padania Plain in North Italy (e. g., GERDOL 1987; SBURLINO & GHIRELLI 1994; SBURLINO & al. 1995a). In Italy, the mountainous areas appear to offer better chances for conservation but, overall along the Apennines, the suitable biotopes are very rare because of the calcareous bedrock (TOMASELLI & BERNARDO 2006). However, in sites with peculiar edaphic conditions, examples of marshy vegetation are described for Northern (e. g., BARBERIS & MARIOTTI 1981), Central (e. g., PEDROTTI 1985; PIRONE 1987) and Southern (e. g., TOMASELLI & BERNARDO 2006) Apennines. The granite mountains of Calabria are particularly favourable to marshy ecosystems, as demonstrated by the studies of VENANZONI 1988 and BRULLO & al. 2001 on Sila and Aspromonte mountains, respectively. Therefore, despite of the Mediterranean position, in Southern Italy ecosystems which offer refugia to many boreal species can occur. Some examples on the Lacìna Plain are *Epipactis palustris, Menyanthes trifoliata, Ranunculus flammula, Sphagnum fallax*, and *Veronica scutellata*.

5. Discussion

With regard to the herbaceous vegetation, the numerical classification identified 15 vegetation units. These units were assigned to 3 already described associations and to 2 new associations. Moreover, the communities with *Carex rostrata*, little helophytes, *Menyanthes trifoliata* and *Potamogeton natans* were assigned to phytosociological units which are not well defined. According to AITA & al. 1976 and WATTEZ & GEHU 1982, we retained the *Sphagnum* formations as a characteristic component of the small *Carex* communities, the typical bog vegetation. Therefore, as suggested by BRAGGIO MORUCCHIO & al. 1978, we considered the assemblages with *Sphagnum fallax* as a subassociation within the Caricetum echinatae rather than an independent unit.

Some northern types (i. e. communities of the Magnocaricion, Caricion fuscae and Eleocharition acicularis) showed a disappearance of typical species together with the occurence of less specialized ones. This could be the result of the site latitude (BARBERIS & MARIOTTI 1981) and of the nitriphication related to herbivors as well as the nutrient load from the surrounding cultivated areas (KLÖTZLI 1983). As reported by PEDROTTI 1985, our data confirmed that the Caricetum vesicariae and the *Carex rostrata* community occur in sites with durable flooding. However, according to DETHIOUX 1982 and PIRONE 1987, the Caricetum vesicariae was related to helophytic vegetation and transition meadows, while the *Carex rostrata* community appeared linked to the bog vegetation.

For other critical groups, the phytosociological definition was complicated by the varying ecology of the dominant species (e. g., *Menyanthes trifoliata* and *Genista anglica*). In particular, it is well known that *Me-*

nyanthes trifoliata has a doubtful position in respect to the communities of Phragmito-Magnocaricetea and Caricion fuscae (MARTINI 1978; ROYER & al. 1979). This was detected in our case too. Indeed, although this species appeared closely related to the initial phase of bog drying, we distinguished two units with *Menyanthes trifoliata*, linked respectively to muddy and peaty areas.

Also the characterization of the *Genista anglica* communities revealed some difficulties. In NW-Europe many authors linked this species to the Atlantic heath-land communities (COOMBE & FROST 1956; GIMINGHAM 1961; WARD 1970, 1971; HUNTLEY & BIRKS 1979), whereas GENTILE 1979 related *Genista anglica* from Sila highland (S. Italy) to hygrophilous communities (Luzulo-Nardetum genistetosum anglicae GIACOMINI & GENTILE 1961) or to meso-xerophilous ones (Koelerio splendentis-Astragalion calabri GIACOMINI & GENTILE 1961). On the other hand, BRULLO & al. 2001 assigned *Genista anglica* (under the name *Genista brutia* BRULLO, SCELSI & SPAMPINATO) from Aspromonte (S. Italy) to the Cytisetea striato-scoparii. Finally, we noted this species occurs, on Lacìna plain, both in the dry aspects of Molinietalia and in that of Caricion fuscae. As consequence, we referred the *Genista anglica* communities to two new variants, one inside the Caricetum echinatae, and another in the Galio debilis-Deschampsietum caespitosae.

Most of the wet woodlands of the Lacìna plain belong to the Alno-Ulmion, this alliance includes the riparian woodlands and, in the Mediterranean regions, it mainly occurs in the mountain belts, as reported also by BRULLO & al. 2001 for the Aspromonte, and by BARBAGALLO & al. 1982 for a place very close to our study area. In addition to these riparian woodlands in the Lacìna plain, we revealed the occurrence of some *Alnus glutinosa* stands referable to marshy forests from Central Europe, included within the Alnion glutinosae, for their meso-acidophilous character. This attribution is supported by a similar floristic structure with respect to the formations described by NOIRFALISE & DETHIOUX 1984, DUMONT 1984 and ROULIER 1984. Following GEHU & al. 1994, the preference of marshy and peaty areas rather than riparian contexts is another important base for discriminating the Alnion glutinosae from the Alno-Ulmion. In particular, as already suggested by OBERDORFER 1983, these woods can be dynamically connected to the communities of the Calthion.

In conclusion, the work highlighted the complexity of the relationship among the vegetation units in marshlands as well as the phytogeographic relevance of some of the described phytocoenoses. Therefore we confirmed the peculiar ecology of the studied biotope and the importance of its protection in order to preserve the regional biodiversity. In fact the geographic position of the site increases the conservation value of its communities as refugia for many relic species in an overall unsuitable environment.

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