

The wetland vegetation of the Natural Reserves and neighbouring stretches of the Arno river in the Arezzo province (Tuscany, Central Italy)

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Abstract

The wetland vegetation along the Arno River between Castelluccio (Capolona) and S. Giovanni Valdarno in the Arezzo province (Tuscany, Central Italy) is described according to the phytosociological method. The study area includes two Natural Reserves (Ponte a Buriano-Penna and Valle dell'Inferno-Bandella). This survey shows the presence along the river of hydrophytic communities (*Lemnetea* and *Potametea* classes), helophytic swampy communities (*Phragmito-Magnocaricetea* class), hygrophilous and hygro-nitrophilous perennial communities (*Molinio-Arrhenatheretea*, *Galio-Urticetea* and *Artemisietea vulgaris* classes), hygro-nitrophilous annual communities (*Bidentetea tripartitae* class) and riparian wet deciduous woodland and willow communities (*Salici purpureae-Populetea nigrae* class). A new association is proposed: *Leersia oryzoidis-Juncetum effusi*, a swampy community dominated by *Juncus effusus* subsp. *effusus* with the presence of *Leersia oryzoides*.

Key words: Arno river, Natural Reserves, phytosociology, Tuscany, wetland vegetation.

Riassunto

La vegetazione delle zone umide delle Riserve Naturali e dei tratti contigui del fiume Arno in provincia di Arezzo (Toscana, Italia Centrale).

La vegetazione delle aree umide del fiume Arno tra Castelluccio (Capolona) e S. Giovanni Valdarno, in provincia di Arezzo (Toscana, Italia centrale) viene descritta mediante il metodo fitosociologico. L'area di studio include le due Riserve Naturali di Ponte a Buriano-Penna e di Valle dell'Inferno-Bandella. Questo studio evidenzia la presenza lungo il fiume di comunità idrofite (classi *Lemnetea* e *Potametea*), elofitiche (classe *Phragmito-Magnocaricetea*), igrofile e igro-nitrofile perenni (classi *Molinio-Arrhenatheretea*, *Galio-Urticetea* e *Artemisietea vulgaris*), igro-nitrofile annuali (classe *Bidentetea tripartitae*) e arboree e arbustive ripariali (classe *Salici purpureae-Populetea nigrae*). Viene proposta una nuova associazione: *Leersia oryzoidis-Juncetum effusi*, una vegetazione palustre a dominanza di *Juncus effusus* con la presenza di *Leersia oryzoides*.

Parole chiave: Fiume Arno, fitosociologia, Riserve Naturali, Toscana, zone umide

Introduction

The present study was carried out with the aim to implement the floristic and vegetational data of the Arezzo province, focusing on the wetland areas, which until recently were unknown from a botanical perspective (see Tomei & Guazzi, 1996).

The study area is located in the tract of the Arno river stretching between Castelluccio and S. Giovanni Valdarno that includes two Natural Reserves: Ponte a Buriano-Penna and Valle dell'Inferno-Bandella.

Study area

The area under investigation is formed by the wetlands of Ponte a Buriano-Penna and Valle dell'Inferno-Bandella Natural Reserves, in addition to the contiguous tracts of the Arno river. In particular, the most significant wetlands of the Reserves are formed by the area of confluence of the Maestro della Chiana Channel in the Arno river in correspondence of Ponte a Buriano village, and the Bandella bight in correspondence of the inflow in Arno of the Ascione stream. The investigated sectors of the Arno river are formed by the tract just upstream of Ponte a Buriano-

Penna Reserve up to Castelluccio village, the tract downstream of the Penna dike in Laterina plain up to the Romito bridge corresponding to the beginning of Valle dell'Inferno-Bandella Reserve and the tract just downstream the Acquaborra dike in Levane up to S. Giovanni Valdarno (Fig. 1).

The tracts within the two Natural Reserves are characterized by the presence of two artificial water bodies formed by the dikes built for electric power production; these have had a fundamental role in the regulation of the water dynamics of the river and therefore also on the development of the hygrophilous vegetation.

The forest vegetation of the two Reserves has been investigated by Viciani & Raffaelli (2003) and a reference to this work is done when the vegetal landscape of the study area is described. The authors also report the floristic list of the two Reserves and some mention to the hygrophilous vegetation. The aim of the present investigation is:

- 1) increasing the knowledge of the swampy and hygrophilous vegetation of the Reserves, to which only short mention is given in the above-cited paper
- 2) studying the vegetation along the contiguous tracts of the Arno river for which at the

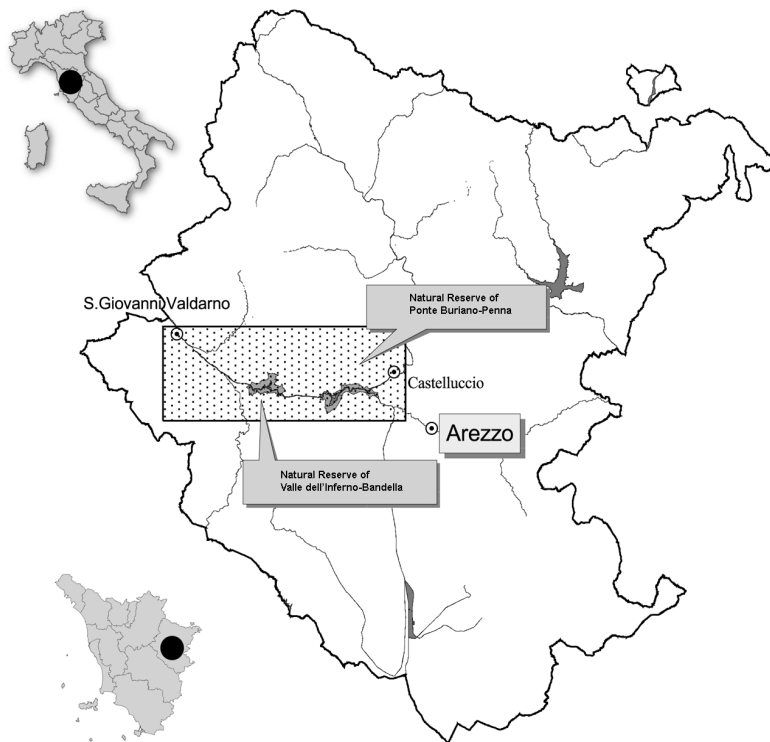


Fig. 1 – The study area within the Arezzo province.

moment only floristic data are available, especially thanks to the works of Chiosi (1976, 1979, 1990) and, to a lesser extent, of Lastrucci & Raffaelli (2006).

Climate and geology

The processing of the climatic data collected from the closest pluviometric stations to the investigated areas (see Viciani & Raffaelli, 2003), i. e. Arezzo (representing the tract of the Arno near Ponte a Buriano-Penna Reserve) and Montevarchi (in proximity of the Valle dell'Inferno-Bandella Reserve), follows the Thornthwaite & Mather (1957) method in compliance with what reported in Vittorini (1972) and Bigi & Rustici (1984). In the study area the climate is expressed by the formula $C2 B'2 s b'4$ for the Ponte a Buriano Reserve and $C2 B'2 r b'4$ for the Bandella Reserve: it is a humid to sub-humid climate, with almost no summer drought (Montevarchi) to moderate summer drought (Arezzo) and summer concentration of the thermal efficiency, which expresses a sub-oceanic tendency (Viciani & Raffaelli, 2003); it is to note that in the Ponte a Buriano-Penna Reserve the “s” index of summer drought is present and implies that a more thermophilous and xerophilous vegetation occurs with respect to the Valle dell'Inferno-Bandella Reserve that is characterized by the “r” index.

From a geomorphologic and lithologic perspective, in the tract including the Ponte a Buriano-Penna Reserve, the Arno river crosses a floodplain, cutting its bed in more recent Holocene fluvio-lacustrine deposits (Viciani & Raffaelli, 2003); afterwards, in the tract between Cartiera and Rondine, it runs embanked in cliffs and vertical slopes and erodes the underlying rocks, uncovering the older schists, marls and sandstones (Oligocene-Miocene); at last, in proximity of Rondine and up to La Penna dike, the Arno widens its channel and newly eroding the Upper Pleistocene deposits made of sandy clays and cobbles and the Lower Pleistocene lacustrine clays and sandy clays. Regarding the tract in the Valle dell'Inferno-Bandella Reserve, after crossing the Laterina plain, the river runs deeply embanked, digging its course on Holocene fluvio-lacustrine deposits made of sandy clays and cobbles, Upper Pleistocene terraced fluvial and stratified fluvio-lacustrine sandy clays and Lower Pleistocene fluvio-lacustrine sediments with arenaceous cobbles. In some cases the lithological substratum crossed by the Arno river results more compact and ancient and is formed by Oligocene turbiditic sandstone (Macigno formation).

Vegetal landscape outline

The landscape surrounding the study area is

prevalently covered by woodlands, and only sporadically by shrublands and grasslands, alternated by cultivated fields stretching up to the proximities of the river.

The woodlands surrounding the Ponte a Buriano wetland are mainly formed by *Quercus pubescens* woods developing on rocky, dry and sloping soils with a floristic composition underlining their thermo-xerophilous character with species belonging to the *Carpinion orientalis* alliance together with elements of the *Quercetea ilicis* class.

The reference association for these thermophilous woods is the *Roso sempervirentis-Quercetum pubescentis* Biondi 1986. Where the soil conditions are more acid the presence of a *facies* of the *Erico arboreae-Quercetum cerridis* Arrigoni in Arrigoni *et al.* 1990 association dominated by *Quercus pubescens* is recorded. The woodlands dominated by *Quercus pubescens* are accompanied by mixed woods, such as the ones with *Ostrya carpinifolia* occurring especially along the gorges formed by the Arno tributaries, or with *Quercus cerris* in the north-facing slopes, and occasionally with *Quercus robur* (Viciani & Raffaelli, 2003). As previously mentioned, the Bandella area is characterized by more humid climate with lower summer drought; these conditions favour the presence of *Quercus cerris* that characterizes the physiognomy of the vegetation. The *Quercus cerris* woods are both high forest and coppice and can occur mixed with other trees like *Quercus robur*, *Carpinus betulus*, *Castanea sativa*, *Quercus pubescens* and *Pinus pinaster*.

Some plant consortia are particularly noteworthy for their floristic richness and for the presence of tall trees. In particular, it is to note the occurrence of mesophilous woods where some species accompanying *Quercus cerris*, like *Quercus robur* and *Carpinus betulus*, can become dominant. From a syntaxonomical perspective these woods were included in the *Melico uniflorae-Quercetum cerridis* subass. *carpinetosum betuli* Arrigoni 1990 (Viciani & Raffaelli, 2003). Shrublands occur in both Reserves, especially in the Valle dell'Inferno-Bandella Reserve where their origin from former cultivated lands is evident and testified by the presence of terracings and fruit trees. This type of vegetation is characterized by species such as *Prunus spinosa* subsp. *spinosa*, *Crataegus monogyna*, *Cornus sanguinea*, *Rubus ulmifolius* and *Rosa canina*.

Materials and Methods

The investigation was carried out following the

phytosociological method of Braun-Blanquet (1932); in accordance with Géhu (1988), the phytocoenoses were delimited by individuating the “close physiognomic and spatial micro-homogeneity” in the attempt to reduce the internal heterogeneity (see Foggi *et al.*, 2006). In all, 136 phytosociological relevés were made. A cluster analysis was carried out for the riparian woods and for the *Iridetum pseudacori* and the *Juncus effusus* and *Leersia oryzoides* community; the last two types of coenoses grow strictly in contact and for this reason the cluster analysis can help to separate the two communities. The cluster analysis was undertaken by means of the software SYNTAX 2000 (Podani, 2001) using the group average algorithm and the similarity ratio coefficient on the phytosociological data converted according to the ordinal scale proposed by Van Der Maarel (1979).

The plants collected in the field were determined using Tutin *et al.* (1968-1980; 1993) and Pignatti (1982) and the nomenclature was updated following Conti *et al.* (2005, 2007). Some species (e.g. *Veronica anagallis-aquatica*, *Nasturtium officinale*, *Persicaria amphibia*) show the capacity of growing in both submerged and aerial conditions, mutating their phenotype according to the environmental conditions (ecophene *sensu* Géhu, 2006). When not specified, in the tables the species are intended in their most common ecophene in the study area, i.e. the terrestrial one. A special case is *Callitriche obtusangula*, a rhizophyte that sometimes shows survival in aerial conditions developing a terrestrial ecophene. The most significant samples collected and exsiccated are deposited in FI Herbarium and in the Herbarium of the Botanical Garden of Florence (Italy).

Results

HYDROPHYTIC VEGETATION (*LEMNETEA* AND *POTAMETEA*)

LEMNA MINOR COMMUNITY (Tab. 1)

Monospecific populations dominated by *Lemna minor* were recorded along a canal that flows in the Arno river just downstream of the Penna dike and along a ditch crossing some cultivated fields in the Quarata area. Even if some authors attribute the vegetation with *Lemna minor* to the *Lemnetum minoris* Oberdorfer ex Müller & Görs 1960 association, as a consequence of the ecological and sociological amplitude of the dominant species, these coenoses are here considered as community or phytocoenon and attributed at the order level (*Lemnetalia minoris*) according to Sbrurlino

Tab. 1 - Vegetation of the *Lemnetea* class

Rel. no.	1	2	Pres.
Altitude (m)	210	178	
Surface (m ²)	4	20	
Coverage (%)	100	100	
<hr/>			
<i>Lemna minor</i> community			
<i>Lemna minor</i> L.	5	5	2

et al. (2004).

ZANNICHELLIA PALUSTRIS COMMUNITY (Tab. 2, Rel. 1)

In a lateral branch of the Arno river near Monteverchi, at a depth of a few centimetres, a paucispecific population of scarce extent dominated by *Zannichellia palustris* was recorded. Similar communities were also signalled, among the others, for the Tiber river by Ceschin & Salerno (2008) and attributed to the *Zannichellietum palustris* Lang 1967 association with a nitrophilous character (Iberite *et al.* 1995); in this case the population may represent an impoverished and fragmented aspect of this association.

PERSICARIA AMPHIBIA AQUATIC ECOPHENE COMMUNITY (Tab. 2, Rel. 2-3)

Populations dominated by the aquatic ecophene of *Persicaria amphibia* grow along the Arno river occurring in shallow waters and nearby the banks where they get into contact with helophytic coenoses. The floristic poverty, together with the high instability of these phytocoenoses, bringing *P. amphibia* to grow in aerial conditions and develop as terrestrial ecophene, suggest to treat these coenoses only at the community level, even if in different circumstances some authors (e.g. Klosowski & Tomaszewicz, 1986) underlined the independence of the *Polygonetum natantis* Soó 1927 association; in central Italy it is reported by Iberite *et al.* (1995) in the Bolsena lake and by Lastrucci *et al.* (2010) in Valdichiana.

CALLITRICHETUM OBTUSANGULAE SEIBERT 1962 (Tab. 2, Rel. 4-5)

This association was recorded along two watercourses in the Quarata plain, one of which feeds a pond used for hunting purposes (Crocina lake). The association is also found in the pond during the filling period and is subsequently replaced by helophytic or hygro-nitrophilous coenoses as the waterbody dries up. It grows in slow running water, showing a good resistance to mineral and organic pollutants as already underlined by Meriaux & Verdevoye (1983). This association is often in contact with the helophytic

coenoses of the *Nasturtio-Glycerietalia*, represented in the study area by the *Nasturtietum officinalis*, generally growing behind the *Callitrichetum* or penetrating it (see Meriaux & Verdevoye, 1983; Prosser & Sarzo, 2003).

ANNUAL HYGRO-NITROPHILOUS VEGETATION (*BIDENTETEA TRIPARTITAE*)

BIDENTI-POLYGONETUM MITIS (ROCH. 1951) TÜXEN 1979 SUBASS. *ECHINOCHLOETOSUM CRURIS-GALLI* BALDONI & BIONDI 1993 (TAB. 3, REL. 1-5)

In late summer, on the muddy elevated banks of the Arno river and some tributaries, good conditions occur for the development of nitrophilous and pioneer species forming even dense populations.

