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THE HYGROPHILOUS VEGETATION OF THE SULMONA BASIN (ABRUZZO, ITALY)

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Abstract: The bottom of the Sulmona basin, in the province of L'Aquila (Abruzzo), also known as *Valle Peligna*, is characterized by calcareous and argillaceous fluvial-lacustrine deposits. The bottom of the basin is almost completely cultivated and built-up, but still there are a few strips of azonal natural vegetation formed by riparian vegetation with the *Salicetum albae* and *Aro italici-Alnetum glutinosae* associations and marshy vegetation with the *Carici ripariae-Alnetum glutinosae* association. Three vegetation series can be identified: the marshy series of *Alnus glutinosa*, which is composed of *Carici ripariae-Alnetum glutinosae* and *Galio palustris-Caricetum ripariae*; the riparian series of *Alnus glutinosa*, composed of *Aro italici-Alnetum glutinosae and*, in addition, by the following associations of wet meadows: *Valeriano-Filipenduletum*, *Epilobio hirsuti-Filipenduletum* and *Lysimachio-Filipenduletum*; riparian series of *Salix alba* (composed of *Salicetum albae*). The marshy woods of the Sulmona basin are residual woods of great phytogeographical interest, undergoing continual and progressive anthropogenic degradation, and thus worthy of protection.

Keywords: anthropogenic disturbance, black alder carr, residual woods, riparian forest vegetation, syntaxonomic classification, vegetation series, wet meadows

Introduction

The Sulmona basin, the birthplace of Publio Ovidio Nasone (Ovid), in the province of L'Aquila (Abruzzo Region, Italy), is also known as *valle peligna* or *conca peligna*. It is located at an average altitude of 300 m. a.s.l. and delimited by the highest mountains of the Appennines, the calcareous chains of the Sirente, Maiella-Morrone, Gran Sasso and Monte Genzana. It flows into the Aterno-Pescara river basin through the Gizio, Sagittario, Vella and Velletta effluents. This basin corresponds to a tectonic fault subsidence subsequently occupied by a lake [1], which has since disappeared. The bottom of the basin is characterized by calcareous and argillaceous fluvial-lacustrine deposits. The toponym *peligno*, which refers to both the place and the ancient people that populated the zone, comes from *pedilimnus*, that is, on the edge of the lake.

The bottom of the basin is almost completely cultivated and built-up; reclamation projects carried out in particular by the monks of the Celestine order and more recently by reclamation consortiums (*Consorzi di bonifica*) have profoundly modified the appearance of the valley bottom, which hosts many springs and watercourses. Currently, there remain small fragments of natural vegetation characterized by willow groves, black alder woods, and wet meadows. In addition, one can note in a few places a process of regeneration of the old coppices, as well as some strips of secondary succession, due to the abandonment of the less convenient or less productive farmlands.

The aim of the present work was to describe the hygrophilous vegetation of the Sulmona basin and to examine the current state of conservation of the residual vegetation strips.

Vegetation

Research focused primarily on the black alder woods and the wet and marshy meadows. The plant associations noted in the Sulmona basin are reported below, in the following synsystematic overview:

LEMNETEA MINORIS de Bolòs *et* Masclans 1955
LEMNETALIA MINORIS de Bolòs *et* Masclans 1955
Lemnion minoris de Bolòs *et* Masclans 1955
Lemnetum minoris Oberdorfer *ex*. T. Müller *et* Görs 1960

PHRAGMITI-MAGNOCARICETEA Klika in Klika *et* Novak 1941
PHRAGMITETALIA Koch 1926
Phragmition communis Koch 1926
Phragmitetum vulgaris von Soò 1927
Typhetum latifoliae Lang 1973
Magnocaricion elatae Koch 1926
Caricetum gracilis Almquist 1929
Galio palustris-Caricetum ripariae Bal.-Tul., Mucina, Ellmauer *et* Wallnöfer 1993 in Grabherr *et* Mucina 1933
Cyperetum longi Micevski 1957
NASTURTIO-GLYCERIETALIA Pignatti 1953
Glycerio-Sparganion Braun-Blanquet *et* Sissingh in Boer 1942
Helosciadetum nodiflori Braun-Blanquet, Roussine *et* Nègre 1952
Veronico-Sietum erecti Passarge 1982
Sparganietum neglecti Casper *et* Krausch 1980

