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Temporary ponds and hygrophilous grasslands plant communities in Monfurado Site of Community Importance

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Abstract: Silva, V., Pinto-Cruz, C. & Espírito-Santo, M.D. *Temporary ponds and hygrophilous grasslands plant communities in the Monfurado Site of Community Importance. Lazaroa 30: 81-88 (2009).*

Temporary ponds are seasonal wetlands subjected to extreme and unstable ecological conditions due to the annual alternation between the flooded and dry phases. The ephemeral character of the flora and the changeable annual weather explain why these habitats have been poorly studied and documented. The objective of this study, in the Monfurado Site of Community Importance, was to characterize seasonal wetland plant communities using a phytosociological approach and numerical analysis (classification and ordination). The results lead to the site's inclusion in two Natura 2000 Network priority habitats: Mediterranean temporary ponds (3170) in depression landform with impermeable layer in the underground with *Isoeto-Nanojuncetea* vegetation complexes; pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*, sub-type '*Malhadais*' (6220pt2) in shallow areas with *Isoeto-Nanojuncetea* species.

Keywords: Natura 2000 Network, Priority habitat, *Isoeto-Nanojuncetea*, Phytosociology, Alentejo.

Resumen: Silva, V., Pinto-Cruz, C. & Espírito-Santo, M.D. *Comunidades vegetales de charcas temporales y pastizales higrófilos del Sitio de la Red Natura 2000 Monfurado. Lazaroa 30: 81-88 (2009).*

Las charcas y lagunas temporales son ecosistemas que experimentan condiciones ambientales extremas y muy variables, debido a constantes fluctuaciones entre periodos de encharcamiento y total desecación. La naturaleza efímera de la flora característica de estos hábitats, así como las variaciones climáticas entre años, explican porque están poco estudiados. El propósito de este trabajo fue caracterizar las comunidades vegetales de suelos temporalmente encharcados en el sitio de la Red Natura 2000 Monfurado, al través de la metodología fitosociológica y tratamiento estadístico (ordenación y clasificación). Los resultados obtenidos para el territorio estudiado permiten incluir este tipo de vegetación en 2 hábitats naturales de interés comunitario: Estanques temporales mediterráneos (3170), en situaciones de depresión conjugadas con la impermeabilidad del suelo donde se observa un complejo de comunidades de la clase *Isoeto-Nanojuncetea* y Zonas subestépicas de gramíneas y anuales del *Thero-Brachypodietea*, subtipo Majadales (6220pt2), en terrenos más planos con una cierta hidromorfía temporal donde se desarrollan pastizales de la clase *Poo bulbosae-Trifolietum subterranei* rico en especies de la clase *Isoeto-Nanojuncetea*.

Palabras clave: Red Natura 2000, Hábitat prioritario, *Isoeto-Nanojuncetea*, Fitosociología, Alentejo.

INTRODUCTION

Temporary ponds are seasonal wetland ecosystems typical of regions with a Mediterranean climate; they are subjected to extreme and unstable ecological conditions due to the alternation between periods of flood and of total dryness. These habitats support rare and threatened plant species and communities, and are therefore a priority for conservation. They are endangered, not only because of their ephemeral character and small size, but also because they are often subjected to various pressures of anthropic origin (BARBOUR & *al.*, 2003; GRILLAS & *al.*, 2004).

In the Natura 2000 Network implementation and es-

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tablishment on Mainland Portugal, habitat classification for the designation of "Mediterranean temporary ponds – 3170" implied simply the combination of temporary flooded soils with the presence *Isoeto-Nanojuncetea* plant communities (e.g. ALVES & *al.* 1998; PINTO-GOMES & *al.*, 1999; ROSSELLÓ-GRAELL & *al*., 2000). Subsequent studies show that this criterion was not always sufficiently well defined, and that several natural habitat types of Community interest can occur in temporary wetlands (DEIL, 2005).