This type of vegetation can be included in the *Bidenti-Polygonetum mitis* (Roch. 1951) Tüxen 1979 association that shows various physiognomic aspects related to the dominant species (Baldoni & Biondi, 1993). It is characterized by facies dominated by *Persicaria dubia* (= *Polygonum mite*), *Persicaria lapathifolia* and aspects dominated by *Bidens frondosa* that can be considered as a facies of the association (Venanzoni & Gigante, 2000). Along the Arno a significant occurrence of *Echinochloa crus-galli* has also been observed, which configures the *echinochloetosum cruris-galli* sub-association described by Baldoni & Biondi (1993) and indicates more unstable environments on mud rich in ammonium salts that dry up for long periods favouring the penetration of less hygrophilous ruderal or synanthropic species. Regarding *B. frondosa*, Lastrucci & Raffaelli (2006) underline that this north-American alien species is particularly diffused in the Arezzo province wetlands where it seems to replace *Bidens tripartita*. The expansion of this species in Italy is also emphasized by Venanzoni & Gigante (2000).

POLYGONO LAPATHIFOLII-XANTHIETUM ITALICI PIROLA & ROSSETTI 1974 (TAB. 3, REL. 6-7)

On the gravelly-cobbly bars of the Arno river emerging in late summer, pioneer vegetation dominated by *Persicaria lapathifolia* and *Xanthium orientale* subsp. *italicum* is sporadically recorded and attributed to the *Polygono-Xanthietum italicum* Pirola & Rossetti 1974 association, typical of gravelly eutrophic soils and often characterized by relatively low cover values (Biondi & Baldoni, 1994).

HELOPHYTIC SWAMPY VEGETATION (*PHRAGMITO-MAGNOCARICETEA*)

Tab. 2 - Vegetation of the *Potametea* class

Rel. no.	1	2	3	4	5	Pres.
Altitude (m)	145	204	168	205	209	
Surface (m ²)	2	4	6	10	4	
Coverage (%)	60	70	75	95	100	
<i>Zannichellia palustris</i> community						
<i>Zannichellia palustris</i> L.	4	.	.	.	.	1
<i>Pericaria amphibia</i> aq. ecoph. community						
<i>Pericaria amphibia</i> (L.) Delarbre aq. ecoph.	.	4	4	.	.	2
Charact. sp. of <i>Callitriche obtusangulae</i>						
<i>Callitriche obtusangula</i> Le Gall	.	.	.	5	5	2
Charact. sp. of <i>Ranuncion fluitantis</i>						
<i>Veronica anagallis-aquatica</i> L. aq. ecoph.	.	.	1	2	+	3
<i>Nasturtium officinale</i> R. Br. aq. ecoph.	1	.	.	.	+	2
Other species						
<i>Paspalum distichum</i> L.	.	.	2	.	.	1
<i>Phalaris arundinacea</i> L. subsp. <i>arundinacea</i>	.	1	.	.	.	1
<i>Alisma plantago-aquatica</i> L.	.	.	.	+	.	1
<i>Juncus articulatus</i> L.	.	.	.	+	.	1
<i>Mentha aquatica</i> L. subsp. <i>aquatica</i>	.	.	+	.	.	1
<i>Pericaria hydropiper</i> (L.) Delarbre	.	+	.	.	.	1
<i>Pericaria lapathifolia</i> (L.) Delarbre	.	.	.	+	.	1
<i>Ranunculus repens</i> L.	.	.	.	.	+	1

Tab. 3 - Vegetation of the *Bidentetea tripartitae* class

Rel. no.	1	2	3	4	5	6	7	Pres.
Altitude (m)	203	175	175	208	210	203	150	
Surface (m ²)	10	10	10	10	10	10	10	
Coverage (%)	100	70	85	100	100	60	60	
Charact. sp. of <i>Bidenti-Polygonetum mitis</i>								
<i>Pericaria dubia</i> (Stein.) Fourr.	5	4	+	1	+	.	+	6
<i>Bidens frondosa</i> L.	+	+	+	4	3	+	.	6
Diff. sp. of subass. <i>Echinochloetosum cruris-galli</i>								
<i>Echinochloa crus-galli</i> (L.) P. Beauv.	.	+	4	2	4	1	.	5
Charact. sp. of <i>Polygono lapathifolii-Xanthietum italici</i>								
<i>Xanthium orientale</i> (L.) subsp. <i>italicum</i> (Moretti) Greuter	.	+	2	2	2	2	3	6
<i>Pericaria lapathifolia</i> (L.) Delarbre	.	.	.	1	.	3	2	3
Charact. sp. of the upper units								
<i>Chenopodium album</i> L.	.	.	.	.	.	.	+	1
<i>Amaranthus retroflexus</i> L.	.	.	.	.	.	.	+	1
Other species								
<i>Lythrum salicaria</i> L.	.	1	.	+	+	1	+	5
<i>Paspalum distichum</i> L.	+	.	.	1	+	.	.	3
<i>Panicum capillare</i> L.	.	.	1	1	.	.	.	2
<i>Cyperus fuscus</i> L.	.	.	.	.	1	.	+	2
<i>Populus nigra</i> L. (pl.)	.	1	.	+	.	.	.	2
<i>Cyperus eragrostis</i> Lam.	.	+	.	.	.	+	.	2
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylvestris</i>	.	.	.	.	.	+	+	2
Sporadic species								
	4	1	1	5	1	1	0	

PHRAGMITETUM VULGARIS VON SOÓ 1927 (TAB. 4, REL. 1-15)

The *Phragmitetum vulgaris* von Soó 1927 association grows profusely along the Arno river and, in particular, in the two Natural Reserves; near Ponte a Buriano it represents the most diffused vegetation type. The association is typical of riverbanks and meso-eutrophic swamps with muddy soils (Venanzoni & Gigante, 2000).

In the study area this association occurs in both the long submerged conditions and in precociously dry areas further away from the river course on the humid and nutrient-rich soils deposited by the floods. Generally the relevés show the typical paucispecificity of the phytocoenosis; in the reed-thicket together with the swampy species also some hygro-nitrophilous species (see Hrivnák, 2004) occur like *Symphotrichum lanceolatum*, *Urtica dioica* subsp. *dioica* and

Tab. 4 - Vegetation of the *Phragmition communis* alliance

Rel. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Pres.		
Altitude (m)	205	204	204	203	168	168	203	203	203	203	168	203	168	203	203	203	168			
Surface (m ²)	50	100	100	25	10	25	25	25	100	100	100	100	100	100	16	5	4			
Coverage (%)	80	100	100	100	90	95	100	100	100	100	100	100	95	100	100	100	85			
Charact. sp. of <i>Phragmitetum vulgaris</i>																				
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	4 5 5 5 5 5 5 5 4 5 5 5 5 5 5																			15
Charact. sp. of <i>Bolboschoenetum maritimi</i>																				
<i>Bolboschoenus maritimus</i> (L.) Palla																	5 4		2	
Charact. sp. of upper units																				
<i>Iris pseudacorus</i> L.			+		1	+				+	+			+				+	7	
<i>Phalaris arundinacea</i> L. subsp. <i>arundinacea</i>							+		3	2		+					2		5	
<i>Lythrum salicaria</i> L.			1					+			+			1					5	
<i>Galium palustre</i> L. subsp. <i>elongatum</i> (C. Presl) Lange											+	r		+			1		4	
<i>Mentha aquatica</i> L. subsp. <i>aquatica</i>													+					2	2	
<i>Alisma plantago-aquatica</i> L.	+					+													2	
<i>Lycopus europaeus</i> L.						+							+						2	
<i>Apium nodiflorum</i> (L.) Lag. subsp. <i>nodiflorum</i>						+													1	
<i>Leersia oryzoides</i> (L.) Sw.																			1	
<i>Veronica anagallis-aquatica</i> L. subsp. <i>anagallis-aquatica</i>	+																		1	
Other species																				
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>		1	2	1				2				1		+					6	
<i>Persicaria amphibia</i> (L.) Delarbre					+				1			+		r			1	+	6	
<i>Symphotrichum lanceolatum</i> (Willd.) G. L. Nesom			1									r		3					3	
<i>Urtica dioica</i> L. subsp. <i>dioica</i>			1	+				1											3	
<i>Elymus repens</i> (L.) Gould subsp. <i>repens</i>								1									2		2	
<i>Salix alba</i> L. (pl.)										+	2								2	
<i>Humulus lupulus</i> L.		+	1																2	
<i>Poa trivialis</i> L.						+		+											2	
<i>Rubus caesius</i> L.				r								r							2	
Sporadic species	2	0	0	1	0	2	0	5	0	0	4	0	0	2	0	6	1			

Calystegia sepium subsp. *sepium*; these are especially abundant in the less prolonged submersion areas and on soils rich in organic substances. Due the tendency of reeds to grow profusely also in areas scarcely or not affected by the presence of water, some authors (Pellizzari *et al.*, 2005) attribute some coenoses of *P. australis* to the *Galio-Urticetea* class.

BOLBOSCHOENETUM MARITIMI EGGLER 1933 (TAB. 4, REL. 16-17)

Plant communities dominated by *Bolboschoenus maritimus* are sporadically found in the two Reserves; they can be attributed to the *Bolboschoenetum maritimi* Egger 1933 association that occurs both in eutrophic brackish or freshwater wetlands (Buchwald, 1994). Especially at Ponte a Buriano, it grows at a distance from water, occurring behind the reed-thickets, in contact with the wet meadows; instead in Bandella the association grows in the typical ecological conditions of the *Phragmition* with extended submersion.

ELEOCHARITETUM PALUSTRIS UBRIZSY 1948 (TAB. 5)

This is a pioneer association (Venanzoni & Gigante, 2000) that occurs diffusely both in the Bandella Reserve and in some tracts of the Arno. This association usually precedes the large-size helophytic ones (Biondi *et al.*,

1997).

In the Crocina pond, during the summer draining, a variant (Tab. 5, Rel. 6-8) growing in total emerged conditions is noted with *Equisetum palustre*, *Juncus articulatus* and *Callitriche obtusangula* terrestrial ecophene (testifying the drained conditions of the pond previously occupied in part by the *Callitrichetum obtusangulae*). In this variant, *Baldellia ranunculoides* is present; this species is considered strongly endangered in Italy (CR) and vulnerable (VU) in Tuscany (Conti *et al.*, 1997). The presence of the latter species within the *Eleocharis palustris* populations is reported by Biondi & Bagella (2005) who describe the association *Baldellio ranunculoidis-Eleocharitetum palustris* Biondi & Bagella 2005 for Maddalena archipelago (Sardinia). This association differs for the presence of distinctive species (*M. pulegium*, *Cyperus longus* subsp. *badius*) absent from our relevés with the exception of *B. ranunculoides*. From a syntaxonomic point of view the description of the *E. palustris* phytocoenoses is not unambiguous and not all the authors agree on their attribution to the association level. In the present paper the attribution to the order *Oenanthion aquaticae* is proposed according with many central-eastern European authors (Brzeg & Wojterska, 2001; Hrivnák, 2003; Nagengast &

Tab. 5 - *Eleocharitetum palustris* Ubrizsy 1948

Rel. no.	1	2	3	4	5	6	7	8	Pres.
Altitude (m)	205	168	168	168	168	205	205	205	
Surface (m ²)	4	2	4	15	6	100	50	8	
Coverage (%)	100	100	85	85	100	100	85	100	
Charact. sp. of <i>Eleocharitetum palustris</i> and upper units									
<i>Eleocharis palustris</i> (L.) Roem. & Schult. subsp. <i>palustris</i>	5	5	4	4	5	2	4	4	8
<i>Mentha aquatica</i> L. subsp. <i>aquatica</i>	.	1	1	+	.	+	+	+	6
<i>Alisma plantago-aquatica</i> L.	.	+	1	.	.	3	+	3	5
<i>Iris pseudacorus</i> L.	.	1	2	.	.	.	.	.	2
<i>Lythrum salicaria</i> L.	.	.	1	+	.	.	.	.	2
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylvestris</i>	+	.	.	.	.	+	.	.	2
<i>Typha latifolia</i> L.	.	.	.	+	+	.	.	.	2
<i>Veronica anagallis-aquatica</i> L. subsp. <i>anagallis-aquatica</i>	.	.	.	.	.	.	+	+	2
<i>Apium nodiflorum</i> (L.) Lag. subsp. <i>nodiflorum</i>	.	.	.	.	.	.	+	.	1
<i>Glyceria notata</i> Chevall.	.	.	.	.	.	.	+	.	1
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	.	+	.	.	.	.	.	.	1
Diff. sp. of <i>Equisetum palustre</i> variant									
<i>Juncus articulatus</i> L.	1	.	.	1	+	1	2	1	6
<i>Equisetum palustre</i> L.	.	.	.	.	.	4	+	1	3
<i>Callitriche obtusangula</i> Le Gall terr. ecoph.	.	.	.	.	.	2	1	2	3
<i>Baldellia ranunculoides</i> (L.) Parl.	.	.	.	.	.	.	.	2	1
Other species									
<i>Persicaria maculosa</i> (L.) Gray	.	.	.	+	1	.	.	.	2
<i>Bidens frondosa</i> L.	+	.	.	+	.	.	.	.	2
Sporadic species									
	0	1	2	4	1	1	0	0	

Ostapiuk, 2004; Makra, 2005).

SPARGANIETUM ERECTI ROLL 1938 (TAB. 6, REL. 1)

Scarcely diffused in the study area, *Sparganietum erecti* was recorded along a ditch flowing in the Arno at Ponte a Buriano. It is an association in between the *Phragmition* and *Glycerio-Sparganion* alliances (see Buchwald, 1994; Lastrucci *et al.*, 2007).

The association occurs in moderate rheophilous conditions with water-level oscillations; these ecological conditions justify its inclusion in the *Glycerio-Sparganion* alliance in which it is located also by Molina (1996), Venanzoni & Gigante (2000) or Maiorca *et al.* (2007).

NASTURTIETUM OFFICINALIS SEIBERT 1962 (TAB. 6, REL. 2)

Association tied to running waters (Baldoni & Biondi, 1993), it occurs along the banks of a ditch that crosses some cultivated fields along the Arno plain at Ponte a Buriano supplying water to the Crocina pond. The association is in contact with *Callitrichetum obtusangulae* growing in deeper waters.