MOLINIO-ARRHENATHERETEA R. Tüxen 1937 em. R. Tüxen 1970
MOLINETALIA Koch 1926
Calthion R.Tüxen 1937 em. Balatova-Tulackova 1978
Filipendulenion (Lohmeyer in Oberdorfer et al. 1967) Balatova-Tulackova 1978
Valeriano officinalis-Filipenduletum Sissingh in Westhoff et al. ex Van Donselaar 1961
Epilobio hirsuti-Filipenduletum Sougnez 1957
Lysimachio vulgaris-Filipenduletum Balatova-Tulackova 1978
POTENTILLO-POLYGONETALIA R.Tüxen 1947
Potentillion anserinae R.Tüxen 1947
Junco inflexi-Menthetum longifoliae Lohmeyer 1953

ALNETEA GLUTINOSAE Braun-Blanquet et R.Tüxen ex Westhoff et al. 1946
ALNETALIA GLUTINOSAE R. Tüxen 1937
Alnion glutinosae Malcuit 1929
Carici ripariae-Alnetum glutinosae Weisser 1970

QUERCO-FAGETEA Braun-Blanquet et Vlieger 1937
POPULETALIA ALBAE Braun-Blanquet ex Tchou 1948
Alno-Ulmion Braun-Blanquet et R. Tüxen ex Tchou 1948
Aro italici-Alnetum glutinosae Gafta et Pedrotti 1995

SALICETEA PURPUREAE Moor 1958
SALICETALIA PURPUREAE Moor 1958
Salicion albae Soò 1930
Salicetum albae Issler 1926

Description of the Plant Associations

Riparian forest

Along the watercourses crossing the Sulmona basin are the *Salicetum albae* and the *Aro italici-Alnetum glutinosae* associations.

Table 1: ***Aro italici-Alnetum glutinosae***

Rel. no.	1	2
Area (m^2)	100	200
Total cover (%)	100	100
Tree layer		
Alnus glutinosa	5.5	5.5
Salix caprea	+	.
Shrub layer		
Sambucus nigra	1.1	1.1
Rubus caesius	1.1	1.1
Ligustrum vulgaris	+	+
Crataegus oxyacantha	+	+
Viburnum opulus	+	+
Rubus fruticosus	1.1	.
Euonymus europaeus	+	+
Cydonia oblonga	+	.
Ulmus campestris	+	.
Cornus sanguinea	.	1.1
Ficus carica	.	+
Liane layer		
Hedera helix	2.2	+
Clematis vitalba	+	.
Lonicera caprifolium	+	.
Vitis berlandieri	+	.
Herb layer		
Ranunculus lanuginosus	1.1	1.1
Urtica dioica	2.2	1.1
Arum italicum	1.1	+
Equisetum maximum	1.1	+
Galium aparine	1.1	+
Bryonia dioica	+	+
Humulus lupulus	+	+
Lamium bifidum	+	+
Hedera helix	2.3	.
Carex pendula	2.2	.
Anthriscus sylvestris	+	.
Lonicera caprifolium	+	.
Petasites hybridus	+	.
Geranium versicolor	+	.
Malachium aquaticum	+	.
Agropyron caninum	+	.
Sanicula europaea	+	.
Cucubalus baccifer	+	.
Brachypodium sylvaticum	.	1.2
Primula acaulis	.	1.1
Stachys sylvatica	.	1.1
Parietaria judaica	.	+.2
Ajuga reptans	.	+
Galium palustre	.	+
Arctium lappa	.	+
Geranium robertianum	.	+
Viola odorosa	.	+
Viola sylvestris	.	+
Eupatorium cannabinum	.	+