The natural habitat of Mediterranean temporary ponds study, in the Monfurado Site of Community Importance (SCI), was integrated within Action A4 - Draft GAPS (LIFE03NAT/P/000018) – Montemor-o-Novo Municipality. The aim was to update the cartography and to establish management guidelines for habitat conservation.

STUDY AREA

The Monfurado SCI is located in the Montemor-o-Novo and Évora council areas of the district of Évora (Figure 1). The territory is situated on the *Peneplanície Alentejana*, a continental plateau which is interrupted by an important relief, the Monfurado range of hills, reaching over 400 metres in altitude (FEIO & MARTINS, 1993).

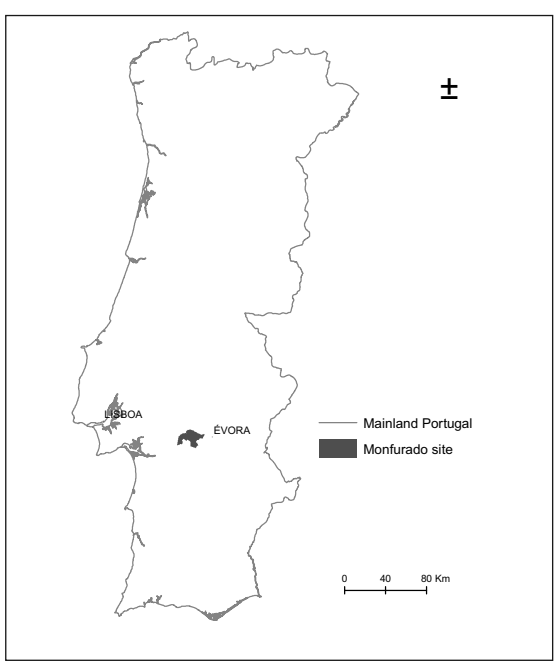

Figure 1— Study area location, showing the limits of the Monfurado SCI.

According to the most recent revision of Iberian Peninsula biogeographical classification by RIVAS-MARTÍNEZ (2005) the study area is included in the Mediterranean Region, the Western Mediterranean Subregion, the Mediterranean West Iberian Province, the Lusitanian-Extremadurean Subprovince, the Marianic-Monchiquensean Sector and the Alentejan District. The west slope of the study area presents a thermomediterranean bioclimate that can reach a mesomediterranean sub-humid bioclimate at its higher points.

Cork oak (*Quercus suber*) and holm oak (*Q. rotundifolia*) woodland – '*montado*' is well preserved here and includes a residual occurrence of *Q. faginea* subsp. *broteroi* and *Q. pyrenaica* woodland, being the study area, for the latter referred to, southern limit of its geographic distribution in Portugal. In the thermomediterranean bioclimate area, occurs the association *Asparago aphylli-Calicotometum villosae*, subserial of the *Asparago aphylli-Quercetum suberis*. These *Calicotome villosa* shrub communities present their optimal area of occurrence in the Évora region. The oak communities of the *Sanguisorbo hybridae-Quercetum suberis* predominate in siliceous soils and the *Phillyreo angustifoliae-Arbutetum unedonis* being their regressive community. In riparian areas with soil of high moisture content, deciduous alder woodlands of *Scrophulario scorodoniae-Alnetum glutinosae* occur, but these are replaced by ash groves of *Ficario ranunculoidis-Fraxinetum angustifoliae* in streams more prone to drought. These communities have, as replacement stages, thickets of *Lonicero hispanicae-Rubetum ulmifolii* and perennial swards of *Juncetum rugosi-effusi* (COSTA & *al.*, 1998; PEREIRA, 2002).