PHALARIDETUM ARUNDINACEAE LIBBERT 1931 (TAB. 7, REL. 1-8)

The *Phalaridetum arundinaceae* association is found mainly in the Ponte a Buriano wetland. It grows in flowing or stagnant waters, eutrophic and base-rich, with marked water-level variations on pioneer and disturbed environments (Venanzoni & Gigante,

2000). It is well-adapted to long emersion periods and occurs also in artificial wetlands (Hrivnák & Ujházy, 2003). For the Ipel' river in central Europe Hrivnák & Ujházy (2003) recognize some variants among which: one with *Iris pseudacorus* (among the other species), indicating higher stagnation conditions; another one with *Persicaria amphibia* (together with *Lysimachia*

Tab. 6 - *Sparganietum erecti* Roll 1938 (Rel. 1) and *Nasturtietum officinalis* Seibert 1962 (Rel. 2)

Rel. no.	1	2	Pres.
Altitude (m)	203	205	
Surface (m ²)	15	4	
Coverage (%)	100	90	
Charact. sp. of <i>Sparganietum erecti</i>			
<i>Sparganium erectum</i> L.	5	.	1
Charact. sp. of <i>Nasturtietum officinalis</i>			
<i>Nasturtium officinale</i> R. Br. subsp. <i>officinale</i>	.	4	1
Charact. sp. of upper units			
<i>Lycopus europaeus</i> L.	2	.	1
<i>Veronica anagallis-aquatica</i> L. subsp. <i>anagallis-aquatica</i>	.	2	1
<i>Lythrum salicaria</i> L.	+	.	1
Other species			
<i>Bidens frondosa</i> L.	2	.	1
<i>Ranunculus repens</i> L.	.	2	1
<i>Callitriche obtusangula</i> Le Gall	.	1	1
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>	1	.	1
<i>Persicaria dubia</i> (Stein.) Fourr.	1	.	1
<i>Persicaria maculosa</i> (L.) Gray	1	.	1
<i>Urtica dioica</i> (L.) subsp. <i>dioica</i>	1	.	1
<i>Epilobium hirsutum</i> L.	+	.	1
<i>Galega officinalis</i> L.	.	+	1
<i>Mentha spicata</i> L.	.	+	1
<i>Persicaria hydropiper</i> (L.) Delarbre	.	+	1
<i>Symphotrichum lanceolatum</i> (Willd.) G. L. Nesom	+	.	1

Tab. 7 - *Phalaridetum arundinaceae* Libbert 1931 with pioneer coenoses of *Persicaria amphibia* (Rel. 6-8) and *Rorippo-Phalaridetum arundinaceae* Kopecký 1961 (Rel. 9-10)

Rel. no.	1	2	3	4	5	6	7	8	9	10	Pres.
Altitude (m)	204	204	203	203	203	203	203	203	204	204	
Surface (m ²)	15	8	16	100	16	100	200	3	30	20	
Coverage (%)	100	90	100	95	90	90	95	100	95	100	
<i>Phalaris arundinacea</i> L. subsp. <i>arundinacea</i>	5	4	5	5	5	2	1	1	4	5	10
Diff. sp. ariant of <i>Phalaridetum arundinaceae</i>											
<i>Persicaria amphibia</i> (L.) Delarbre	.	1	+	2	2	5	5	5	+	+	9
Diff. sp. of <i>Rorippo-Phalaridetum arundinaceae</i>											
<i>Bidens frondosa</i> L.	.	.	.	.	.	.	.	.	2	+	2
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylvestris</i>	.	.	.	.	.	.	.	.	+	+	2
<i>Urtica dioica</i> L. subsp. <i>dioica</i>	.	.	.	.	.	.	.	.	+	+	2
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>	.	.	.	.	.	.	.	.	+	.	1
<i>Persicaria hydropiper</i> (L.) Delarbre	.	.	.	.	.	.	.	.	+	.	1
<i>Galium aparine</i> L.	.	.	.	.	.	.	.	.	.	+	1
Charact. sp. of upper units											
<i>Iris pseudacorus</i> L.	1	2	1	+	.	+	+	.	.	.	6
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	1	.	+	+	.	.	.	.	.	.	3
<i>Lythrum salicaria</i> L.	.	.	+	.	.	.	.	.	1	.	2
<i>Galium palustre</i> L. subsp. <i>elongatum</i> (C. Presl) Lange	.	+	.	.	.	.	.	.	.	.	1
<i>Leersia oryzoides</i> (L.) Sw.	.	.	.	.	.	.	.	.	+	.	1
<i>Rorippa anceps</i> (Wahlenb.) Rehb.	.	.	.	.	.	.	.	.	.	+	1
Hygro-nitrophilous species of <i>Bidentetea</i> and <i>Galio-Urticetea</i>											
<i>Persicaria dubia</i> (Stein.) Fourr.	.	.	.	.	.	.	.	.	+	.	1
<i>Stellaria aquatica</i> (L.) Scop.	.	.	.	.	.	.	.	.	.	+	1
<i>Symphotrichum lanceolatum</i> (Willd.) G. L. Nesom	.	.	.	.	.	.	.	.	+	.	1
<i>Xanthium orientale</i> (L.) subsp. <i>italicum</i> (Moretti) Greuter	.	.	.	.	.	.	.	.	+	.	1
Sporadic species	2	0	1	0	0	0	0	1	2	2	

vulgaris), tied to secondary environments, long flooded by shallow waters, with a long period of seasonal water-level decrease below the soil surface. In spite of the presence of *Iris pseudacorus* in some relevés, the natural dynamics of the Arno river, and especially the effects of the dike management with prolonged periods of submersion alternated with severe draining, favour the pioneer features of *Persicaria amphibia* terrestrial ecophene that in fact is constantly present in sword-grass stands, especially in the vegetation belts nearer to the Arno river. As the muddy bars dry up, true paucispecific mantles dominated by *Persicaria amphibia* (Tab. 7, Rel. 6-8) grow in the late summer and are interpreted as an extreme pioneer and seasonal aspect of the variant with *Persicaria amphibia* in the *Phalaris arundinacea* stands. The pioneer character of this species in drained conditions was also noted in southern Maremma (southern Tuscany) by Lastrucci *et al.* (2007). Regarding the syntaxonomical treatment of this association, which is not unequivocal as underlined by Buchwald (1994) or Lastrucci *et al.* (2007), reference is made to Balátová-Tuláčková *et al.* (1993) or Ořáhel'ová *et al.* (2001) who include it in the *Magnocaricion*.

RORIPPO-PHALARIDETUM ARUNDINACEAE KOPECKÝ 1961

(TAB. 7, REL. 9-10)

This association differs ecologically from the *Phalaridetum arundinaceae* for its briefer exposure to regular flooding and therefore its longer exposure to complete emersion conditions; the preferential habitats of this association are islets, riverbanks and terraces. In these conditions the presence of a prolonged emersion phase allows micro-organisms to transform nitrogen compounds in disposable forms for plants (Hrivnák & Ujházy, 2003). This implies a floristic diversity compared to the *Phalaridetum arundinaceae* association, with a strong occurrence of hygro-nitrophilous species of the *Galio-Urticetea* and *Bidentetea* classes instead of those of the *Phragmito-Magnocaricetea* class (Meriaux, 1983; Hrivnák & Ujházy, 2003).

Among the relevés on the *P. arundinacea* stands at least the Rel. 9 and 10 of Tab. 7, carried out on the Arno riverbank upstream of the Ponte a Buriano Reserve, can be attributed to this association for the strong occurrence of the *Bidentetea* and *Galio-Urticetea* species. The association is included in the *Phalaridion arundinaceae* alliance, of the *Nasturtio-Glycerietalia* (see Balátová-Tuláčková *et al.*, 1993).

IRIDETUM PSEUDACORI EGGLE 1933 EX BRZEG ET M.

WOJTERSKA 2001 (TAB. 8, REL. 1-7)

The *Iris pseudacorus* stands occur in the wetlands of both Natural Reserves; in Bandella *Iridetum pseudacori* is widespread, growing behind the reed thickets on depressions with stagnant waters and stretching up to the *Alnus glutinosa* woods. Near Ponte a Buriano this type of vegetation is less diffused and is located in narrow strips at the confluence of the Chiana Channel in the Arno river in contact with the more common phytocoenoses dominated by *Phragmites australis* or *Phalaris arundinacea* subsp. *arundinacea*. The constant presence of the terrestrial ecophene of *Persicaria amphibia* inside the *Iris* stands can be interpreted as a local differential of the association and indicates strong water level variations; these conditions favour the presence of this pioneer species. *Iris pseudacorus* dominated communities have been described in various Italian wetlands from the Trentino region in the north (Prosser & Sarzo, 2003) to Tuscany in the centre (Lastrucci *et al.*, 2008), to the Calabria region in the south (Maiorca *et al.*, 2007) up to Sicily (Brullo *et al.*, 1994). For nomenclature and

syntaxonomical treatment, reference is made to Brzeg & Wojterska (2001) and Nagengast & Ostapiuk (2004).

LEERSIO ORYZOIDIS-JUNCETUM EFFUSI ASS. NOVA (TAB. 8, REL. 8-14, REL. TYPUS NO. 10)

In the Bandella wetland the dominant swampy vegetation is represented by an extensive *Juncus effusus* community. It is fairly homogeneous from the floristic point of view and quite separate from the adjacent coenoses, in particular *Iridetum pseudacori* (see Fig. 2); these floristic and, as will be described below, ecological peculiarities allow considering these phytocoenoses as a new swampy association named *Leersio oryzoidis-Juncetum effusi* with the following characteristic and differential (diff.) species: *Juncus effusus* subsp. *effusus* (dominant), *Juncus inflexus*, *Galium palustre* subsp. *elongatum* and *Leersia oryzoides* (diff.). A numerous group of representatives of the *Phragmito-Magnocaricetea* occur that allow placing these phytocoenoses at the class level. *Leersia oryzoides* is the dominant species of *Leersietum oryzoidis* Egger 1933 (all. *Glycerio-*

Tab. 8 - *Iridetum pseudacori* Egger 1933 ex Brzeg et M. Wojterska 2001 (Rel. 1-7) and *Leersia oryzoidis-Juncetum effusi* ass. nov. (Rel. 8-14; Rel. typ. no. 10)

Rel. no.	1	2	3	4	5	6	7	8	9	10*	11	12	13	14	Pres.
Altitude (m)	203	203	168	168	168	168	168	168	168	168	168	168	168	168	168
Surface (m ²)	30	30	30	6	10	20	20	40	60	85	40	100	100	20	
Coverage (%)	80	90	100	100	95	100	95	100	95	100	95	100	100	100	
Charact. and diff. sp. of <i>Iridetum pseudacori</i>															
<i>Iris pseudacorus</i> L.	4	5	4	5	4	5	5	+	1	1	1	1	1	.	13
<i>Persicaria amphibia</i> (L.) Delarbre (diff.)	+	+	1	r	+	+	+	.	.	+	.	.	1	2	10
Charact. and diff. sp. of <i>Leersia oryzoidis-Juncetum effusi</i>															
<i>Juncus effusus</i> L. subsp. <i>effusus</i>	.	.	2	.	2	2	.	5	5	5	5	5	4	5	10
<i>Galium palustre</i> L. subsp. <i>elongatum</i> (C. Presl) Lange	.	.	1	1	2	1	+	+	.	2	.	+	2	1	10
<i>Leersia oryzoides</i> (L.) Sw.	.	.	.	.	.	.	.	.	+	1	1	1	1	1	6
<i>Juncus inflexus</i> L.	.	.	.	.	.	.	.	+	.	1	1	1	1	.	5
Charact. sp. of <i>Phragmito-Magnocaricetea</i>															
<i>Mentha aquatica</i> L. subsp. <i>aquatica</i>	.	.	2	2	3	+	.	1	.	1	1	+	2	.	9
<i>Lytrum salicaria</i> L.	.	.	.	.	1	+	+	.	1	1	1	1	.	.	7
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	.	.	.	.	.	+	1	1	+	1	1	2	.	.	7
<i>Eleocharis palustris</i> (L.) Roem. & Schult. subsp. <i>palustris</i>	.	.	2	2	1	.	.	.	.	2	.	.	2	2	6
<i>Lycopus europaeus</i> L.	.	.	r	r	+	.	.	2	.	+	.	.	.	1	6
<i>Alisma plantago-aquatica</i> L.	.	.	+	.	1	.	.	.	+	.	.	.	1	+	5
<i>Veronica anagallis-aquatica</i> L. subsp. <i>anagallis-aquatica</i>	.	.	.	.	.	.	1	+	.	.	.	.	1	+	4
<i>Phalaris arundinacea</i> L. subsp. <i>arundinacea</i>	2	2	.	.	.	.	.	.	.	.	.	.	.	.	2
<i>Nasturtium officinale</i> R. Br. subsp. <i>officinale</i>	.	.	.	.	.	.	2	.	.	.	.	.	.	.	1
<i>Apium nodiflorum</i> (L.) Lag. subsp. <i>nodiflorum</i>	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
<i>Bolboschoenus maritimus</i> (L.) Palla	.	.	.	+	.	.	.	.	.	.	.	.	.	.	1
<i>Glyceria notata</i> Chevall.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
<i>Schoenoplectus tabernaemontani</i> (C. C. Gmel.) Palla	.	.	.	.	.	.	.	.	.	.	.	.	.	+	1
<i>Scutellaria galericulata</i> L.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1
Other species															
<i>Salix alba</i> L. (pl.)	.	.	.	.	.	.	.	1	+	+	+	1	.	.	5
<i>Stachys palustris</i> L.	.	+	.	.	+	.	.	.	1	.	.	.	1	.	4
<i>Persicaria maculosa</i> (L.) Gray	.	.	.	.	.	.	.	+	.	+	+	1	.	.	4
<i>Ranunculus repens</i> L.	.	.	r	r	+	.	+	.	.	.	.	.	.	.	4
<i>Bidens frondosa</i> L.	.	.	.	.	.	.	.	+	1	.	.	+	.	.	3
<i>Solidago gigantea</i> Aiton	1	+	.	.	.	.	+	.	.	.	.	.	.	.	3
<i>Amorpha fruticosa</i> L.	.	.	.	.	+	.	.	.	+	.	.	+	.	.	3
Sporadic species	1	1	1	2	4	3	8	3	3	2	0	2	3	1	

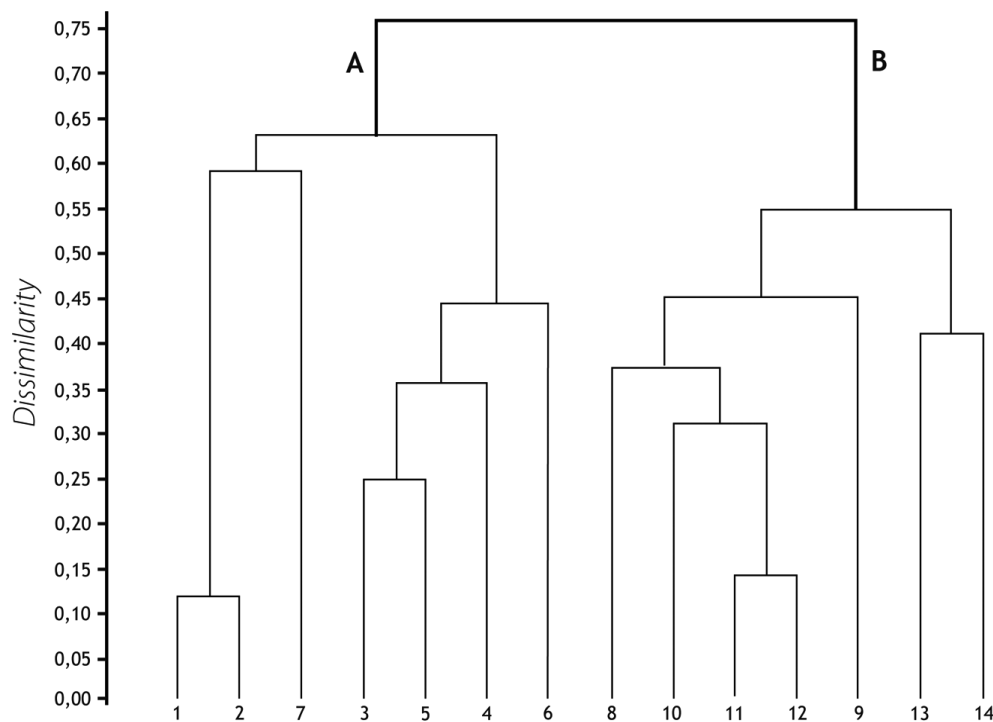


Fig. 2 - Dendrogram of *Iridetum pseudacori* (A, Rel. 1-7) and *Leersio oryzoidis-Juncetum effusi* (B, Rel. 8-14).

Sparganion) and *Bidenti-Leersietum oryzoidis* Poli & Tx. 1960 (all. *Bidention*, see Zeliberova *et al.* 2000); as regards ecology and floristic composition, these two associations differ from the *Leersio oryzoidis-Juncetum effusi* where the dominant species is always *Juncus effusus* and where *Leersia oryzoidis* has the role of differential species.

Coenoses dominated by *Juncus effusus* are reported for the Umbria region by Venanzoni & Gigante (2000) as *Equiseto palustris-Juncetum effusi*; this association was described for Sicily by Minissale & Spampinato (1990). From the original table it is evident that the association gravitates in the *Molinio-Arrhenatheretea (Agropyro-Rumicion) syntaxa* and, therefore, is not suited for the phytocoenoses present there. Communities with presence of both *Juncus effusus* and *Iris pseudacorus* are reported by Barbagallo *et al.* (1979) who describe the sub-association *Dactylorhizo-Juncetum effusi* Brullo & Grillo 1978 *iridetosum pseudacori*; they are separated from the Arno communities for both ecological and floristic characteristics. Also ecologically different because tied to wet meadows are the British communities of *Holco-Juncetum effusi iridetosum* Page 1980, reported by Rodwell (1992) or those of *Epilobio-Juncetum effusi* Oberd. 57 (Oberdorfer, 1983).