Table 2: ***Carici ripariae-Alnetum glutinosae***

Rel. no.	1	2	3	4
Area (m^2)	100	200	100	100
Total cover (%)	100	100	100	100
Tree layer				
Alnus glutinosa	5.5	5.5	5.5	5.5
Salix alba	.	+	.	.
Acer pseudoplatanus	+	.	.	.
Shrub layer				
Sambucus nigra	+	+	.	1.1
Rubus caesius	1.1	+	.	1.1
Euonymus europaeus	+	+	.	.
Cornus sanguinea	1.1	.	+	.
Viburnum opulus	+	.	+	.
Ligustrum vulgaris	+	.	.	.
Prunus avium	+	.	.	.
Salix alba	+	.	.	.
Rubus fruticosus	.	.	.	+
Liane layer				
Hedera helix	+	.	+	.
Clematis vitalba	+	.	.	.
Vitis berlandieri	.	+	.	.
Herb layer				
Carex riparia	3.4	4.4	2.3	2.2
Carex remota	2.3	+	+	
Filipendula ulmaria	2.2	+	+	+
Scrophularia umbrosa	+	+	+	+
Eupatorium cannabinum	1.1	+	+	1.1
Ranunculus repens	+	1.1	1.1	1.1
Galium palustre	+	1.1	1.1	+
Solanum dulcamara	+	+	2.3	
Iris pseudacorus	.	1.2	1.2	+.2
Humulus lupulus	+	+	+	
Equisetum maximum	+	+	.	+
Myosotis scorpioides	+	1.1	.	+
Poa trivialis	+	+	.	+
Ranunculus lanuginosus	1.1	.	.	+
Sparganium erectum	+	.	+.2	.
Valeriana officinalis	+	+	.	.
Calystegia saepium	+	+	.	.
Lythrum salicaria	.	+	+	.
Apium nodiflorum	.	+	+	.
Cirsium creticum	.	+	.	+
Phragmites australis	+	.	.	.
Carex pendula	1.1	.	.	.
Urtica dioica	+	.	.	.
Brachypodium sylvaticum	+	.	.	.
Equisetum arvense	+	.	.	.
Rumex conglomeratus	+	.	.	.
Ajuga reptans	+	.	.	.
Hypericum quadrangulum	+	.	.	.
Angelica sylvestris	+	.	.	.
Mentha aquatica	.	+	.	.
Potentilla reptans	.	+	.	.
Pastinaca urens	.	+	.	.
Holcus lanatus	.	+	.	.
Cucubalus baccifer	.	+	.	.
Lemna minor	.	.	+	.
Lycopus europaeus	.	.	+	.
Stachys palustris	.	.	.	+
Malachium aquaticum	.	.	.	+

Aro italici-Alnetum glutinosae is composed in the tree layer almost exclusively of *Alnus glutinosa,* while the shrub layer is richer in species, as is the herb layer, where one can observe, among other many species, *Arum italicum*, *Cucubalus baccifer*, *Stachys sylvatica*, *Carex pendula*, *Ranunculus lanuginosus*, *Sanicula europaea*, and *Urtica dioica* (Table 1). The following species can be considered differential compared to *Carici ripariae-Alnetum glutinosae*: *Bryonia dioica*, *Agropyron caninum*, *Sanicula europaea*, *Cucubalus baccifer*, *Stachys sylvatica* and *Parieteria judaica*. This forest association is distributed throughout central Italy [4], where it is fairly common, although in small areas which are often very degraded. In the Sulmona basin these alder woods still have an adequate species composition, but almost everywhere they are invaded by adventive species such as *Robinia pseudoacacia, Acer negundo, Populus x canadensis, Vitis berlandieri* and sometimes even *Ailanthus altissima*.