MATERIALS AND METHODS

Field surveys, conducted between February and July 2006, allowed the mapping of the geographical distribution of the Mediterranean temporary ponds in the Monfurado area to be undertaken. The plant communities survey followed the phytosociological approach (GÉHU & RIVAS-MARTÍNEZ, 1981; CAPELO, 2003) combined with an ecological parameters assessment. The identification of plant species was according to CASTROVIEJO & *al.* (1986-2005), FRANCO (1984), FRANCO & ROCHA AFONSO (1994-2003) and VALDÉS & *al.* (1987). Sintaxonomical nomenclature followed RIVAS-MARTÍNEZ & *al.* (2001, 2002). Seasonal assessments (spring and autumn) allowed the occurring habi-

tats to be classified according to Natura 2000 Network criteria (cf. ALFA, 2005), and potential threats to the conservation of temporary ponds to be identified. Hierarchical plant community classification was done using TWINSPAN (PC-ORD, version 4.0, McCune & Mefford, 1999) and the relationship between environmental factors and species was explored through Canonical Correspondence Analysis (CCA) using the software package CANOCO (version 4.5, ter Braak & Smilauer, 2002).

RESULTS

TWINSPAN dendrogram analysis illustrated the similarities between sampled plant communities and revealed an ecological gradient of humidity (Figure 2), distinguishing at the first level two groups characterized by different periods of inundation time-lengths. The first group dichotomous division with a satisfactory eigenvalue (λ=0.65) clustered the relevés in damp but not drenched soil, including the well preserved perennial grasslands of *Poo bulbosae-Trifolietum subterranei* and grasslands with a predominance of annual species. This last group is divided into two subgroups, one corresponding to the higher nitrogen soil contents meadows of *Poo bulbosae-Trifolietum subterranei*, with *Spergula arvensis* as differential species, and the other to the *Isoeto-Nanojuncetea* class of plant communities with a shorter flood period (*Pulicario paludosae-Agrostietum pourretii*, *Loto hispidi-Chaetopogonetum fasciculati*, *Molineriello laevis-Illecebretum verticillati*, *and Junco capitati-Isoetetum histricis*). The second group, which includes relevés done in drenched soil conditions, separates itself into two subgroups with a highly satisfactory eigenvalue (λ=0.844): *Isoeto-Nanojuncetea* plant communities that are submerged until late spring (*Junco pygmaei-Isoetetum velati*, *Peplido hispidulae-Isoetetum delilei*), and those that are only dry in summer and are consequently classified as *Phragmito-Magnocaricetea* and *Potametea*.

CCA results are presented in Figure 3 (next page). A separation of the different types of habitats is pointed out, namely the Mediterranean temporary ponds (habitat 3170) from the flood plain perennial grasslands – '*Malhadais*' (habitat 6220pt2). The relevés made in de-