From the Umbria region Venanzoni & Gigante (2000) describe the *Galio palustris-Juncetum inflexi* association, swampy reed-beds of the *Magnocaricion*, which show a higher affinity with the Bandella

coenosis for the presence of *Juncus inflexus* (in our case never dominant); however, the Arno communities differ floristically for the presence of species (among which *Iris pseudacorus*, *Leersia oryzoides*) missing in the relevés from Umbria, and furthermore for the presence of *Galium palustre* subsp. *elongatum* instead of *Galium palustre* subsp. *palustre*. From an ecological perspective, the Bandella *Juncus* community grows on soils prolongly submerged by a few centimetres of water and in contact with the rest of the swampy vegetation, particularly with the *Phragmitetum vulgaris* or the *Iridetum pseudacori*, the latter more tied to the presence of depressions with higher water stagnation and in contact with alder-woods. Compared to these phytocoenoses the *Juncus* community is favoured by the shallow waters in connection with water-regime control by the dikes, by the periodical oscillations of the water level (natural and dike-induced), and by the general trend towards silting observed in the last years in the Bandella bight (Gusmeroli, *in verbis*).

CYPERETUM LONGI MICEVSKI 1957 (TAB. 9, REL. 1)

Widespread mostly in the Balkan and Dalmatian territories (Brullo & Spampinato, 1990), the *Cyperetum longi* association is also found in various Italian regions such as Lombardy (Andreis *et al.*, 1998), Umbria (Venanzoni & Gigante, 2000), Abruzzo (Pirone *et al.*, 2003), Basilicata (Venanzoni *et al.*, 2003), and Sicily (Brullo & Spampinato, 1990). This association is often observed at the margins of the

Tab. 9 - *Cyperetum longi* Micevski 1957 (Rel. 1) and *Carex riparia* community (Rel. 2)

Rel. no.	1	2	Pres.
Altitude (m)	203	168	
Surface (m ²)	6	10	
Coverage (%)	100	100	
<hr/>			
Charact. sp. <i>Cyperetum longi</i>			
<i>Cyperus longus</i> L.	5	.	1
<hr/>			
<i>Carex riparia</i> community			
<i>Carex riparia</i> Curtis	.	4	1
<hr/>			
Charact. sp. of upper units			
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	1	3	2
<i>Lythrum salicaria</i> L.	1	+	2
<i>Alisma plantago-aquatica</i> L.	.	+	1
<i>Bolboschoenus maritimus</i> (L.) Palla	+	.	1
<i>Galium palustre</i> L. subsp. <i>elongatum</i> (C. Presl) Lange	+	.	1
<i>Gratiola officinalis</i> L.	+	.	1
<i>Iris pseudacorus</i> L.	.	+	1
<hr/>			
Other species			
<i>Ranunculus repens</i> L.	+	+	2
<hr/>			
Sporadic species	7	0	

Carex communities and where the soils are drenched with water, even if it emerges in dry land for a part of the year (Venanzoni & Gigante, 2000).

As shown by the relevés carried out it was recorded in one stand only near Ponte a Buriano where, besides, it appears in an impoverished state for the low occurrence of species of the *Magnocaricion*, in particular those belonging to *Carex* genus that are poorly diffused in the study area, showing a resemblance with the relevé by Pirone *et al.* (2003) in the Serranella Lake (Abruzzo, central Italy).

CAREX RIPARIA COMMUNITY (TAB. 9, REL. 2)

The only coenosis dominated by large sedges of the *Magnocaricetalia* order occurs in the Bandella Reserve where it occupies a narrow strip between the reed-beds (the presence of which is testified by the high cover value of *Phragmites australis* within the *Carex riparia* population) and the riparian woods with *Alnus glutinosa* and *Salix alba*.

Regarding this, Venanzoni & Gigante (2000) underline that the sedge-beds with *Carex riparia* also grow in secondary sites derived from the destruction of the *Alno-Ulmion* alliance woods. The coenosis along the Arno river could represent a degraded aspect of the *Galio palustris-Caricetum ripariae* Bal.-Tul. *et al.* 1993 recorded in Umbria (Venanzoni & Gigante, 2000) or in Tuscany (Lastrucci *et al.*, 2008); in this case, however, the significant invasion of the reeds influences the survival of the sedge-beds, which are at present strongly penetrated by *P. australis*.

SYNANTHROPIC, FRINGE AND MEGAFORBIC HYGRO-

NITROPHILOUS VEGETATION (*ARTEMISIETEA VULGARIS* AND *GALIO-URTICETEA*)

SAPONARIO-ARTEMISIETUM VERLOTIURUM BALDONI & BIONDI 1993 (TAB. 10)

On the emerged gravelly river beds and elevated terraces of the Arno river in the tract between Levane and S. Giovanni Valdarno, on sandy-cobbly soils rich in nutrients deposited by the floods of the autumn-spring period, a thick vegetation is encountered, characterized by the abundant presence of the alien species, *Artemisia verlotiorum*. These coenoses are attributed to the *Saponario-Artemisietum verlotiorum* association, tied to the elevated and dry sectors of the fluvial islets, described for the Esino river by Baldoni & Biondi (1993) and recently reported in Tuscany by Arrigoni & Papini (2003).

ELYMUS REPENS SUBSP. REPENS COMMUNITIES (TAB. 11)

In the study area, the phytocoenoses dominated by *Elymus repens* subsp. *repens* grow in two different typologies of environments. Along the cobbly banks rich in plant material deposited by the floods (Tab. 11, Rel. 1-2), in the clearings of black poplar woods or willow shrubs, a vegetation with well-represented species of the *Artemisietea* is recorded and shows affinity with the *Loto tenuis-Agropyretum repentis* association described for the Taro river by Biondi *et al.* (1997). The Arno communities may represent an impoverished aspect of the association for the absence of species like *Lotus tenuis* or *Festuca arundinacea*, well-represented in the typical association.

In the Ponte a Buriano wetland (Tab. 11, Rel. 3-4) some vegetational aspects are recorded that are almost completely devoid of *Artemisietea* species and enriched with more hygrophilous species (e.g. *Scirpoides holoschoenus*, *Thalictrum lucidum*); since

Tab. 10 - *Saponario-Artemisietum verlotiorum* Baldoni & Biondi 1993

Rel. no.	1	2	3	Pres.
Altitude (m)	145	145	204	
Surface (m ²)	4	6	25	
Coverage (%)	95	100	100	
<hr/>				
Charact. sp. of ass. and upper units				
<i>Artemisia verlotiorum</i> Lamotte	3	4	5	3
<i>Elymus repens</i> (L.) Gould subsp. <i>repens</i>	+	+	+	3
<i>Mentha spicata</i> L.	2	3	.	2
<i>Saponaria officinalis</i> L.	3	1	.	2
<hr/>				
Other species				
<i>Equisetum ramosissimum</i> Desf.	1	+	+	3
<i>Poa trivialis</i> L.	+	+	+	3
<i>Medicago sativa</i> L.	2	+	.	2
<hr/>				
Sporadic species	6	4	10	

Tab. 11 - *Elymus repens* subsp. *repens* communities

Rel. no.	1	2	3	4	Pres.
Altitude (m)	203	178	203	203	
Surface (m ²)	20	6	50	16	
Coverage (%)	100	100	100	100	
<hr/>					
<i>Elymus repens</i> (L.) Gould subsp. <i>repens</i>	5	5	4	4	4
Charact. and diff. sp. of <i>Loto tenuis-Agropyretum repentis</i>					
<i>Xanthium orientale</i> (L.) subsp. <i>italicum</i> (Moretti) Greuter	+	+	.	.	2
<i>Melilotus albus</i> Medik.	.	r	.	.	1
Charact. sp. of <i>Artemisietea vulgaris</i>					
<i>Artemisia vulgaris</i> L.	+	.	.	+	2
<i>Cirsium vulgare</i> (Savi) Ten.	+	.	.	.	1
<i>Daucus carota</i> L.	+	.	.	.	1
<i>Elminthotheca echioides</i> (L.) Holub.	+	.	.	.	1
<i>Lactuca serriola</i> L.	+	.	.	.	1
<i>Saponaria officinalis</i> L.	.	+	.	.	1
<i>Tanacetum vulgare</i> L.	.	.	+	.	1
Species of <i>Molinio-Arrhenatheretea</i> and <i>Galio-Urticeta</i> classes					
<i>Scirpoides holoschoenus</i> (L.) Sojak	.	.	2	3	2
<i>Thalictrum lucidum</i> L.	.	.	3	1	2
<i>Poa trivialis</i> L.	1	.	1	.	2
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>	+	.	.	+	2
<i>Galium aparine</i> L.	.	.	+	+	2
<i>Potentilla reptans</i> L.	.	.	+	+	2
<i>Althaea cannabina</i> L.	.	.	.	2	1
<i>Althaea officinalis</i> L.	.	.	1	.	1
<i>Carex otrubae</i> Podp.	.	.	.	+	1
<i>Inula britannica</i> L.	.	.	.	+	1
<i>Cruciata laevipes</i> Opiz	.	.	+	.	1
<i>Galega officinalis</i> L.	.	.	+	.	1
<i>Lycopus exaltatus</i> Ehrh.	.	.	+	.	1
<i>Pulicaria dysenterica</i> (L.) Bernh.	.	.	.	+	1
Other species					
<i>Aristolochia rotunda</i> L.	.	+	+	+	3
<i>Cirsium arvense</i> (L.) Scop.	+	r	.	+	3
Sporadic species	8	3	9	5	

they are hard to interpret with the available data, at moment they are not included in the syntaxonomical scheme. These phytocoenoses are different from the previous in being more tied to conditions in contact with riparian woods, as indicated by the presence of *Thalictrum lucidum*, or with wet meadows. Features of the *Loto tenuis-Agropyretum repentis* enriched by species of the *Molinio-Arrhenatheretea* were identified also in Umbria by Venanzoni & Gigante (2000) where they were interpreted as indicators of less disturbed fluvial dynamic conditions. Moreover for Sicily, *Elymus repens* dominated phytocoenoses, rich in *Plantaginetalia* and *Agropyro-Rumicion* elements, are described as *Epilobio hirsuti-Agropyretum repentis* by Minissale & Spampinato (1986) indicating that this species sometimes characterizes true *Molinio-Arrhenatheretea* wet meadows.

PHALARIDO-PETASITETUM HYBRIDI SCHWICK. 1933 (TAB. 12, REL. 1-4)

This vegetation grows on the banks of the watercourses, often on the fringes of the riparian

woods (Baldoni & Biondi, 1993). In the study area the association occurs along the Arno or in some minor streams like the Faltognano where it grows at the borders of the willow and poplar woods. In more disturbed or less humid conditions the association is replaced by populations of alien species like *Helianthus tuberosus*, *Artemisia verlotiorum* or *Solidago gigantea* as evidenced also by Martini & Poldini (1981) for the Noncello river in Pordenone (northern Italy).

URTICO DIOICAE-SAMBUCETUM EBULI (BR.-BL. IN BR.-BL., GAJEWSKI, WRABER & WALAS 1936) BR.-BL. IN BR.-BL., ROUSSINE & NÈGRE 1952 (TAB. 12, REL. 5-6)

This thermo-heliophilous and nitrophilous association grows on eutrophic soils with high water supply and presents a central-European distribution; however, in mesophilous and mountain sites this association occurs frequently in the Mediterranean region (Maiorca *et al.*, 2007). In the study area the association occurs sporadically along the banks of the Arno and in the Ponte a Buriano wetland in elevated positions respect to the water-level and behind the helophyte formations.

CALYSTEGIO-ASTERETUM LANCEOLATI (HOLZNER ET AL. 1978) PASS. 1993 (TAB. 12, REL. 7-11)

Along the Arno riverbanks and in the Ponte a Buriano wetland, some stands of vegetation were recorded dominated by *Symphyotrichum lanceolatum* (*Aster lanceolatum*), an alien north-American species detectable at the end of September and beginning of October for the chromatic impact of its flowerings. The floristic composition of the community is heterogeneous: together with a group of hydro-nitrophilous species of the *Galio-Urticetea* and *Bidentetea* also a numerous group of species of the *Phragmito-Magnocaricetea* (*Lythrum salicaria*, *Lycopus europaeus*, *Iris pseudacorus*) occurs indicating high hygrophilous conditions. A similar situation is observed in Müller (1983) where in the *Aster* sp. pl. vegetation table a significant occurrence of species of the *Phragmito-Magnocaricetea* class is found. Schubert (2001) reports the *Calystegio-Asteretum lanceolati* association that shows many affinities with our relevés and to which our coenoses are therefore referred. The association, widespread in the Ponte a Buriano Reserve area, occurs behind *Phragmitetum*

Tab. 12 - Vegetation of the *Galio-Urticetea* class

Rel. no.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	Pres.	
Altitude (m)	204	205	178	203	178	205	179	214	203	178	203	210	168	206	214	203	203		
Surface (m ²)	6	4	6	16	100	25	6	5	9	4	10	10	25	10	4	10	12		
Coverage (%)	100	100	90	95	100	100	85	75	100	100	100	100	100	100	100	100	100		
Charact. sp. of <i>Phalarido-Petasitetum hybridi</i>	5 5 5 4																		
<i>Petasites hybridus</i> (L.) P. Gaertn., B. Mey & Scherb. subsp. hybridus	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	5
Charact. sp. <i>Urtico-Sambucetum ebuli</i>	5 4																		
<i>Sambucus ebulus</i> L.	.	1	.	+	5	4	.	.	.	.	+	.	.	.	.	.	.	2
<i>Urtica dioica</i> L. subsp. dioica	.	.	.	.	1	1	.	.	2	.	+	.	.	1	2	2	1	10
Charact. sp. <i>Convolvulo-Asteretum lanceolati</i>	4 4 5 5 5																		
<i>Symphotrichum lanceolatum</i> (Willd.) G. L. Nesom	.	.	.	+	.	+	+	.	1	.	+	.	.	1	.	.	.	6	
<i>Calystegia sepium</i> (L.) R. Br. subsp. sepium	.	.	.	+	.	.	.	.	.	.	.	.	.	1	1	.	.	8
<i>Solidago gigantea</i> community	.	+	.	.	.	.	.	.	.	.	.	5	5	.	.	.	.	3
<i>Solidago gigantea</i> Aiton	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
<i>Helianthus tuberosus</i> community	.	1	.	.	.	.	.	.	.	.	.	.	.	4	5	5	5	5
<i>Helianthus tuberosus</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	5
Charact. sp. of <i>Galio-Urticetea</i>	2																		
<i>Eupatorium cannabinum</i> L.	+	.	2	.	.	.	.	.	.	.	+	.	.	.	.	+	.	4
<i>Galium aparine</i> L.	.	.	.	r	+	.	.	.	.	.	+	.	.	.	.	.	.	4
<i>Scrophularia auriculata</i> L. subsp. auriculata	+	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	2
<i>Stellaria aquatica</i> (L.) Scop.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	.	2
<i>Stachys palustris</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Alliaria petiolata</i> (M. Bieb.) Cavara & Grande	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Pastinaca sativa</i> L.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Aegopodium podagraria</i> L.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Barbarea vulgaris</i> R. Br.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Cruciata laevipes</i> Opiz	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	.	1
<i>Galega officinalis</i> L.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Rumex obtusifolius</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	1
<i>Thalictrum flavum</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
<i>Tortilis japonica</i> (Houtt.) DC.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
Other species																			
<i>Artemisia vulgaris</i> L.	1	+	+	+	+	+	.	.	.	.	.	.	.	+	.	.	.	8
<i>Lythrum salicaria</i> L.	.	.	.	r	.	.	2	1	+	1	.	.	.	+	.	.	.	7	
<i>Rubus caesius</i> L.	.	2	.	.	.	+	1	.	.	.	+	.	.	1	.	+	.	7	
<i>Elymus repens</i> (L.) Gould subsp. repens	.	.	.	.	1	2	.	.	.	.	.	2	.	.	.	+	1	5
<i>Humulus lupulus</i> L.	.	.	.	+	.	.	.	.	.	.	.	+	.	.	.	.	.	4
<i>Rubus ulmifolius</i> Schott.	.	.	.	.	2	3	.	.	.	.	.	2	.	.	.	.	.	3
<i>Bromus sterilis</i> L.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	3
<i>Bidens frondosa</i> L.	.	.	.	+	.	.	.	.	.	.	.	.	.	3	.	.	.	3
<i>Aristolochia clematitis</i> L.	.	.	.	+	.	.	.	.	.	.	.	.	.	.	.	.	.	3
<i>Equisetum ramosissimum</i> Desf.	.	.	.	.	r	1	.	.	.	.	.	.	.	.	.	.	.	3
<i>Tanacetum vulgare</i> L.	.	.	.	.	+	1	.	.	.	.	.	.	.	.	.	.	.	3
Sporadic species	7	0	1	12	1	10	2	1	2	3	3	1	12	5	1	1	4		

or *Phalaridetum*, in emerged conditions, at least in the late-summer period when *Symphyotrichum lanceolatum* grows on cool nutrient-rich soils that are not submerged. This association is also present along the minor ditches that cross the fields in highly disturbed grounds from farming activities, while in the tract of the Arno river downstream of the Penna dike it grows also on the sandy-gravelly banks in contact with shrubby willow and poplar formations.