White willow woods (*Salicetum albae*) are limited to a few significant strips, above all along the rivers, even though a large proportion has been eliminated by Man, also in recent times.

Marshy forest

In the flat zones of the basin bottom is a black alder carr corresponding to the *Carici ripariae-Alnetum glutinosae*; it grows in the depressions with a high water table both in cultivated plains and within the *Aro italici-Alnetum glutinosae*; a few strips are present near some springs. In these depressions the water is stagnant for at least 5–6 months (in rare cases, even all year) and during the summer months the soil remains moist. This black alder marshy wood is characterized by *Carex riparia*, *Solanum dulcamara*, *Phragmites australis*, *Mentha acquatica*, *Lycopus europaeus*, *Iris pseudacorus*, *Hypericum quadrangulum* and *Stachys palustris* (Table 2). It is not uncommon to find here wet meadow species such as *Filipendula ulmaria*, *Scrophularia umbrosa* and others; in the permanent pools *Lemna minor* is also present.

The following species can be considered differential compared to *Aro italici-Alnetum glutinosae*: *Filipendula ulmaria*, *Lycopus europaeus*, *Mentha aquatica*, *Scrophularia umbrosa*, *Sparganium erectum*, *Solanum dulcamara*, *Phragmites australis*, *Iris pseudacorus*, *Lemna minor*, *Stachys palustris* and *Hypericum quadrangulum*. However, as one can see from Table 2, there are also some typically riparian species; this is due to the environmental degradation underway, with a consequent mixing of species.

The black alder carr of *Carici ripariae-Alnetum glutinosae* is a very rare association, reported here for the first time in Italy (Fig. 1). In the past this association was certainly more widespread; it was later eliminated almost everywhere when valley bottoms were drained and reclaimed for farming.

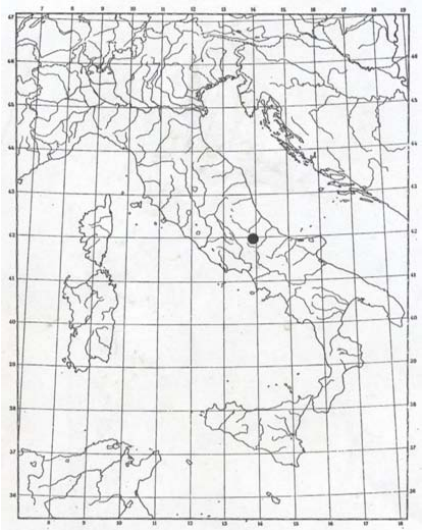

Fig. 1: The distribution in Italy of *Carici ripariae-Alnetum glutinosae* association.

Wet meadows

In some localities within the Sulmona basin, on terraces occupied by black alder riparian woods in the past, are wet meadows of two alliances. In the *Filipendulion* alliance are the *Valeriano-Filipenduletum, Epilobio hirsuti-Filipenduletum* and *Lysimachio-Filipenduletum* associations. In the *Potentillion anserinae* alliance there is only the *Junco-Menthetum longifoliae* association.