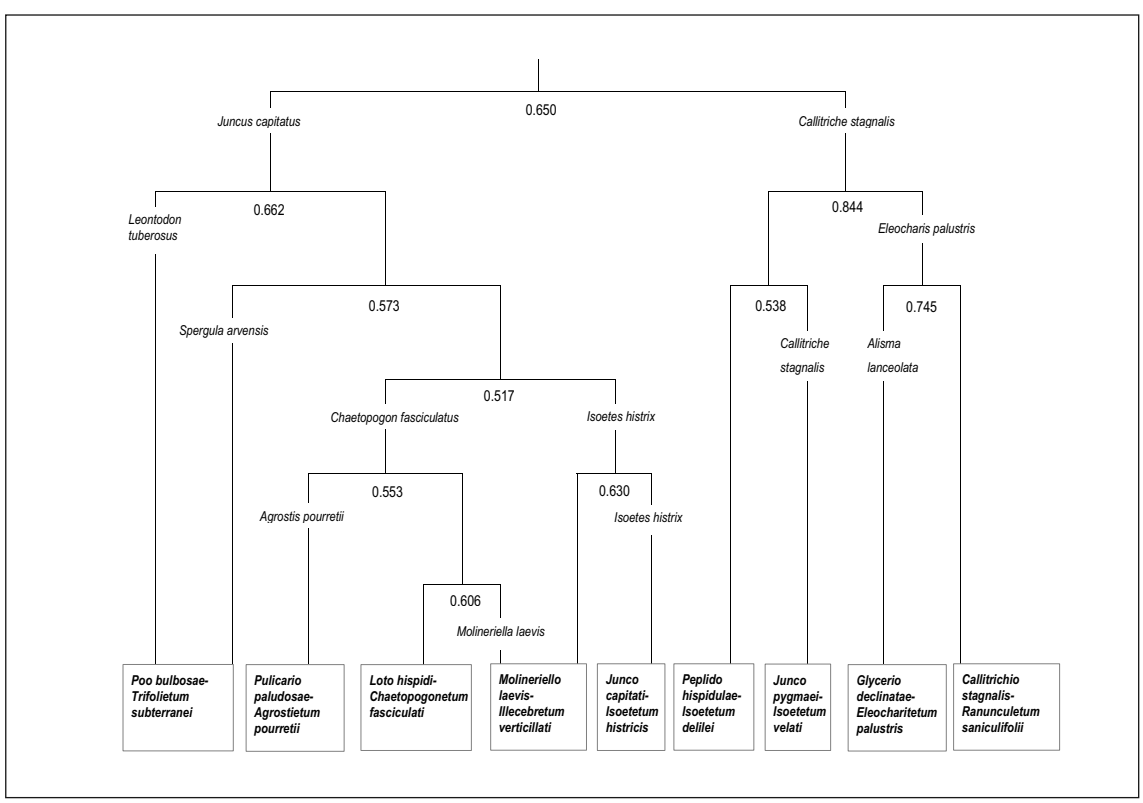

Figure 2.— TWINSPAN classification dendrogram.

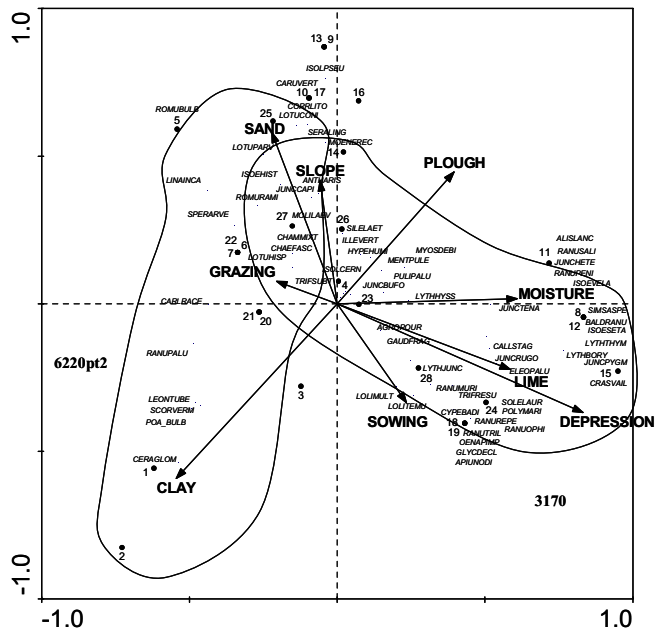

Figure 3. Ordination diagram of the CCA on ephemeral wetland relevés. Environmental variables: moisture, depression, slope, soil texture (clay, sand, lime) and land use (grazing, sowing, ploughing).

pressions with a longer flood phase are more grouped in the diagram (cf. Figura 3) and a complex of species such as, *Lythrum borysthenicum*, *L. thymifolia*, *Isoetes velatum, I. setaceum* and *Juncus pygmaeus* are closely related to depression and moisture environmental factors. Comparing the ordination and classification results of the plant communities, both methods display a marked moisture gradient as the most important environmental factor.

The results of the CCA ordination of species and environmental factors are summarized in Table 1. The first three canonical axes account for 22.2% of the total variance. Nevertheless, this analysis is supported by the correlation between species and environment variables, which explains 51.4% of the total variance. Soil mobilization and depression type are the variables with greater weight in the axis I, contributing to 21.2% of the variance, with canonical coefficients of 0.79 and 0.54 respectively. Axis II reflects 15.5% of the total variance and is mainly correlated to clay texture (0.81), depression (0.44) and humidity (0.44) variables.