SOLIDAGO GIGANTEA COMMUNITY (TAB. 12, REL. 12-13)

Along the Arno river, between Castelluccio and Ponte a Buriano and in the Bandella wetland, stands dominated by *Solidago gigantea* occur; this north-American species is present in northern and central Italy whereas is absent in southern Italy with the exception of Calabria (Celesti-Grapow *et al.*, 2009). The most significant stands grow immediately behind the more strictly hygrophilous vegetation, in semi-shaded areas and on nutrient-rich soils that represent the ideal environment for the development of the *Convolvulion sepium* communities; in this alliance many communities of watercourse alien species are included (Bolòs *et al.*, 1988). *Solidago gigantea* communities are reported also by Biondi *et al.* (1997) for the Taro river Park in the Emilia-Romagna region, by Sartori & Bracco (1997) for the Po plain in Lombardy and by Marchiori & Sburlino (1997) for the Venetian plain.

HELIANTHUS TUBEROSUS COMMUNITY (TAB. 12, REL. 14-17)

Along the Arno banks and in the Ponte a Buriano wetland, some stands dominated by *Helianthus tuberosus* occur; this north-American species was introduced for alimentary purposes and is now present almost everywhere in Italy where it grows mostly in fallow lands and at the margins of cultivated fields (Viegi & Cela Renzoni, 1981; Celesti-Grapow *et al.*, 2009). *H. tuberosus* communities were reported for Italy by Martini & Poldini (1981), Baldoni & Biondi (1993), Sartori & Bracco (1997), Marchiori & Sburlino (1997), Pirone & Ferretti (1999) and Arrigoni & Papini (2003), among the others. In the study area, this species often forms dense communities that grow at the edge of the riparian woods in rarely flooded areas or occasionally in contact with the synanthropic-ruderal communities of the *Artemisietea* on the banks and terraces, more elevated with respect to the course level of the river. The Arno coenoses show some affinities with the *Oenothero biennis-Helianthetum tuberosi* association described by Bolòs *et al.* (1988) for Spain.

PERENNIAL HYGROPHILOUS VEGETATION OF WET MEADOWS (*MOLINIO-ARRHENATHERETEAE*)

PASPALO DISTICHI-POLYPOGONETUM VIRIDIS BR.-BL. IN BR.-BL., GAJEWSKI, WRABER & WALAS 1936 NOM. MUT. PROPOS. RIVAS-MARTINEZ *ET AL.* 2002 (TAB. 13)

Along the riverbanks a vegetation characterized by the alien species *Paspalum distichum* (an invasive alien species for Tuscany, according to Celesti-Grapow *et al.*, 2009) was observed, often associated with high cover values of *Cyperus eragrostis*, a naturalized alien species in Tuscany (see Celesti-Grapow *et al.*, 2009) very widespread in the study area (see Lastrucci & Raffaelli, 2006). The attribution of the *Paspalum distichum* coenoses is not always straightforward since this species often forms monophytic or paucispecific carpets. *Paspalum distichum* is characteristic of several associations among which *Paspalo distichi-Polypogonetum viridis* that is included in the riparian wood series with *Salix* sp. pl. (Baldoni & Biondi, 1993); it has a Mediterranean distribution but is also observed in some localities of the Temperate Region of Italy (Braun-Blanquet *et al.*, 1936; Biondi *et al.*, 1997; Scoppola, 1998). Among the characteristic species of the association, *Cyperus eragrostis* appears (Tchou, 1948; Braun-Blanquet *et al.* 1952, sub *C. vegetus* Willd.). Also described in Italy is the association *Loto tenuis-Paspaletum paspaloidis* (Biondi *et al.*, 2002), while for Spain, Peinado Lorca *et al.* (1988) formalize the sub-association *Ranunculo scelerati-Paspaletum paspaloidis* Rivas Goday 1964 corr. Peinado *et al.* 1988. *rorippetosum sylvestris*; although some affinities with the Arno coenoses are evident, this last *syntaxon* cannot be used here for the absence of *Ranunculus sceleratus* and *Pulicaria paludosa* (differential with respect to *Paspalo-Polypogonetum*), as well as other differential species of the sub-association *Rumex crispus* and *Lepidium latifolium*. Closely-related floristic communities, even if averagely richer in species, are reported for Spain by Amigo (2006) who describes the *Cypero eragrostidi-Bidentetum frondosae* association that however is dominated by annual species like *Persicaria hydropiper* (absent in our relevés) and *Bidens frondosa* (the contribution of which is very low in the Arno coenoses). Therefore, although *Polypogon viridis* is absent, the present relevés are attributed to *Paspalo-Polypogonetum*, for which a *Cyperus eragrostis*-dominated facies is here distinguished; this species tends to increase its cover in the highly disturbed and extensively dry areas. The presence of *Rorippa sylvestris* testifies the contact with *Rorippo-Phalaridetum* or *Rorippo-Agrostidetum*

Tab. 13 - *Paspalo distichi-Polypogonetum viridis* Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936 nom. mut. propos. Rivas-Martínez *et al.* 2002

Rel. no.	1	2	3	4	5	6	7	8	9	Pres.
Altitude (m)	168	145	203	203	203	175	175	168	203	
Surface (m ²)	15	4	6	8	6	4	4	50	10	
Coverage (%)	100	90	95	100	100	95	100	100	90	
Charact. sp. of association										
<i>Paspalum distichum</i> L.	5	4	5	5	5	5	5	4	+	9
<i>Cyperus eragrostis</i> Lam.	.	+	1	+	2	+	+	+	4	8
<i>Symphotrichum squamatum</i> (Spreng.) G. L. Nesom	.	.	.	.	.	+	.	.	+	2
Charact. sp. upper units										
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylvestris</i>	.	2	1	+	+	.	.	.	.	4
<i>Juncus articulatus</i> L.	1	1	.	.	.	.	.	.	.	2
<i>Potentilla reptans</i> L.	.	+	.	.	.	.	.	.	+	2
<i>Ranunculus repens</i> L.	.	+	.	.	+	.	.	.	.	2
<i>Juncus effusus</i> L. subsp. <i>effusus</i>	.	.	.	.	.	.	.	1	.	1
<i>Juncus inflexus</i> L.	1	.	.	.	.	.	.	.	.	1
<i>Inula britannica</i> L.	.	.	.	.	.	.	.	.	+	1
<i>Juncus compressus</i> Jacq.	.	.	.	.	+	.	.	.	.	1
<i>Lysimachia nummularia</i> L.	.	.	.	.	+	.	.	.	.	1
<i>Plantago major</i> L.	.	.	.	.	.	.	.	.	+	1
Others										
<i>Echinochloa crus-galli</i> (L.) P. Beauv.	2	.	.	1	+	+	.	3	2	6
<i>Persicaria dubia</i> (Stein.) Fourr.	.	.	.	.	+	2	1	2	1	5
<i>Lythrum salicaria</i> L.	.	+	.	+	.	+	1	.	+	5
<i>Persicaria lapathifolia</i> (L.) Delarbre	.	+	.	.	.	.	r	+	1	4
Sporadic species	3	3	0	4	3	4	4	5	9	

stoloniferae that the *Paspalo-Polypogonetum* tends to substitute especially in the more disturbed areas (see also Campos & Herreras, 2009). The association is referred to the *Molinio-Arrhenatheretea* class according to Peinado *et al.* (1988) and Baldoni & Biondi (1993); for the syntaxa below the class level the attribution follows Rivas-Martínez *et al.* (2002) and Biondi *et al.* (2004).

RORIPPO-AGROSTIETUM STOLONIFERAE (MOOR 1958) OBERD. ET MÜLL. 1961 (TAB. 14, REL. 1-4)

This type of vegetation dominated by *Agrostis stolonifera* and *Rorippa sylvestris* generally grows in narrow strips occupying the riverbanks emerged in summer (Carreras *et al.*, 1988). The habitat typology implies that this association is often in contact with the vegetation of the peripheral areas like the *Bidention* coenoses (see Carrera *et al.*, 1988) or, in the study area, with *Rorippo-Phalaridetum*, *Paspalo-Polypogonetum*, or with shrubby and arboreal willow and poplar communities. In Tuscany, coenoses with only *Agrostis stolonifera* were reported for the Merse river by Landi *et al.* (2002) and for southern Maremma by Lastrucci *et al.* (2007). For the treatment at the upper syntaxonomical units level, we refers to Rivas-Martínez *et al.* (2001; 2002).

CIRSIO TRIUMFETTI-EUPATORIETUM CANNABINI BRULLO & SPAMPINATO 1990 (TAB. 14, REL. 5)

This association was described for the watercourses

of Sicily where it occupies very humid stands with accumulation of organic material, located in the narrow strip between the riverbed and the riparian woods (Brullo & Spampinato, 1990). It was recently reported also for the Abruzzo region by Pirone (2000). In the study area it grows at the edge of a small watercourse in the Venere locality; the coenosis presents an high cover of the two characteristic species of the association: *Eupatorium cannabinum* and *Cirsium creticum* subsp. *triumfetti*, subspecies that in Tuscany reaches the north-western limit of its distribution in the Italian peninsula (see Conti *et al.*, 2005).

CAREX HIRTA AND LYCOPUS EXALTATUS COMMUNITY (TAB. 14, REL. 6-7)

In the Ponte a Buriano wetland, above Monte sopra Rondine village, behind the large helophytic formations, wet meadows vegetation occurs characterized by the presence of *Carex hirta* and *Lycopus exaltatus*, a species that in the investigated area is ecologically differentiated from the more common *L. europaeus* highly tied to swampy environments. Regarding the phytosociologic valence of *Carex hirta*, some authors (e.g. Carreras *et al.*, 1988) attribute *Carex hirta* coenoses to the *Festuco-Caricetum hirtae* O. Bolòs 1962 association of the *Agropyro-Rumicion* alliance, while for central Europe the synanthropic and sub-xerophilous association *Convolvulo arvensis-Caricetum hirtae* of the *Convolvulo-Agropyron* is described (Jehlik, 1994). Other authors, however,

Tab. 14 - Vegetation of the *Plantagineta* *majoris* order

Rel. no.	1	2	3	4	5	6	7	Pres.
Altitude (m)	168	175	209	203	210	203	203	
Surface (m ²)	4	2	6	3	6	10	10	
Coverage (%)	100	90	90	85	100	100	100	
Charact. sp. of <i>Rorippo-Agrostietum stoloniferae</i>								
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylyvestris</i>		4	4	5				3
<i>Agrostis stolonifera</i> L.	5	+	+					3
Charact.sp. of <i>Cirsio triumfetti-Eupatorietum cannabini</i>								
<i>Cirsium creticum</i> (Lam.) d'Urv. subsp. <i>triumfetti</i> (Lacaita) Werner					3			1
<i>Eupatorium cannabinum</i> L.					3			1
<i>Carex hirta</i> and <i>Lycopus exaltatus</i> community								
<i>Carex hirta</i> L.						2	5	2
<i>Lycopus exaltatus</i> Ehrh.						5	2	2
Charact. sp. of <i>Molinio-Arrhenatheretea</i>								
<i>Ranunculus repens</i> L.	1	2				+		3
<i>Paspalum distichum</i> L.		2	2					2
<i>Potentilla reptans</i> L.						+	2	2
<i>Poa trivialis</i> L.						1		1
<i>Carex otrubae</i> Podp.						+		1
<i>Holcus lanatus</i> L.					+			1
<i>Juncus articulatus</i> L.	+							1
<i>Mentha spicata</i> L.					+			1
<i>Plantago major</i> L.		+						1
Other species								
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>			1		+	2	1	4
<i>Persicaria amphibia</i> (L.) Delarbre	+			1		+	+	4
<i>Persicaria dubia</i> (Stein.) Fourr.		+				+	+	3
Sporadic species	3	4	5	1	4	10	5	

underline the low diagnostic significance of this species, treating its coenoses only as *Carex hirta* community (e. g. Tomaselli & Bernardo, 2006).

RIPARIAN WET DECIDUOUS WOODLANDS AND WILLOW COMMUNITIES (*SALICI PURPUREAE-POPULETEA NIGRAE*)

SHRUBBY PIONEER WILLOW COMMUNITIES (*SALICION INCANAE*)

SAPONARIO OFFICINALIS-SALICETUM PURPUREAE (BR.-BL. 1930) TCHOU 1946 (TAB. 15)

The prevalently shrubby vegetation developing on cobbly-sandy bars subjected to prolonged flooding of the investigated Arno tracts can be referred to the *Saponario officinalis-Salicetum purpureae* association. This pioneer association often represents the first stage of the fluvial environments colonization by woody species dynamically preceding the *Salix alba* communities (see Landi *et al.*, 2002) or, in some cases in the study area, the black poplar stands when the conditions for the development of *Rubus ulmifolii-Salicetum albae* are lacking. The floristic composition shows the presence of a group of species (*Lythrum salicaria*, *Lycopus europaeus*, *Saponaria officinalis*, *Melilotus alba*) significantly frequent in the association (Pirone, 2000). Noteworthy in our relevés is the presence of *Populus nigra* in the tree

layer; this species seems to be favoured by the cutting management practices, to which it responds with the emission of vigorous shoots. Even the Merse river shrubs (Tuscany, Central Italy) display a strong black poplar cover (see Landi *et al.*, 2002). Ceschin & Salerno (2008) underline the significant role of these communities in the stabilization of the flooded soils thanks to their renewal by vegetative propagation and to the remarkable radical development of the species characterizing these coenoses.

RIPARIAN WOODS (*SALICION ALBAE* AND *POPULETALIA ALBAE*)

Thanks to the dendrogram made by cluster analysis (Fig. 3) it was possible to discriminate the following wood typologies: willow woods with *Salix alba* (A), poplar woods with *Populus nigra* often accompanied by *Salix alba* (B), woods dominated by *Alnus glutinosa* (C) or characterized by the presence of *Ulmus minor* (D), and woods with *Robinia pseudacacia* and *Sambucus nigra*, with sporadic occurrence of *Populus nigra* (E). For the treatment at the upper syntaxonomical units level, we refer to Rivas-Martínez *et al.* (2001, 2002) and Biondi *et al.* (2004).

RUBUS ULMIFOLII-SALICETUM ALBAE ALLEGREZZA, BIONDI & FELICI 2006 (TAB. 16, REL. 1-8)

Along the Arno tracts and in the Reserves woods

Tab. 15 - *Saponario officinalis* - *Salicetum purpureae* (Br.-Bl. 1930) Tchou 1946. A: species of the arboreal layer.