Table 3: ***Plant associations of Filipendulion***

Rel. no.	1	2	3	4	5	6	7	8	9
Area (m^2)	20	10	10	20	10	100	20	20	100
Total cover (%)	100	100	100	100	100	100	100	100	100
Diagnostic sp. (ass. Epilobio-Filipenduletum)									
Epilobium hirsutum	+	2.3	+	+	4.4	5.5	.	.	
Diagnostic sp. (ass. Valeriano-Filipenduletum)									
Valeriana officinalis	.	.	.	.	.	.	2.2	2.2	
Diagnostic sp. (ass. Lysimachio-Filipenduletum)									
Lysimachia vulgaris	.	.	.	.	.	.	.	.	2.2
Other species									
Filipendula ulmaria	4.4	4.5	4.4	4.5	1.1	+	4.5	4.4	4.5
Equisetum maximum	2.3	1.1	1.1	2.2	1.1	1.1	2.2	1.1	1.1
Potentilla reptans	+	.	.	+	.	+	1.1	.	+
Calystegia saepium	+	+	+	.	+	.	.	+	
Ranunculus repens	+	.	.	+	.	1.1	.	1.1	+
Vicia saepium	+	.	+	.	.	.	+	+	+
Eupatorium cannabinum	.	.	+	+	+	+	.	.	+
Menta longifolia	.	.	+	.	.	1.1	+	+	+
Holcus lanatus	.	.	.	+	.	+	+	+	+
Galium mollugo	.	.	.	+	+	+	+	.	+
Scrophularia umbrosa	.	.	.	.	+	+	.	+	+
Lythrum salicaria	.	+	.	.	+	+	.	+	
Carex hirta	.	.	.	+	+	+	.	+	
Urtica dioica	1.1	1.1	.	.	.	.	.	1.1	
Lathyrus pratensis	.	.	.	1.1	.	.	1.1	.	1.1
Pulicaria disenterica	.	.	.	+	+	+	.	.	
Humulus lupulus	.	.	.	.	+	1.1	.	.	+
Myosotis scorpioides	+	.	.	.	.	.	.	+	
Carex gracilis	.	.	+	.	.	.	.	.	+
Cornus sanguinea	.	.	.	.	.	.	+	.	+
Rubus caesius	.	.	.	.	1.1	.	.	.	1.1
Poa trivialis	.	.	.	.	+	.	.	+	
Cirsium arvense	.	.	.	.	+	.	.	.	+
Galium aparine	.	.	.	.	+	+	.	.	.
Petasites hibridus	.	.	.	.	.	.	.	+	
Angelica sylvestris	.	+	.	.	.	.	.	.	
Iris pseudacorus	+	.	.	.	.	.	.	.	
Lycopus eurapaeus	+	.	.	.	.	.	.	.	
Cirsium creticum	.	.	.	.	.	.	.	.	1.1
Ajuga reptans	.	.	.	.	.	.	.	.	+
Typha latifolia	.	.	.	.	+	.	.	.	.
Lactuca scariola	.	.	.	.	+	.	.	.	.
Rumex sanguineum	.	.	.	.	.	+	.	.	.
Agrostis stolonifera	.	.	.	.	.	1.1	.	.	.
Salix alba	.	.	.	.	.	+	.	.	.
Alnus glutinosa	.	.	.	.	.	+	.	.	.
Epilobium parviflorum	.	.	.	.	.	1.1	.	.	.
Juncus inflexus	.	.	.	.	.	+	.	.	.
Rubus fruticosus	.	.	.	.	.	.	.	.	1.1

Valeriano-Filipenduletum, the association characterized by *Valeriana officinalis* (Table 3), has developed in the flat parts of the basin, sometimes also near the riparian alder woods; in the Sulmona plain it is most widespread among the wet meadows.

Epilobio hirsuti-Filipenduletum is characterized by *Epilobium hirsutum* (Table 3) and grows in the channels with flowing water that cross the meadows of *Valeriano-Filipenduletum*.

Lysimachio-Filipenduletum is characterized by *Lysimachia vulgaris* (Table 3) and grows in wetter places with soil richer in humus; usually it is an acidophilous association.

These three associations are distributed throughout the central Apennines [2, 5], but should be considered rare because of the reclamation projects and tillage of the natural environment over the centuries.

Finally, also of note is the *Junco inflexi-Menthetum longifoliae* association; it is present in some strips in a field where a notable secondary succession towards black alder woods is in progress; this association was reported by [3] in the irrigated meadows (*marcite*) of Norcia in Umbria.

Drainage canal communities

The *Helosciadetum nodiflori* association is usually found in the tracts uphill from the canals; it is followed a bit further downhill by *Veronico-Sietum erecti* (Table 4).