Table 1
Poetea bulbosae and *Isoeto-Nanojuncetea* plant communities in Monfurado SCI

Axes	1	2	3	4	Total inertia
Eigenvalues	0.704	0.515	0.491	0.376	7.689
Species-environ. corr.	0.967	0.930	0.923	0.895	
Cum. perc. var.					
of species data:	9.2	15.9	22.2	27.1	
of species-environ. rel.	21.2	36.7	51.4	62.7	
Sum of all eigenv.					7.689
Sum of all canonical eigenv.					3.325

The relevés are summarized in a synoptic table (Table 2, next page) concerning to the *Poo bulbosae-Trifolietum subterranei* and *Isoeto-Nanojuncetea* surveyed plant communities.

DISCUSSION AND CONCLUSIONS

At the Monfurado SCI, well preserved *Poo bulbosae-Trifolietum subterranei* grasslands should be classified as habitat 6220pt2 (pseudo-steppe with grasses and annuals of the *Thero-Brachypodietea*, subtype "Malhadais"). In this region, as previously verified by Rivas Goday (1964) in Extremadura, these communities are themselves enriched with *Isoeto-Nanojuncetea* elements in areas temporarily flooded by seepage lines in a flat topography. The presence of annual *Juncus* species and *Isoetes histrix* indicates hygrophilous faciation of *Poo bulbosae-Trifolietum subterranei*.

In more sandy soils with short flood periods the *Pulicario paludosae-Agrostietum pourretii*, *Loto hispidi-Chaetopogonetum fasciculati*, *Molineriello laevis-Illecebretum verticillati* and *Junco capitati-Isoetetum*

Table 2
Synthetic table of studied communities

Group	1	2	3	4	5	6	7
Number of relevés	4	2	3	4	7	3	1
Characteristics of Poetea bulbosae							
Poa bulbosa	4						
Trifolium subterraneum	2	1					
Ranunculus paludosus	4			1	II		
Erodium bothrys	2			1			
Leontodon tuberosus	4						
Chamaemelum fuscatum	2						
Romulea ramiflora	2						
Scorpiurus vermiculatus	2						
Trifolium pratense	2						
Trifolium strictum	2						
Characteristics of Isoeto-Nanojuncetea							
Pulicaria paludosa		2	1	1			1
Agrostis pourretii		2					
Lotus hispidus	1	2	3	3	I		
Chaetopogon fasciculatus			3	1	I		
Molineriella laevis	1			4	I		
Illecebrum verticillatum		1	1	4	IV	1	1
Isoetis histrix	4				V		
Juncus capitatus	1	2	2	1	V		
Isoetes setaceum						3	
Lythrum borysthenicum						3	1
Juncus pygmaeus						3	1
Isoetes velatum							1
Juncus bufonius	1	2	3	1	IV	1	1
Mentha pulegium		2	1	1	II		1
Lythrum hyssopifolia		2	2		I		1
Hypericum humifusum		2		1	II		
Juncus tenageia			1		I	2	
Isolepis pseudosetacea				1	II	1	
Carlina racemosa	5				I		
Lotus parviflorus	3			1			
Lythrum thymifolia						2	1
Isolepis cernua			2				
Ranunculus muricatus					I		
Crassula vaillantii						1	
Sisymbrella aspera							1