Rel. no.	1	2	3	4	5	Pres.
Altitude (m)	172	207	208	145	207	
Surface (m ²)	100	20	20	30	20	
Coverage (%)	100	100	100	100	100	
Charact. sp. of <i>Saponario officinalis</i> - <i>Salicetum purpureae</i> and upper units						
<i>Salix purpurea</i> L.	3	4	3	4	5	5
<i>Populus nigra</i> L.	1	3	3	3	1	5
<i>Saponaria officinalis</i> L.	+	+	+	+	.	4
<i>Salix alba</i> L.	3	.	+	1	1	4
<i>Brachypodium sylvaticum</i> (Huds.) P. Beauv.	1	.	1	.	r	3
<i>Populus nigra</i> L. (A)	2	.	.	.	1	2
<i>Salix alba</i> L. (A)	1	.	.	.	1	2
<i>Rubus caesius</i> L.	1	.	.	.	.	1
<i>Carex pendula</i> Huds.	.	.	.	.	+	1
Transgr. from <i>Artemisietea</i> and <i>Galio-Urticetea</i> classes						
<i>Solidago gigantea</i> Aiton	3	.	+	.	2	3
<i>Barbarea vulgaris</i> R. Br.	+	+	.	+	.	3
<i>Melilotus albus</i> Medik.	+	.	2	.	.	2
<i>Artemisia vulgaris</i> L.	.	+	1	.	.	2
<i>Tanacetum vulgare</i> L.	+	.	1	.	.	2
<i>Calystegia sepium</i> (L.) R. Br. subsp. <i>sepium</i>	.	+	.	.	+	2
<i>Arctium lappa</i> L.	+	.	.	.	.	1
<i>Galega officinalis</i> L.	.	.	.	+	.	1
<i>Pastinaca sativa</i> L.	.	.	+	.	.	1
<i>Eupatorium cannabinum</i> L.	.	.	.	.	r	1
<i>Helianthus tuberosus</i> L.	.	.	.	.	r	1
<i>Rumex crispus</i> L.	.	.	.	r	.	1
Transgr. from <i>Bidentetea tripartitae</i> class						
<i>Bidens frondosa</i> L.	1	1	+	1	+	5
<i>Xanthium orientale</i> (L.) subsp. <i>italicum</i> (Moretti) Greuter	.	1	+	1	2	4
<i>Persicaria maculosa</i> (L.) Gray	.	r	.	.	+	2
<i>Persicaria hydropiper</i> (L.) Delarbre	.	.	.	2	.	1
<i>Atriplex patula</i> L.	.	.	+	.	.	1
<i>Echinochloa crus-galli</i> (L.) P. Beauv.	.	.	.	+	.	1
<i>Persicaria dubia</i> (Stein.) Fourn.	.	.	+	.	.	1
Other species						
<i>Lythrum salicaria</i> L.	3	1	.	+	1	4
<i>Rorippa sylvestris</i> (L.) Besser subsp. <i>sylvestris</i>	+	2	.	1	2	4
<i>Lycopus europaeus</i> L.	1	1	.	.	+	3
<i>Paspalum distichum</i> L.	.	.	.	+	3	2
<i>Mentha aquatica</i> L. subsp. <i>aquatica</i>	.	.	.	2	1	2
<i>Centaurea gr. nigrescens</i>	1	1	.	.	.	2
<i>Amorpha fruticosa</i> L.	1	.	.	1	.	2
<i>Equisetum arvense</i> L.	+	.	.	.	1	2
<i>Juncus compressus</i> Jacq.	.	+	+	.	.	2
Sporadic species	11	3	6	0	3	

dominated by *Salix alba* are quite widespread, appearing as more or less extensive stands or at times simply as linear formations along the river course. The *Salix alba* woods in Central Italy can be referred to the association *Rubo ulmifolii-Salicetum albae* Allegrezza, Biondi & Felici 2006 that represents the geographic vicariant of the association *Salicetum albae* Issler 1926 of central Europe and of the associations *Salicetum albo-brutiae* Brullo & Spampinato 1997 and *Salicetum albo-pedicellatae* Brullo & Spampinato 1990 described for Calabria and Sicily (Allegrezza et al., 2006).

The arboreal layer in the study area is always dominated by *Salix alba*, generally with high cover values, accompanied to a lesser extent by *Populus nigra* and *Alnus glutinosa*. The shrubby layer is quite

poor and is formed by some shrubby willows (*Salix purpurea*, *S. triandra*), *Sambucus nigra*, *Cornus sanguinea* or *Crataegus monogyna*.

In our relevés a certain mixture of the herbaceous layer species is noted; nonetheless it is possible to individuate a group of relevés with a prevalent hygrophilous composition (Tab. 16, Rel. 5, 6, 7) with species like *Phalaris arundinacea*, *Iris pseudacorus*, *Phragmites australis* or *Lythrum salicaria*, indicating a more prolonged submersion; a second group (Tab. 16, Rel. 1, 2, 3, 4) appears more clearly characterized by a hygro-nitrophilous contingent, with abundant *Rubus caesius*, *Carex pendula*, *Eupatorium cannabinum*, *Urtica dioica* and *Galium aparine*, suggesting a longer emersion period.

In the rel. no. 8 *Amorpha fruticosa* is present,

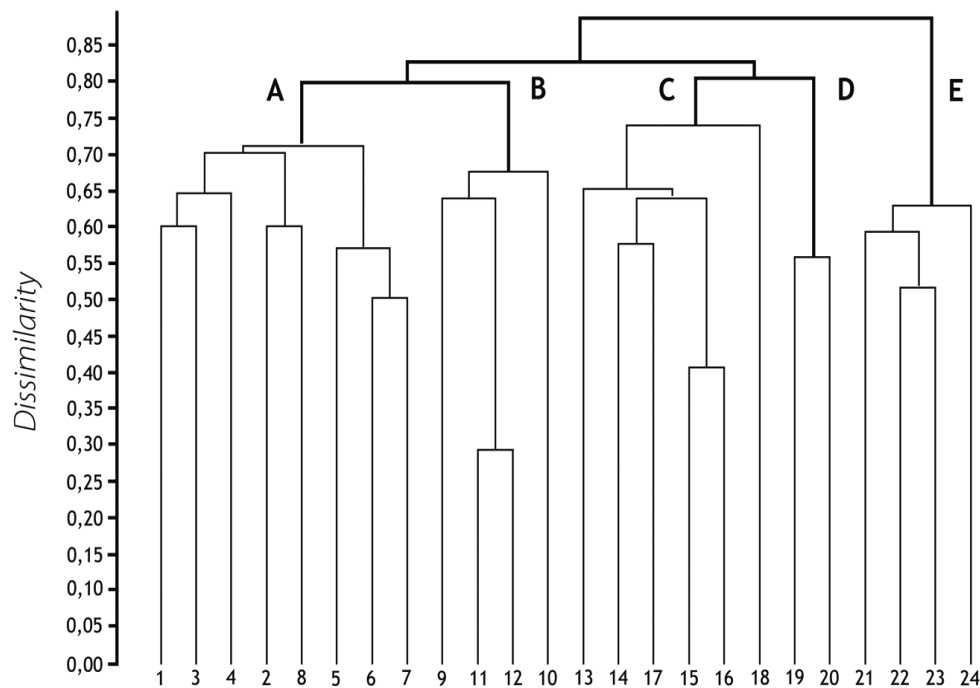


Fig. 3 - Dendrogram of the riparian woods relevés: *Rubo ulmifolii-Salicetum albae* (A), *Populus nigra* and *Salix alba* community (B), *Aro italici-Alnetum glutinosae* (C), *Ulmus minor* community (D), *Robinia pseudacacia* community (E).

as already reported in *Salix alba* communities by Venanzoni & Gigante (2000) in Umbria and by Biondi *et al.* (1999) in the Stirone Park (Emilia-Romagna).

POPULUS NIGRA AND *SALIX ALBA* COMMUNITY (TAB. 16, REL. 9-12)

On the terraced banks or the terraces flanking the Arno river, behind the *Salix purpurea* shrubs or the *Salix alba* woods, on more developed soils that are less exposed to the fluvial dynamics, *Populus nigra*-dominated woods occur, often accompanied by *Salix alba*, most times displaying a more or less linear structure. The low frequency of helophytes and highly hygrophilous species with respect to the *Salix alba* woods indicates a lower exposition to prolonged submersion. The frequency with which *Salix purpurea* appears in the shrubby layer indicates the contact with the *Salicetalia* coenoses of the exposed gravelly river beds. On the higher parts of the terraces these woods are enriched by species like *Bromus sterilis*, *Sambucus nigra* or *Elymus repens* that testify the contact with the *Robinia pseudacacia* woods located in more external position and by which they are totally substituted in the more disturbed areas. From a syntaxonomical and ecological point of view these woods are ascribed to the *Populion* alliance, presenting some affinity with the coenoses reported as *Salici-Populetum nigrae* (Tx.

1931) Meyer-Drees 1936 by Biondi *et al.* (1999) or by Landi *et al.* (2002). The abundant presence of *Populus nigra* in many areas of Tuscany is often connected to the economic importance that this species had in the past (De Dominicis & Casini, 1997; Arrigoni & Papini, 2003).

ARO ITALICI-ALNETUM GLUTINOSAE GAFTA & PEDROTTI 1995 (TAB. 16 REL. 13-18)

The *Alnus glutinosa*-dominated woods were observed along the Arno, in the Bandella bight at the confluence with the Ascione, and along some of its tributaries like the Rimaggio stream. The alder woods diffused along the watercourses of the north-central Apennines are generally referred to the *Aro italici-Alnetum glutinosae* Gafta & Pedrotti 1995 (see Pedrotti & Gafta, 1996) association of the *Alnion incanae* (*Alno-Ulmion*) alliance. This association is interpreted by Venanzoni & Gigante (2000) as a silting alder wood potentially evolving towards *Populetum albae* association. With respect to the typical association the floristic composition of the present relevés is quite impoverished especially regarding the contingent of *Alno-Ulmion* species, while it is enriched with hygrophilous species (e.g. *Iris pseudacorus*, *Mentha aquatica*, *Lycopus europaeus*); in addition the presence of *Salix alba* is more marked than in the

typical association both in frequency and in cover. Overall these alder woods, especially in the Bandella wetland, are fairly similar to those in the floodplains of other large rivers like the Tiber in Umbria (Venanzoni & Gigante, 2000) or in Lazio (Ceschin & Salerno, 2008), attributed to the *Aro italici-Alnetum glutinosae*. For the Alviano lake (Venanzoni & Gigante, 2000), the abundant presence of *Salix alba* in the association is interpreted as a transit stage from the willow wood to the alder wood that is favoured by the regime regulation of the Tiber river. In the Bandella area the soil development is slowed down by the river dynamics in connection with the dike and the periodical flooding creates an ecological condition of contact between the *Rubus ulmifolii-Salicetum albae* and the *Aro italici-Alnetum glutinosae* association. This can explain both the high cover values of white willow and the presence of various species in common with the white willow woods and of hygrophytes in the alder woods.

ULMUS MINOR COMMUNITY (TAB. 16, REL. 19-20)

Along the path around the Bandella bight, on a more elevated position respect to the water level that is rarely subjected to flooding, small thickets dominated by *Ulmus minor* occur and at times are accompanied by a high cover of *Acer campestre*; these thickets are in contact with the mesophilous vegetation dominated by *Quercus cerris* belonging to the *Quercetalia pubescenti-petraeae*. These thickets show some ecological and floristic affinity with the *Aro italici-Ulmetum minoris* Rivas-Martínez ex Lòpez 1976 association recorded, among the others, by Maiorca *et al.* (2007) in Calabria or with the *Symphyto bulbosi-Ulmetum minoris* Biondi & Allegranza 1996 described in the hilly territory of Ancona (Biondi & Allegranza, 1996).

ROBINIA PSEUDACACIA COMMUNITY (TAB. 16, REL. 21-24)

These are neo-formation woods that grow on the elevated banks of Arno tributaries, especially in the Laterina plain, near roads or cultivated fields or behind the black poplar woods occurring on the Arno terraces. The relationship with poplar woods is evident from the high frequency of *Populus nigra* in the relevés. These coenoses on one side show some affinity with the *Sambuco nigrae-Robinetum pseudacaciae* association described by Arrigoni (1997) in the Cerbaie (Tuscany), on the other they are located in a topographical position closer to the *Populetales* coenoses, which they substitute in some cases. In fact, the *Sambuco nigrae-Robinetum pseudacaciae* association, although representing transitional aspects towards the *Populetales* or the *Crataego-Quercion* mesophilous woods, is still included in the *Lonicero-Quercion* by Arrigoni (1997). In the present case, instead, these thickets show significant relationships with the *Populetales* formations as testified by the presence of *Populus nigra* (absent in the original association) and of an important contingent of characteristic species of the order (in which these coenoses are temporarily included). In the lower layers of these thickets abundant nitrophilous elements are recorded (e.g. *Sambucus nigra*, *Rubus ulmifolius* or *Ballota nigra*), typical of *Robinia pseudacacia* woods in connection with the nitrogen-fixing activity of *Robinia* (Arrigoni, 1997), together with species of *Populetales* (*Carex remota*, *Carex pendula*, *Rubus caesius*) and ruderal or synanthropic species (*Bromus sterilis*, *Juglans regia*, *Ailanthus altissima*). Black locust woods included in the *Populetales* (*Alnion incanae* alliance) syntaxa are reported by Biondi *et al.* (1997) for the Taro river and by Landi *et al.* (2002) for the Merse river.

Hygro-nitrophilous species of <i>Gallo-Urticetea</i> class																			
Urtica dioica L. subsp. dioica	1	3	1	1	1	1	1	1	1	1	1	1	1	3	1	1	17		
Gallium aparine L.	3	+	1	1	1	1	1	1	1	1	1	1	1	+	+	8			
Alliaria petiolata (M. Bieb.) Cavara & Grande															2	8			
Tortilis japonica (Houtt.) DC.															+	5			
Ballota nigra L.															1	5			
Geum urbanum L.															+	4			
Lanium maculatum L.															1	4			
Galega officinalis L.															+	3			
Helianthus tuberosus L.															+	3			
Petasites hybridus (L.) P. Gaertn., B. Mey & Scherb. subsp. hybridus	3			2											+	2			
Epilobium hirsutum L.				1											+	2			
Sambucus ebulus L.															+	2			
Aegopodium podagraria L.															+	2			
Lapsana communis L. subsp. communis															+	2			
Pastinaca sativa L.															+	2			
Pulicaria dysenterica (L.) Bernh.															+	2			
Reynoutria japonica Houtt.				2											+	1			
Symphoricarichum lanceolatum (Willd.) G. L. Nesom		1													+	1			
Barbarea vulgaris R. Br.															+	1			
Crucifera laevipes Opiz															+	1			
Scrophularia auriculata L. subsp. auriculata															+	1			
Stachys palustris L.															+	1			
Other species																			
Cornus sanguinea L.		1	+													1	10		
Crataegus monogyna Jacq.		1														+	10		
Ranunculus lanuginosus L.		+														+	10		
Artemisia vulgaris L.																+	9		
Rumex conglomeratus Murray																+	9		
Bromus sterilis L.																1	8		
Amorpha fruticosa L.																+	7		
Prunus spinosa L. subsp. spinosa																+	7		
Gallium mollugo L. subsp. erectum Syme																+	7		
Poa trivialis L.																+	7		
Acer campestre L.																+	7		
Chaerophyllum temulum L.																+	6		
Ligustrum vulgare L.																+	6		
Persicaria dubia (Stein.) Fourr.																+	6		
Silene latifolia Poir. subsp. alba (Mill.) Greuter & Burdet																+	6		
Bidens frondosa L.																+	6		
Prunella vulgaris L. subsp. vulgaris																+	6		
Ranunculus repens L.																+	6		
Elymus repens (L.) Gould subsp. repens																+	5		
Arcium lappa L.																+	4		
Helleborus foetidus L. subsp. foetidus																+	4		
Sporadic species																			
	1	0	5	2	0	2	5	11	10	11	10	4	9	4	2	1	8	4	5

Syntaxonomical scheme

- Lemnetea* Tüxen ex O. Bolòs et Masclans 1955
Lemnetalia minoris Tüxen ex O. Bolòs et Masclans 1955
Lemna minor community
- Potametea* Klika in Klika & V. Novák 1941
Potametalia Koch 1926
Potamion (Koch 1926) Libbert 1931
Zannichellia palustris community
Nymphaeion albae Oberdorfer 1957
Persicaria amphibia aquatic ecophene community
Ranunculion fluitantis Neuhäusl 1959
Callitrichetum obtusangulae Seibert 1962
- Bidentetea tripartitae* Tüxen, Lohmaeyer & Preising ex von Rochow 1951
Bidentetalia tripartitae Br.-Bl. & Tüxen ex Klika & Hadač 1944
Bidention tripartitae Nordhagen 1940
Bidenti-Polygonetum mitis (Roch. 1951) Tüxen 1979
echinochloetosum cruris-galli Baldoni & Biondi 1993
Chenopodion rubri (Tüxen ex Poli & J. Tüxen 1960) Kopecký 1969
Polygono lapathifolii-Xanthietum italici Pirola & Rossetti 1974
- Phragmito-Magnocaricetea* Klika in Klika & V. Novák 1941
Phragmitetalia Koch 1926
Phragmition communis Koch 1926
Phragmitetum vulgare von Soó 1927
Bolboschoenetum maritimi Egger 1933
Oenanthetalia aquatica Hejny in Kopecký et Hejny 1965
Oenanthion aquatica Hejny ex Neuhäusl 1959
Eleocharitetum palustris Ubrizsy 1948
Nasturtio-Glycerietalia Pignatti 1954
Glycerio-Sparganion Br.-Bl. & Sissingh in Boer 1942
Sparganietum erecti Roll 1938
Phalaridion arundinaceae Kopecký 1961
Rorippo-Phalaridetum arundinaceae Kopecký 1961
Nasturtion officinalis J. M. & Géhu 1987
Nasturtietum officinalis Seibert 1962
Magnocaricetalia Pignatti 1954
Magnocaricion elatae Koch 1926
Iridetum pseudacori Egger 1933 ex Brzeg et M. Wojterska 2001
Leersio oryzoidis-Juncetum effusi ass. nova
Phalaridetum arundinaceae Libbert 1931
Cyperetum longi Micevski 1957
Carex riparia community
- Artemisietea vulgaris* Lohmeyer, Preising & Tüxen ex von Rochow 1951
Artemisietalia vulgaris Lohmeyer in Tüxen 1947
Arction lappae Tüxen 1937
Saponario-Artemisietum verlotiorum Baldoni & Biondi 1993
Agropyretalia repentis Oberdorfer, Müller & Görs in Oberdorfer *et al.* 1967
Inulo viscosae-Agropyron repentis Biondi & Allegrezza 1996

