THE CURRENT STAGE OF RESEARCH ON AQUATIC AND PALUDICOLOUS VEGETATION IN BANAT

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***Abstract*:** *The paper is a synthesis of the researches on aquatic and swamp vegetation in Banat, containing a list of the main plant associations described in Romanian Banat with their Natura 2000 habitats correspondence. Previous botanical researches on wetlands concerned the diatoms, the bryophytes, inventories of flora and vegetation, observations on the evolution of flora, vegetation dynamics analysis etc. (NEACȘU, 2008). The areas studied are the swamp, the interfluve, rivers, wet meadows, lakes (wet zones). Data processed refers to a long period of time, the first information to which we refer belong to KITAIBEL (1802, in COSTE et al., 1995). Beside thematic papers (flora and vegetation of wet zones), we took in consideration botanical monographs (e.g. COSTE, 1975), as well as ours previous studies concerning the cormophyte diversity in the main reservoirs in Timiș county (29 plant associations - NEACȘU & ARSENE, 2011); some of these rare in Banat (e.g. Leersietum oryzoides Krause 1955 em. Pass. 1957, Najadetum minoris Ubrizsy 1948 1961, Ceratophylletum demersii (Soó 1927) Hild 1956 (NEACȘU et al., 2010)). In terms of conservation, we consider important to note the species Lindernia procumbens (Krocker) Philcox, found at Surduc (NEACȘU, 2008) and Cirsium brachycephallum Juratzka, found at Călacea (TURCEAN et al., 2014), from Annexes II and IV of the Habitats Directive. Another aspect that mention here is the intrusion of invasive species (e.g. Amorpha fructicosa L., Reynoutria japonica Houtte.) in wetlands area, with negative effects on their biodiversity. Sites of Community Importance (SCI) of NATURA 2000 in Banat, including 19 wetland habitats, some of these contain only the classes of aquatic and swamp vegetation. We found a poor level of knowledge of wet zones vegetation outside protected areas, as well within some sites of community importance.*

Key words: *Banat, vegetation, weetlands, conservation, Natura 2000*

INTRODUCTION

The broad diversity of plant species in Banat has raised the interest of many researchers, starting with the 18th century. More than half of the Romanian cormophytes flora (over 2000 species) can be found here. It was closely studied during the 19th century (KITAIBEL, 1802, ROCHEL, 1828, HEUFFEL, 1858 etc., *in* COSTE *et al*., 1995). In the 20th century the first vegetation researches were carried out by: BORZA (1929), NYÁRÁDY (1929), BUJOREAN (1942), POPESCU (1960), DUMITRIU-TĂTĂRANU (1965), POP (1977), HODIȘAN (1968), CSÜRÖS (1969), GRIGORE (1971) etc. (*in* COSTE *et al*., 1995). The following areas are known for their remarkable diversity: Valea Cernei, Domogled Mountains, Cazanele Dunării, Masivul Țarcu-Godeanu, Aninei Mountains, Cheile Nerei. In Banat, one can partially find the site Ramsar no. 1606 Mures Flood plain.

Biodiversity studies of humid habitats were undertaken by SORAN, 1954, BOȘCAIU, 1966, OPREA *et al.*, 1970, GRIGORE, 1971, ARVAT, 1977, ARSENE *et al*., 2005, NEACȘU, 2008, DRĂGULESCU, 2013 etc. Aside from the evaluation of the areas biodiversity, many aspects are still to be discussed. Humid habitats are sensitive to climatic changes, thus making it necessary to monitor their evaluation from the point of view of multiple indices (SIENKIEWICZ *et al.*, 2014). Another fact worth mentioning is that they are the most predisposed to species invasion. Thus, OTVES *et al.*, 2014 presents 82 invasive and potential invasive species from the Banat

humid areas. Of the 101 humid areas neophyte list from Romania made up by ANASTASIU *et al.*, 2007, 10 are considered the most invasive ones, of which, in Banat, *Amorpha fruticosa* and *Reynoutria japonica* are the most problematic. According to HOBOHM & BRUCHMANN, 2011 the number of endemic plants in humid habitats is much smaller than in other habitats, this thing was caused by their young ages and their reduced ecologic continuity.

MATERIAL AND METHODS

We studied closely papers referring to aquatic and paludicolous vegetation from Banat, to which we added our own studies. On the basis of that information, we discussed the topic approached by various authors and we made up a list of the main aquatic and paludicolous associations in Banat. Other aspects of the aquatic and paludicolous vegetation have been taken into account, some cenotaxonomy framing issues, references to the current statute of some plant species. We also present in a table form humid habitats from the NATURA 2000 sites of community importance.

RESULTS AND DISCUSSIONS

In Romania, studies in the field of aquatic and paludicolous flora and vegetation (table 1) have been elaborated by MORARIU (1964), PĂUN (1966), DONIȚĂ (1967), RACLARU & ZANOSCHI (1968), POP (1968), RAICU (1972), POPESCU (1974), DOBRESCU (1981), MITITELU (1982) etc (*in* NEACȘU, 2008). In Banat, research was carried out by SORAN, 1954, BOȘCAIU, 1966, OPREA *et al.*, 1970, GRIGORE, 1971, ARVAT, 1977, ARSENE *et al.*, 2005, NEACȘU, 2008, DRĂGULESCU, 2013 etc. Aspect of the aquatic and paludicolous vegetation are treated in other reference papers (e.g. SCHRÖTT, 1972, COSTE, 1975).