Table 4: *Veronico-Sietum erecti* and *Helosciadetum nodiflori*

Rel. no.	1	2	3
Area (m^2)	100	100	100
Total cover (%)	3	8	8
Diagnostic sp. (ass. Veronico-Sietum erecti)			
Veronica anagallis-aquatica	+	.	1.2
Berula erecta	5.5	.	.
Diagnostic sp. (ass. Helosciadetum nodiflori)			
Apium nodiflorum	.	5.5	5.5
Other species			
Sparganium erectum	+	.	+
Lythrum salicaria	+	.	+
Rumex conglomeratus	.	+	+
Ranunculus repens	.	+	+
Solanum dulcamara	+	.	.
Scrophularia umbrosa	.	+	.
Lycopus europaeus	.	.	+
Holcus lanatus	.	.	+

Table 5: *Typhetum latifoliae*

Rel. no.	1	2
Area (m^2)	8	10
Total cover (%)	100	100
Typha latifolia	5.5	5.5
Lythrum salicaria	+	.
Calistegia saepium	+	.
Solanum dulcamara	+	1.1
Apium nodiflorum	+	3.4
Humulus lupulus	+	.
Urtica dioica	+	.
Veronica anagallis-aquatica	+	+
Helodea canadensis	.	1.3

Table 6: *Caricetum gracilis*

Rel. no.	1
Area (m^2)	10
Total cover (%)	100
Carex gracilis	5.5
Ranunculus repens	1.1
Convolvulus saepium	1.1
Equisetum maximum	1.1
Eupatorium cannabinum	+
Potentilla reptans	+
Mentha longifolia	+
Galium mollugo	+
Vicia saepium	+

Marsh communities

Phragmitetum vulgaris is present in some ditches and tends to expand from there to the wet and uncultivated areas nearby. *Typhetum latifoliae* was observed in the part downhill from the drainage ditches and canals where eutrophication of the waters has taken place (Table 5). In some drainage ditches a few strips of *Sparganietum erecti* were observed.

Vegetation Series

The three vegetation series in the Sulmona basin are: the riparian series of black alder (*Alnus glutinosa*) [the *Aro italici-Alneto glutinosae* sigmetum], the riparian series of white willow (*Salix alba*) [the *Saliceto albae* sigmetum], and the marshy series of black alder (*Alnus glutinosa*) [the *Carici ripariae-Alneto glutinosae* sigmetum].

The riparian series of black alder (Fig. 2) is composed of the following associations: riparian forests of black alder (*Aro italici-Alnetum glutinosae*), scrubs of *Ligustrum vulgare*, *Viburnum opalus* and *Rhamnus catartica* (*Prunetalia*), and wet meadows (*Valeriano-Filipenduletum, Epilobio hirsuti-Filipenduletum*).

The marshy series of black alder (Fig. 3) is composed of the following associations: marshy forests of black alder (*Carici ripariae-Alnetum glutinosae*), thickets of *Frangula alnus* (*Salicion cinereae* cfr.), and wet meadows (*Galio palustris-Caricetum ripariae*).

The scrub woods, which cannot be attributed to a particular association because they are very fragmentary and rare, are worthy of more specialized inquiry.

To date, the white willow series only contains groves of white willow (*Salicetum albae*).

In the black alder woods, the substrate is rich in organic matter and covered with a thick litter and parts of branches and fallen trunks. The riparian sections consist of a belt of tree vegetation at times in contact with the running water, above all during floods, while in the depressions or in proximity of springs one observes the marshy character with flooded terrain, which, however, can dry out during the summer. Interposed in their midst are areas of white willow groves and shrubby willow groves.