Elymus repens subsp. *repens* community

Galio-Urticetea Passarge ex Kopecký 1969

Galio aparines-Alliarietalia petiolatae Görs & Müller 1969

Aegopodion podagrariae Tüxen 1967

Phalarido-Petasitetum hybridi Schwick. 1933

Balloto-Conion maculati Brullo in Brullo & Marcenó 1985

Urtico dioicae-Sambucetum ebuli (Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936) Br.-Bl. in Br.-Bl., Roussine & Nègre 1952

Convolvuletalia sepium Tüxen ex Mucina 1993

Convolvulion sepium Tüxen ex Oberdorfer 1957

Calystegio-Asteretum lanceolati (Holzner *et al.* 1978) Pass. 1993

Solidago gigantea community

Helianthus tuberosus community

Molinio-Arrhenatheretea Tüxen 1937

Crypsio-Paspaletalia distichi Br.-Bl. in Br.-Bl., Roussine & Nègre 1952 nom. inv. et nom. mut. propos. Rivas-Martínez *et al.* 2002

Paspalo-Polypogonion viridis Br.-Bl. in Br.-Bl., Roussine & Nègre 1952 nom. mut. propos. Rivas-Martínez *et al.* 2002

Paspalo distichi-Polypogonetum viridis Br.-Bl. in Br.-Bl., Gajewski, Wraber & Walas 1936 nom. mut. propos. Rivas-Martínez *et al.* 2002

Plantaginetalia majoris Tüxen & Preising in Tüxen 1950

Agrostion stoloniferae Görs 1966

Rorippo-Agrostietum stoloniferae (Moor 1958) Oberd. et Müll. 1961

Mentho-Juncion inflexi De Foucault 1984

Cirsio triumfetti-Eupatorietum cannabini Brullo & Spampinato 1990

Carex hirta and *Lycopus exaltatus* community

Salici purpureae-Populetea nigrae (Rivas-Martínez & Cantó ex Rivas-Martínez *et al.* 1991) Rivas-Martínez, T. E. Diaz, Fernandez-Gonzalez, Izco, Loidi, Lousa & Penas 2002

Salicetalia purpureae Moor 1958

Salicion incanae Aichinger 1933

Saponario officinalis-Salicetum purpureae (Br.-Bl. 1930) Tchou 1946

Salicion albae Soó 1930

Rubo ulmifolii-Salicetum albae Allegrezza, Biondi & Felici 2006

Populetalia albae Br.-Bl. ex Tchou 1948

Robinia pseudacacia community

Populion albae Br.-Bl. ex Tchou 1948

Populus nigra and *Salix alba* community

Alnion incanae Pawłowski in Pawłowski, Sokołowski & Wallisch 1928

Aro italici-Alnetum glutinosae Gafta & Pedrotti 1995

Ulmus minor community

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Addenda

Locality and date of the relevés

Tab. 1

Rel. 1 ditch between the Arno river and Quarata 20.05.04; rel. 2 canal just downstream of the Penna dike 23.09.04.

Tab. 2

Rel. 1 lateral branch of the Arno river near Montevarchi 16.06.08; rel. 2 Arno River between Castelluccio and Ponte a Buriano 16.07.04; rel. 3 Bandella bight 29.07.05; rel. 4 Crocina lake, between Quarata and Ponte a Buriano 14.05.04; rel. 5 ditch between Quarata and Ponte a Buriano 04.08.04.

Tab. 3

Rel. 1 Ponte a Buriano wetland 30.09.05; rel. 2 and 3 Arno river between Penna dike and Ponte Romito 01.19.04; rel. 4 Arno river between Castelluccio and Ponte a Buriano 23.09.04; rel. 5 Arno river between Castelluccio and Ponte a Buriano 29.07.04; rel. 6 Arno river near Ponte a Buriano 11.09.07; rel. 7 Arno river between Levane and Montevarchi 11.09.07.

Tab. 4

Rel. 1 Arno river between Castelluccio and Ponte a Buriano 14.05.04; rel. 2 Arno river between Castelluccio and Ponte a Buriano 03.06.04; rel. 3 Arno river between Castelluccio and Ponte a Buriano 26.08.04; rel. 4 and 7 Ponte a Buriano wetland 13.05.05; rel. 5 and 6 Bandella bight 13.05.05; rel. 8 Ponte a Buriano wetland 07.06.05; rel. 9 and 10 Ponte a Buriano wetland 06.07.05; rel. 11 and 13 Bandella bight 31.08.05; rel. 12 and 14 Ponte a Buriano wetland 31.08.05; rel. 15 Ponte a Buriano wetland 30.09.05; rel. 16 Ponte a Buriano wetland 22.06.05; rel. 17 Bandella bight 29.07.05.

Tab. 5

Rel. 1, 4, 6 and 7 Crocina lake between Quarata and Ponte a Buriano 14.05.04; rel. 2 Bandella bight 13.05.05; rel. 3 Bandella bight 15.05.05; rel. 5 Bandella bight 31.08.05; rel. 8 Crocina lake between Quarata and Ponte a Buriano 07.07.04.

Tab. 6

Rel. 1 ditch near Ponte a Buriano 31.08.05; rel. 2 ditch of the Crocina lake 07.07.04.

Tab. 7

Rel. 1 Ponte a Buriano wetland 26.08.04; rel. 2 Ponte a Buriano wetland 16.07.04; rel. 3 and 5 Ponte a Buriano wetland 13.05.05; rel. 4, 6 and 7 Ponte a Buriano wetland 06.07.05; rel. 9 Arno river between Castelluccio and Ponte a Buriano 11.09.07; rel. 8, 10 Arno river near Ponte a Buriano 25.05.09.

Tab. 8

Rel. 1 and 2 Ponte a Buriano wetland, near Monte Sopra Rondine 13.05.05; rel. 3 Bandella bight 13.05.05; rel. 4 Bandella bight 15.05.05; rel. 5 Bandella bight 22.06.05; rel. 6 Bandella bight 31.08.05; rel. 7 banks of the Arno river near Bandella bight 25.05.09; rel. 8, 9 and 13 Bandella bight 16.06.08; rel. 10 Bandella bight 31.08.05; rel. 11 and 12 Bandella bight 29.07.05; rel. 14 Bandella bight 22.06.05.

Tab. 9

Rel. 1 Ponte a Buriano wetland 22.06.05; rel. 2 Bandella bight 31.08.05.

Tab. 10

Rel. 1 Arno river between Levane and Montevarchi 10.07.09; rel. 2 Arno river near S. Giovanni Valdarno 10.07.09; rel. 3 Ponte a Buriano wetland, near Monte sopra Rondine 11.09.05.

Tab. 11

Rel. 1 Ponte a Buriano wetland 11.09.05; rel. 2 banks of the Arno river between Penna dike and Ponte del Romito 24.08.04; rel. 3 and 4 Ponte a Buriano wetland, near Monte Sopra Rondine 08.07.07.

Tab. 12

Rel. 1 banks of the Arno river between Castelluccio and Ponte a Buriano 14.07.04; rel. 2 banks of the Arno river between Castelluccio and Ponte a Buriano 26.08.04; rel. 3 banks of the Arno river between Penna dike and Ponte del Romito 27.09.04; rel. 4 Ponte a Buriano wetland, near the bridge 03.05.05; rel. 5 banks of the Arno river between Penna dike and Ponte del Romito 24.08.04; rel. 6 Ponte a Buriano wetland 11.09.05; rel. 7 banks of the Arno river between Penna dike and Ponte del Romito 17.07.09; rel. 8 banks of the Arno river between Castelluccio and Ponte a Buriano 23.09.04; rel. 9 Ponte a Buriano wetland 30.09.05; rel. 10 banks of the Arno river between Penna dike and Ponte del Romito 03.10.07; rel. 11 Ponte a Buriano 17.09.09; rel. 12 Arno river between Castelluccio and Ponte a Buriano 04.08.04; rel. 13 Bandella bight 07.06.05; rel. 14 banks of the Arno river near the bridge of Ponte a Buriano 26.08.04; rel. 15 banks of the Arno river between Castelluccio and Ponte a Buriano 23.09.04; rel. 16 Ponte a Buriano wetland 23.09.04; rel. 17 Ponte a Buriano wetland 16.06.08.

Tab. 13

Rel. 1 and 8 Bandella bight 31.08.05; rel. 2 banks of the Arno river between Levane and Montevarchi 10.07.09; rel. 3 and 5 Ponte a Buriano wetland 17.07.09; rel. 4 and 9 Ponte a Buriano wetland 24.09.08; rel. 6 and 7 banks of the Arno river between Penna dike and Ponte del Romito 01.10.04.

Tab. 14

Rel. 1 Bandella bight 22.06.05; rel. 2 banks of the Arno river between Penna dike and Ponte del Romito 17.07.09; rel. 3 banks of the Arno river near Castelluccio 17.07.09; rel. 4 Ponte a Buriano wetland 13.05.05; rel. 5 ditch between the Arno river and Quarata 04.08.04; rel. 6 and 7 Ponte a Buriano wetland 11.09.05.

Tab. 15

Rel. 1 Arno river between Penna dike and Ponte del Romito 07.07.04; rel. 2 and 5 Arno river near Castelluccio 04.08.04; rel. 3 Arno river near Castelluccio 23.09.04; rel. 4 Arno river

between Levane and Montevarchi 10.07.09.

Tab. 16

Rel. 1 Arno river between Castelluccio and Ponte a Buriano 09.06.04; rel. 2 Ponte a Buriano wetland 30.09.05; rel. 3 Bandella bight 06.07.05; rel. 4 Arno river between Castelluccio and Ponte a Buriano 10.07.04; rel. 5 and 6 Arno river between Castelluccio and Ponte a Buriano 03.06.04; rel. 7 Ponte a Buriano wetland 13.05.05; rel. 8 Bandella bight along the the Ascione stream 13.07.09; rel. 9 Arno river between Castelluccio and Ponte a Buriano 16.07.04; rel. 10 Arno river between Castelluccio and Ponte a Buriano 22.06.04; rel. 11 and 12 Arno river between Levane and Montevarchi 16.06.08; rel. 13 and 16 Bandella bight 07.06.05; rel. 14 Bandella bight 11.09.07; rel. 15 Bandella bight 15.05.05; rel. 17 Bandella bight 07.08.05; rel. 18 Torrente Rimaggio, near Ponte del Romito 19.09.04; rel. 19 Bandella bight 22.06.05; rel. 20 Bandella bight 22.06.08; rel. 21 terrace of the Arno river between Castelluccio and Ponte a Buriano 16.06.08; rel. 22 terrace of the Arno river between Castelluccio and Ponte a Buriano 14.07.05; rel. 23 Oreno stream in the Laterina plain 07.07.04; rel. 24 Ganascione stream in the Laterina plain 28.07.04

Sporadic species

Tab. 3

Rel. 1: *Bolboschoenus maritimus* (L.) Palla (1), *Leersia oryzoides* (L.) Sw. (+), *Phragmites australis* (Cav.) Trin. ex Steud. (+), *Populus alba* L. (pl.) (+); rel. 2: *Panicum dichotomiflorum* Michx. (+); rel. 3: *Lycopus europaeus* L. (+); rel. 4: *Elymus repens* (L.) Gould subsp. *repens* (+), *Erigeron canadensis* L. (+), *Mentha spicata* L. (+), *Plantago major* (+), *Pulicaria dysenterica* (L.) Bernh. (+); rel. 5: *Veronica anagallis-aquatica* L. subsp. *anagallis-aquatica* (1); rel. 6: *Persicaria amphibia* (L.) Delarbre (1).

Tab. 4

Rel. 1: *Callitriche obtusangula* Le Gall (2), *Persicaria lapathifolia* (L.) Delarbre (2); rel. 4: *Solidago gigantea* Aiton (r); rel. 6: *Juncus effusus* L. subsp. *effusus* (1), *Juncus inflexus* L. (+); rel. 8: *Atriplex prostrata* Boucher ex DC. (1), *Cirsium arvense* (L.) Scop. (1), *Agrimonia eupatoria* L. (+), *Aristolochia rotunda* L. (+), *Stachys palustris* L. (+); rel. 11: *Salix purpurea* L. (2), *Amorpha fruticosa* L. (1), *Equisetum arvense* L. (+), *Persicaria hydropiper* (L.) Delarbre (+); rel. 14: *Carex hirta* L. (+), *Potentilla reptans* L. (r); rel. 16: *Epilobium hirsutum* L. (1), *Populus alba* L. (pl.) (+), *Rumex conglomeratus* Murray (1), *Agrostis stolonifera* L. (+), *Stellaria aquatica* (L.) Scop. (r), *Ranunculus repens* L. (r); rel. 17: *Paspalum distichum* L. (r).

Tab. 5

Rel. 2: *Persicaria amphibia* (L.) Delarbre (1); rel. 3: *Ranunculus repens* L. (+), *Ranunculus sceleratus* L. (+); rel. 4: *Paspalum distichum* L. (2), *Cyperus eragrostis* Lam. (+), *Dittrichia viscosa* (L.) Greuter (+), *Juncus effusus* L. subsp. *effusus* (+); rel. 5: *Echinochloa crus-galli* (L.) P. Beauv. (1); rel. 6: *Persicaria hydropiper* (L.) Delarbre (1).

Tab. 7

Rel 1: *Cyperus eragrostis* Lam. (+), *Inula britannica* L. (+); rel. 3: *Carex hirta* L. (r); rel. 8: *Paspalum distichum* L. (+); rel. 9: *Rubus caesius* L. (2), *Ranunculus repens* (+); rel. 10: *Salix alba* L. (2), *Bromus sterilis* L. (+).

Tab. 8

Rel. 1: *Oenanthe silaifolia* M. Bieb. (+); rel. 2: *Calystegia sepium* (L.) R. Br. subsp. *sepium* (+); rel. 3: *Carex otrubae* Podp. (1); rel. 4: *Poa trivialis* L. (+), *Ranunculus sceleratus* L. (+); rel. 5: *Agrostis stolonifera* L. (1), *Carex otrubae* Podp. (1), *Trifolium resupinatum* L. (1), *Calystegia sepium* (L.) R. Br. subsp. *sepium* (+); rel. 6: *Rumex conglomeratus* Murray (+), *Carex hirta* L. (1), *Potentilla reptans* L. (+); rel. 7: *Oenanthe silaifolia* M. Bieb. (1), *Persicaria dubia* (Stein.) Fourr. (+), *Poa trivialis* L. (+), *Rumex conglomeratus* Murray (+), *Carex remota* L. (1), *Carex pendula* Huds. (+), *Lysimachia nummularia* L. (+), *Alopecurus myosuroides* Huds. (r); rel. 8: *Epilobium hirsutum* L. (1), *Echinochloa crus-galli* (L.) P. Beauv. (+), *Juncus conglomeratus* L. (+); rel. 9: *Juncus conglomeratus* L. (+), *Paspalum distichum* L. (1), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+); rel. 10: *Juncus articulatus* L. (+), *Persicaria dubia* (Stein.) Fourr. (+); rel. 12: *Epilobium hirsutum* L. (r), *Echinochloa crus-galli* (L.) P. Beauv. (+); rel. 13: *Agrostis stolonifera* L. (1), *Trifolium resupinatum* L. (r), *Ranunculus sceleratus* L. (+); rel. 14: *Juncus articulatus* L. (1).