Companions							
Briza minor		2	2	1		1	
Chamaemelum mixtum	1		4	3	I		
Ornithopus pinnatus	1	1	2	3			
Myosotis debilis			1	1		2	1
Serapias lingua		1		3	I	1	
Leontodon longirostris	1		1	2	I		
Rumex bucephalophorus	4		2	3			
Rumex angiocarpus	3		1	1			
Echium plantagineum	3		1	1			
Ornithopus compressus	1		1	3			
Gaudinia fragilis		2		2		1	
Parentucellia viscosa			2	1	I		
Corrigiola litoralis	1				I	1	
Phalaris coerulescens	1	1	1				
Silene laeta		1			I	1	
Vulpia geniculata			2	1			
Stachys arvensis	2			1			
Vulpia bromoides		1		1			
Vicia villosa			1	1			
Anagallis arvensis			1	1			
Callitriche stagnalis			1			1	
Daucus carota	1	1					
Trifolium campestre	1	1					
Lythrum junceum		1	1				
Tolpis barbata		1	1				
Ornithopus isthmocarpus	1			1			
Silene gallica			1	1			
Lotus conimbricensis	1			1			
Spergula arvensis	3						
Bellardia trixago	2						
Cerastium glomeratum	2						
Chamaemelum fuscatum	2						
Linaria incarnata	2						
Raphanus raphanistrum	2						
Aira caryophyllea		2					
Logfia gallica		2					

Other taxa: Characteristics of *Poetea bulbosae: Gynandriris sisyrinchium, Hypochoeris radicata, Parentucellia latifolia, Plantago lagopus, Romulea bulbocodium, Trifolium angustifolium, Trifolium campestre* and *Trifolium nigrescens* 1 in 1; *Trifolium glomeratum* 2 in 2; Companion species: *Anchusa undulata, Arabidopsis thaliana, Avena lusitanica, Brachypodium distachyon, Centaurea pullata, Crepis haenseleri, Cynara humilis, Erodium moschatum, Geranium molle, Lathyrus sphaericus, Linaria amethystea, Linaria spartea, Linum bienne, Medicago polymorpha, Muscari comosum, Ononis australis, Reseda luteola, Scabiosa atropurpurea, Senecio jacobaea, Senecio vulgaris, Sherardia arvensis, Teesdalia nudicaulis, Trigonella foenum-graecum, Urginea maritima, Vicia lutea* and *Vulpia muralis* 1, *Hypochaeris glabra* and *Galactites tomentosa* 2, in 1; *Cyperus longus, Euphorbia exígua, Juncus rugosus, Ranunculus repens* and *Trifolium resupinatum* 1 in 2; *Anacyclus radiatus, Anthoxanthum aristatum, Avena macrantha, Carex divulsa, Coleostephus myconis, Hedypnois cretica, Lathyrus annus, Lolium multiflorum, Poa annua* and *Trifolium angustifolium* 1 in 3; *Lathyrus clymenum, Lolium temulentum, Moenchia erecta, Myosotis dubia, Spergularia purpurea, Trifolium cernuum, Trifolium cherleri, Trifolium nigrescens* and *Trifolium strictum* 1 in 4; *Carum verticillatum* I, *Dactylis glomerata*, *Euphorbia exigua*, *Festuca ampla*, *Galium divaricatum*, *Holcus lanatus* and *Sanguisorba verrucosa* I in 5; *Cynodon dactylon*, *Polypogon maritimus*, *Ranunculus hederaceus* and *Ranunculus ophioglossifolius* 1 in 6; *Baldellia ranunculoides*, *Euphorbia amygdaloides*, *Juncus acutiflorus*, *Oenanthe crocata* and *Scirpoides holoschoenus* 1 in 7.

Studied syntaxa: 1: *Poo bulbosae-Trifolietum subterranei*; 2: *Pulicario paludosae-Agrostietum pourretii*; 3: *Loto hispidi-Chaetopogonetum fasciculati*; 4: *Molineriello laevis-Illecebretum verticillati*; 5: *Junco capitati-Isoetetum histricis*; 6: *Peplido hispidulae-Isoetetum delilei,* 7: *Junco pygmaei-Isoetetum velati.*

histricis plant associations can be distinguished (cf. RIVAS GODAY, 1971; RIVAS-MARTÍNEZ & *al.*, 1980). They occur either in the upper borders of depressions or in shallow to gently sloped areas, often of difficult to identify individually because of vegetation mosaic pattern.