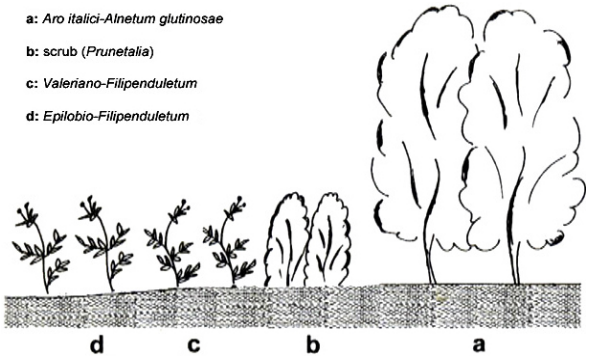

Fig. 2: The riparian series of black alder (*Alnus glutinosa*) [*Aro italici-Alneto glutinosae* sigmetum].

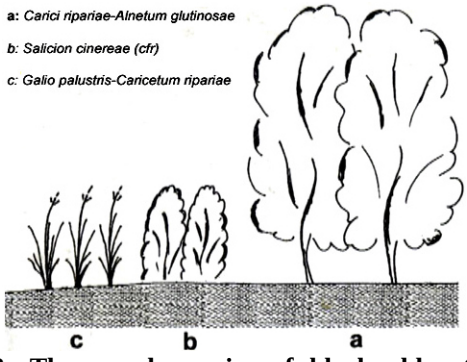

Fig. 3: The marshy series of black alder (*Alnus glutinosa*) [*Carici ripariae-Alneto glutinosae* sigmetum].

Closing Considerations

The marshy woods of the Sulmona basin are residual woods of great ecological and phyto-geographical interest, important also in terms of the landscape. Unfortunately, they are undergoing continuous and progressive disturbance and anthropogenic degradation, the principal causes of which are the expansion of agriculture, the continual advance of construction and other interventions, the excavation of drainage canals, frequent logging, illegal garbage dumping, and the progressive invasion of exotic species such as *Robinia pseudoacacia*, *Ailanthus altissima*, *Acer negundo*, etc.

Of the two types of black alder woods here, the black alder carr (*Carici ripariae-Alnetum glutinosae*) is at greater risk, above all because of the drainage and filling of depressions with various materials such as rubble, earth from excavations, sand, etc.

It is hoped that this study has contributed to a better knowledge of the local flora and vegetation, the conservation status of the associations and the natural history value of the area. This information points to the need for general conservation of the entire Sulmona basin, in the

part where riparian and marshy forests grow, and restoration of the damaged habitats, all of which are of European interest.

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VEGETAȚIA HIGROFILĂ DIN BAZINUL SULMONA (ABRUZZO, ITALIA)

(Rezumat)

Fundul bazinului Sulmona, din provincia Aquila (Regiunea Abruzzo), cunoscută şi ca Valle Peligna, este caracterizat de depozite fluvial-lacustre calcaroase şi argiloase. Bazinul este cultivat şi acoperit de construcţii aproape în întregime, dar mai există câteva fâşii de vegetaţie naturală azonală formată din asociaţiile ripariene *Salicetum albae* şi *Aro italici-Alnetum glutinosae*, şi vegetaţie palustră aparţinând asociaţiei *Carici ripariae-Alnetum glutinosae*. Au fost identifice trei serii de vegetaţie: seria palustră a aninului negru, care este alcatuită din *Carici ripariae-Alnetum glutinosae* şi *Galio palustris-Caricetum ripariae*; seria ripariană a aninului negru, alcatuită din *Aro italici-Alnetum glutinosae* şi următoarele asociaţii de pajişti umede: *Valeriano-Filipenduletum*, *Epilobio hirsuti-Filipenduletum* şi *Lysimachio-Filipenduletum*; seria ripariană a salciei albe, compusă din *Salicetum albae*. Pădurile mlăştinoase ale bazinului Sulmona sunt păduri relictare de mare interes fitogeografic, care se află într-un proces continuu şi progresiv de degradare antropogenă şi, de aceea, merită să fie protejate.

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