Tab. 9

Rel. 1: *Calystegia sepium* (L.) R. Br. subsp. *sepium* (2), *Potentilla reptans* L. (2), *Elymus repens* (L.) Gould subsp. *repens* (1), *Agrostis stolonifera* L. (+), *Scirpoides holoschoenus* (L.) Soják (+), *Symphotrichum lanceolatum* (Willd.) G. L. Nesom (+), *Equisetum arvense* L. (r).

Tab. 10

Rel. 1: *Agrostis stolonifera* L. (1), *Plantago lanceolata* L. (1), *Dactylis glomerata* L. (+), *Lolium perenne* L. (+), *Medicago lupulina* L. (+), *Odontites vulgaris* Moench subsp. *vulgaris* (+); rel. 2: *Galega officinalis* L. (1), *Cuscuta campestris* Yunck. (+), *Galium mollugo* L. subsp. *erectum* Syme (+), *Lolium multiflorum* Lam. (+); rel. 3: *Calystegia sepium* (L.) R. Br. subsp. *sepium* (1), *Carex hirta* L. (1), *Inula britannica* L. (1), *Potentilla reptans* L. (1), *Rubus caesius* L.

(1), *Bromus secalinus* L. (+), *Cirsium arvense* (L.) Scop. (+), *Galium palustre* L. subsp. *elongatum* (C. Presl) Lange (+), *Prunus spinosa* L. subsp. *spinosa* (+), *Thalictrum lucidum* L. (+).

Tab. 11

Rel. 1: *Bromus secalinus* L. (1), *Atriplex prostrata* Boucher ex DC. (1), *Lythrum salicaria* L. (+), *Bidens frondosa* L. (+), *Persicaria dubia* (Stein.) Fourr. (+), *Persicaria maculosa* (L.) Gray (+), *Phalaris arundinacea* L. subsp. *arundinacea* (+), *Phragmites australis* (Cav.) Trin. ex Steud. (+); rel. 2: *Amorpha fruticosa* L. (1), *Rubus ulmifolius* Schott. (1), *Clematis vitalba* L. (+); rel. 3: *Galium verum* L. (1), *Aristolochia clematitis* L. (+), *Bromus secalinus* L. (+), *Euphorbia platyphyllos* L. (+), *Agrimonia eupatoria* L. (+), *Galium mollugo* L. subsp. *erectum* Syme (+), *Lythrum salicaria* L. (+), *Lycopus europaeus* L. (+), *Equisetum ramosissimum* Desf. (r); rel. 4: *Aristolochia clematitis* L. (2), *Rosa canina* L. (1), *Euphorbia platyphyllos* L. (+), *Agrimonia eupatoria* L. (+), *Galium mollugo* L. subsp. *erectum* Syme (+).

Tab. 12

Rel. 1: *Arctium lappa* L. (1), *Melilotus albus* Medik. (+), *Plantago major* L. (+), *Populus nigra* L. (pl.) (+), *Rorippa sylvestris* (L.) Besser subsp. *sylvestris* (+), *Salix eleagnos* Scop. (+), *Saponaria officinalis* L. (+); rel. 3: *Persicaria dubia* (Stein.) Fourr. (1); rel. 4: *Equisetum telmateia* Ehrh (2), *Trifolium repens* L. (2), *Stellaria media* (L.) Vill. (1), *Ranunculus repens* L. (1), *Poa trivialis* L. (1), *Cirsium arvense* (L.) Scop. (+), *Silene latifolia* Poir. subsp. *alba* (Mill.) Greuter & Burdet (+), *Trifolium pratense* L. (+), *Vicia sativa* L. (+), *Cota tinctoria* (L.) J. Gay (r), *Dactylis glomerata* L. (r), *Veronica persica* Poir. (r); rel. 5: *Convolvulus arvensis* L. (+); rel. 6: *Cornus sanguinea* L. (1), *Melissa officinalis* L. (1), *Cirsium arvense* (L.) Scop. (+), *Galium mollugo* L. subsp. *erectum* Syme (+), *Silene latifolia* Poir. subsp. *alba* (Mill.) Greuter & Burdet (+), *Dactylis glomerata* L. (+), *Achillea millefolium* L. (+), *Althaea cannabina* L. (+), *Ranunculus bulbosus* L. (+), *Tordilium apulum* L. (+); rel. 7: *Amorpha fruticosa* L. (+), *Setaria viridis* (L.) P. Beauv. (r); rel. 8: *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (2); rel. 9: *Carex hirta* L. (+), *Phragmites australis* (Cav.) Trin. ex Steud. (+); rel. 10: *Iris pseudacorus* L. (+), *Persicaria dubia* (Stein.) Fourr. (+), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+); rel. 11: *Bolboschoenus maritimus* (L.) Palla (+), *Galium palustre* L. subsp. *elongatum* (C. Presl) Lange (+), *Phalaris arundinacea* L. subsp. *arundinacea* (+); rel. 12: *Elymus caninus* (L.) L.; rel. 13: *Amorpha fruticosa* L. (2), *Poa trivialis* L. (1), *Iris pseudacorus* L. (1), *Chaerophyllum temulum* L. (1), *Holcus lanatus* L. (1), *Vicia parviflora* Cav. (1), *Galium mollugo* L.

subsp. *erectum* Syme (+), *Anthoxanthum odoratum* L. (+), *Bromus secalinus* L. (+), *Campanula rapunculus* L. (+), *Carex pendula* Huds. (+), *Medicago arabica* (L.) Huds. (+); rel. 14: *Ranunculus repens* L. (+), *Bidens tripartita* L. (+), *Echinochloa crus-galli* (L.) P. Beauv. (+), *Persicaria lapathifolia* (L.) Delarbre (+), *Sonchus arvensis* L. (+); Rel. 15: *Atriplex patula* L. (+); rel. 16: *Artemisia verlotiorum* Lamotte (+); rel. 17: *Atriplex patula* L. (+), *Carex hirta* L. (+), *Agrimonia eupatoria* L. (+), *Daucus carota* L. (+).

Tab. 13

Rel. 1: *Persicaria maculosa* (L.) Gray (1), *Iris pseudacorus* L. (+), *Alisma plantago-aquatica* L. (r); rel. 2: *Leersia oryzoides* (L.) Sw. (2), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+), *Schoenoplectus tabernaemontani* (C. C. Gmel.) Palla (+); rel. 4: *Persicaria amphibia* (L.) Delarbre (1), *Persicaria maculosa* (L.) Gray (+), *Mentha aquatica* L. subsp. *aquatica* (+), *Phalaris arundinacea* L. subsp. *arundinacea* (+); rel. 5: *Persicaria amphibia* (L.) Delarbre (+), *Phragmites australis* (Cav.) Trin. ex Steud. (+), *Phalaris arundinacea* L. subsp. *arundinacea* (+); rel. 6: *Equisetum arvense* L. (1), *Cyperus fuscus* L. (+), *Panicum dichotomiflorum* Michx. (+), *Panicum capillare* L. (+); rel. 7: *Lycopus europaeus* L. (1), *Bidens frondosa* L. (+), *Panicum dichotomiflorum* Michx. (+), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+); rel. 8: *Eleocharis palustris* (L.) Roem. & Schult. subsp. *palustris* (2), *Leersia oryzoides* (L.) Sw. (1), *Mentha aquatica* L. subsp. *aquatica* (+), *Alisma plantago-aquatica* L. (+), *Salix alba* L. (pl.) (+); rel. 9: *Bidens frondosa* L. (2), *Cyperus fuscus* L. (+), *Phragmites australis* (Cav.) Trin. ex Steud. (+), *Artemisia vulgaris* L. (+), *Elymus repens* (L.) Gould subsp. *repens* (+), *Polygonum aviculare* L. (+), *Rubus caesius* L. (+), *Symphotrichum lanceolatum* (Willd.) G. L. Nesom (+), *Solidago gigantea* Aiton (+).

Tab. 14

Rel. 1: *Mentha aquatica* L. subsp. *aquatica* (1), *Veronica anagallis-aquatica* L. subsp. *anagallis-aquatica* (1), *Eleocharis palustris* (L.) Roem. & Schult. subsp. *palustris* (+); rel. 2: *Lythrum salicaria* L. (1), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (1), *Mentha aquatica* L. subsp. *aquatica* (+), *Galega officinalis* L. (+); rel. 3: *Populus nigra* L. (pl.) (2), *Lythrum salicaria* L. (1), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (1), *Salix purpurea* L. (pl.) (1), *Solidago gigantea* Aiton (+); rel. 4: *Phalaris arundinacea* L. subsp. *arundinacea* (+); rel. 5: *Carex pendula* Huds. (2), *Equisetum telmateia* Ehrh (2), *Glechoma hederacea* L. (1), *Urtica dioica* L. subsp. *dioica* (1); rel. 6: *Aristolochia clematitis* L. (1), *Iris pseudacorus* L. (1), *Symphotrichum lanceolatum* (Willd.) G. L. Nesom (1), *Bromus secalinus* L. (1), *Elymus repens* (L.) Gould subsp. *repens* (1), *Equisetum ramosissimum* Desf. (+), *Phragmites*

australis (Cav.) Trin. ex Steud. (+), *Galium palustre* L. subsp. *elongatum* (C. Presl) Lange (+), *Stachys palustris* L. (+), *Phalaris arundinacea* L. subsp. *arundinacea* (+); rel. 7: *Elymus repens* (L.) Gould subsp. *repens* (1), *Stachys palustris* L. (1), *Bromus secalinus* L. (+), *Galium palustre* L. subsp. *elongatum* (C. Presl) Lange (+), *Rubus caesius* L. (+).

Tab. 15

Rel. 1: *Iris pseudacorus* L. (1), *Robinia pseudacacia* L. (1), *Cyperus eragrostis* Lam. (+), *Schoenoplectus tabernaemontani* (C. C. Gmel.) Palla (+), *Cornus mas* L. (+), *Lotus corniculatus* L. (+), *Mentha spicata* L. (+), *Poa trivialis* L. (+), *Rosa canina* L. (+), *Serratula tinctoria* L. (+), *Trifolium repens* L. (+); rel. 2: *Scirpoides holoschoenus* (L.) Sojak (1), *Juncus articulatus* L. (+), *Veronica anagallis-aquatica* L. subsp. *anagallis-aquatica* (r); rel. 3: *Galium mollugo* L. subsp. *erectum* Syme (1), *Agrostis stolonifera* L. (+), *Bromus sterilis* L. (+), *Dactylis glomerata* L. (+), *Plantago major* L. (+), *Rubus ulmifolius* Schott. (+); rel. 5: *Vitis* cfr. *riparia* Michx. (1), *Clematis vitalba* L. (+), *Prunella vulgaris* L. subsp. *vulgaris* (r).

Tab. 16

Rel. 1: *Morus alba* L. (1); rel. 3: *Equisetum arvense* L. (1), *Holcus lanatus* L. (+), *Rosa canina* L. (+), *Oenanthe pimpinelloides* L. (+), *Rumex acetosa* L. subsp. *acetosa* (+); rel. 4: *Persicaria amphibia* (L.) Delarbre (+), *Mentha spicata* L. (+); rel. 6: *Plantago major* L. (+), *Rumex crispus* L. (+); rel. 7: *Stellaria media* (L.) Vill. (3), *Ranunculus ficaria* L. (2), *Equisetum arvense* L. (+), *Persicaria amphibia* (L.) Delarbre (+), *Potentilla reptans* L. (+); rel. 8: *Agrostis stolonifera* L. (3), *Potentilla reptans* L. (1), *Tussilago farfara* L. (1), *Daucus carota* L. (+), *Arctium minus* (Hill.) Bernh. (+), *Equisetum arvense* L. (+), *Persicaria amphibia* (L.) Delarbre (+), *Rosa canina* L. (+), *Plantago major* L. (+), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+), *Senecio aquaticus* Hill (+); rel. 9: *Ostrya carpinifolia* Scop. (1), *Prunus domestica* L. subsp. *insititia* (L.) Bonnier & Layens (1), *Dactylis glomerata* L. (+), *Aethusa cynapium* L. (+), *Atriplex prostrata* Boucher ex DC. (+), *Consolida regalis* Gray (+), *Clematis vitalba* L. (+), *Lactuca serriola* L. (r), *Papaver rhoeas* L. subsp. *rhoeas* (r), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (r); rel. 10: *Dactylis glomerata* L. (1), *Tanacetum vulgare* L. (1), *Vitis* cfr. *riparia* Michx. (1), *Persicaria maculosa* (L.) Gray (1), *Clematis vitalba* L. (+), *Rumex crispus* L. (+), *Xanthium orientale* (L.) subsp. *italicum* (Moretti) Greuter (+), *Cichorium intybus* L. (+), *Echium vulgare* L. (+), *Plantago lanceolata* L. (+), *Melilotus albus* Medik. (+); rel. 11: *Agrostis stolonifera* L. (2), *Morus alba* L. (1), *Artemisia verlotiorum* Lamotte (1), *Persicaria hydropiper* (L.) Delarbre (1), *Plantago major* L. (+), *Senecio aquaticus* Hill (+), *Aristolochia clematitis* L.

(+), *Cyperus eragrostis* Lam. (+), *Campanula trachelium* L. subsp. *trachelium* (+), *Stellaria aquatica* (L.) Scop. (+); rel. 12: *Persicaria hydropiper* (L.) Delarbre (1), *Morus alba* L. (+), *Artemisia verlotiorum* Lamotte (+), *Campanula trachelium* L. subsp. *trachelium* (+); rel. 13: *Juncus inflexus* L. (2), *Carex otrubae* Podp. (1), *Aristolochia clematidis* L. (+), *Potentilla reptans* L. (+), *Rosa canina* L. (+), *Holcus lanatus* L. (+), *Ranunculus bulbosus* L. (+), *Cirsium arvense* (L.) Scop. (+), *Oenanthe pimpinelloides* L. (+); rel. 14: *Holcus lanatus* L. (+), *Myosotis arvensis* (L.) Hill subsp. *arvensis* (+), *Silene flos-cuculi* (L.) Clairv. (r), *Melica uniflora* Retz. (r); rel. 15: *Myosotis arvensis* (L.) Hill subsp. *arvensis* (1), *Carex otrubae* Podp. (+); rel. 16: *Persicaria lapathifolia* (L.) Delarbre (+); rel. 17: *Euonimus europaeus* L. (1), *Reseda lutea* L. subsp. *lutea* (1), *Chenopodium album* L. (+), *Solanum nigrum* L. (+), *Arctium minus* (Hill.) Bernh.

(+); rel. 18: *Melica uniflora* Retz. (1), *Carpinus betulus* L. (1), *Fraxinus ornus* L. subsp. *ornus* (1), *Ruscus aculeatus* L. (1), *Carex distans* L. (+), *Geranium nodosum* L. (+), *Juncus inflexus* L. (+); rel. 19: *Euonimus europaeus* L. (2), *Vitis* cfr. *riparia* Michx. (1), *Medicago lupulina* L. (+), *Campanula rapunculus* L. (r), *Cirsium vulgare* (Savi) Ten. (r), *Equisetum ramosissimum* Desf. (r); rel. 20: *Aristolochia clematidis* L. (1), *Viola alba* Besser (1); rel. 21: *Juglans regia* L. (+); rel. 22: *Euonimus europaeus* L. (1), *Vitis* cfr. *riparia* Michx. (1), *Ailanthus altissima* (Mill.) Swingle (1), *Ficus carica* L. (1), *Hordeum murinum* L. (1), *Chelidonium majus* L. (+), *Juglans regia* L. (+), *Dactylis glomerata* L. (+); rel. 23: *Chelidonium majus* L. (1), *Sedum cepaea* L. (1), *Sonchus arvensis* L. (+), *Tamus communis* L. (+); rel. 24: *Cirsium vulgare* (Savi) Ten. (+), *Artemisia verlotiorum* Lamotte (+), *Clematis vitalba* L. (+), *Picris hieracioides* L. (+), *Tanacetum vulgare* L. (+).