Pond topographic depression, together with soil of higher clay content promotes a longer hydrophase, creating good conditions for *Isoetes setaceum* and *I. velatum* development, revealing the *Peplido hispidulae-Isoetetum delilei* and *Junco pygmaei-Isoetetum velati* associations. In deeper depressions where moisture persists until late spring *Peplido hispidulae-Isoetetum delilei* and *Junco pygmaei-Isoetetum velati* often come into contact with the *Glycerio declinatae-Eleocharitetum palustris* communities, as previously mentioned by MOLINA (2005).

The occurrence of Mediterranean temporary ponds (3170) habitat in the study area is concentrated in a flat physiographic area (Figure 4) that presents a geological complex associated with sandstone rocks. In this hydromorphic soil area, the depressions are characterized by an impervious soil layer.

To conclude, topographic depression together with soil impermeability and an inundation period until late-spring creates the ecological conditions for the development of Mediterranean temporary ponds habitat. This conclusion in relation to the Monfurado SCI is in accordance with ESPÍRITO-SANTO & ARSÉNIO (2005), who carried out a study in a different region of the Alentejo.

The continuance, as well as the conservation of Mediterranean temporary ponds habitat, depends primarily on good agricultural and forestry practices, preventing soil mobilization (e.g. drainage and dredging of ponds and contiguous areas), avoiding the introduction of forage species and reducing the use of fertilizers. Management measures are necessary, even if via economic incentives. An example of this is extensive grazing support leading to soil compactation, which in turn favours *Isoetes* species.

Figure 4.— Mediterranean temporary ponds distribution in Monfurado SCI.

SYNTAXONOMIC SCHEME

POTAMETEA Klika in Klika & V. Novák 1941
  Potametalia Koch 1926
  Ranunculion aquatilis Passarge 1964
    Callitricho stagnalis-Ranunculetum saniculifolii Galán in A.V. Pérez, Galán, P. Navas, D. Navas, Y. Gil & Cabezudo 1999
ISOETO-NANOJUNCETEA Br.-Bl. & Tüxen ex Westhoff, Dijk & Passchier 1946
  Isoetetalia Br.-Bl. 1936
  Isoetion Br.-Bl. 1936
    Junco capitati-Isoetetum histricis Br.-Bl. 1936

Peplido hispidulae-Isoetetum delilei Br.-Bl. 1936 corr. Barkman, Moravec & Rauschert 1986
Menthion cervinae Br.-Bl. ex Moor 1936 nom. mut.
Junco pygmaei-Isoetetum velati Rivas Goday in Rivas Goday et al. 1956
Agrostion pourretii Rivas Goday 1958 nom. mut.
Loto hispidi-Chaetopogonetum fasciculati Rivas-Martínez & Costa *in* Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980
Molineriello laevis-Illecebretum verticillati Rivas Goday 1954 nom. mut.
Pulicario paludosae-Agrostietum pourretii Rivas Goday in Rivas Goday et al. 1956 nom. mut.
Phragmito-Magnocaricetea Klika in Klika & Novák 1941
Nasturtio-Glycerietalia Pignatti 1954
Glycerio-Sparganion Br.-Bl. & Sissingh in Boer 1942
Glycerienion fluitantis (Géhu & Géhu-Franck 1987) J.A. Molina 1996
Glycerio declinatae-Eleocharitetum palustris Rivas-Martínez & Costa in Rivas-Martínez, Costa, Castroviejo & E. Valdés 1980
Poetea bulbosae Rivas Goday & Rivas-Martínez *in* Rivas-Martínez 1978
Poetalia bulbosae Rivas Goday & Rivas-Martínez *in* Rivas Goday & Ladero 1970
Periballio-Trifolion subterranei Rivas Goday 1964 nom. inv.
Poo bulbosae-Trifolietum subterranei Rivas Goday 1964 nom. inv.

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