Research regarding the Timiş-Bega interfluve flora and vegetation carried out by GRIGORE, 1971, resulted in the description of an impressive number of vegetal associations, 143, aquatic and paludicolous, grassy, segetal and ruderal, sylvan. At the time, the author had underlined the fact that aquatic and paludicolous vegetation was becoming more and more limited in natural stations, because of drainage and draining works. On the other hand, he signalled the presence of new stations, for these phytocoenoses in irrigation or draining canals and water mirrors, during periods with significant precipitation. In rainy years, reed, rush and sedge formations were abundantly developed. From the vegetation compendium, there are 14 aquatic, 21 paludicolous associations, to which we add a few meadow associations. Among the frequent species there was the *Marsilea quadrifolia*, included today in the 2nd and 4th annexes of the Habitat Directive (92/43/EEC) and which can only be found in a few everglades in the Timișului meadow.

Table 1

Research in the field of aquatic and paludicolous flora and vegetation in Romania (NEACȘU, 2008, modified)

general topics	*area*	*autors*
study of diatoms, bryophytes, evolution of flora, vegetation dynamics	Banat - Crișana	SORAN (1956), BOȘCAIU (1966), POP (1962, 1963, 1968), GRIGORE (1971), COSTE (1975), ARVAT (1977), OPREA (1976), BURESCU (2003), ARSENE *et al.* (2005), NEACȘU (2008), SINITEAN (2011) etc.
	Transilvania	BORZA (1959), MORARIU (1964), HODIȘAN (1966), PETERFI (1966), ȘUTEU (1970), PÁZMÁNY (1971), GERGELY & RAȚIU (1973), RESMERIȚĂ & RATIU (1974), KARACSONYI (1980, 1990), DRĂGULESCU (1995) etc.
	Moldova	MIHAI (1959, 1969), RĂVĂRUȚ *et al.* (1957), DOBRESCU (1974, 1981), MITITELU (1973), MITITELU & BARABAS

		(1975), BARABAS (1978) etc.
	Delta Dunării	TARNAVSCHI & NEDELCU (1970), SANDA & POPESCU (1973, 1983), GODEANU (1976), CIOCÂRLAN (1998, 1999), SÂRBU (2002) etc
	Oltenia	ROMAN (1953), PĂUN (1964, 1966, 1969), ULARU (1967, 1969), NEGRUȘ (1972), ZAHARIA (1972), MALOȘ (1977), POPESCU (1974, 2001) etc.
	Muntenia	NEDELCU (1967, 1968, 1969, 1972), PĂUN (1969), TURCU (1970), NEDELCU *et al.* (1972, 1977, 1986) etc.

OPREA *et al*., 1970, presents the main aquatic and paludicolous phytocoenoses, from Satchinez, belonging to the following vegetal associations: *Lemno-Utricularietum, Ceratophyllo-Hydrocharitetum, Myriophyllo-Potametum, Parvipotameto-Zannichelietum, Nymphoidetum peltatae, Scirpeto-Phragmitetum, Acoretum calami, Bolboschoenetum maritimi continentale, Glycerio-Sparganetum neglecti, Pulicaria vulgaris-Mentha pulegium*. Research at Satchinez were carried out by COCORA-TIEZ & SPINNER, 1967, but of a floristic nature. ARSENE *et al.*, *in* STĂNESCU, 2005 describe 11 representative aquatic and paludicolous associations: *Phragmitetum australis, Schoenoplectetum lacustris, Typhaetum angustifoliae, Glycerietum maximae, Lemnetum minoris, Ceratophyllo-Hydrocharietum, Caricetum acutiformis, Iridetum pseudacori, Sambucetum ebuli, Pruno spinosae-Crataegetum, Rubo-Salicetum cinereae*. As a result of the last years' research (unpublished data), carried out within this reservation, we observed the presence of the adventive species *Asclepias syriaca*, in open and sunny areas, with scant vegetation. It is a likely fact that the species has arrived here in an anemochorous way, and it reproduces rapidly due to optimal conditions on the account of the habitat perturbation and fragility.

On the occasion of the Liebling flora study, SORAN, 1954 describes grassy associations as well, in marsh areas: *Lemno-Utricularietum, Salvinietum natantis, Scirpeto-Phragmitetum, Myriophylletum-Potametum.* On semi-saturated and humid lands, the *Lindernia pixidaria-Isolepis supina* associations are described as well as the probatory *Pholiurus pannonicus*. At Liebling, we analyzed 124 de phytocoenoses, from 19 vegetal associations. We have not found phytocoenoses from the *Salvinietum natantis* and *Lemno-Utricularietum* associations (nor the probatory species, *Salvinia natans* and *Utricularia vulgaris*), described by SORAN, 1954.

The same author (SORAN, 1956), presents a short history of the research achieved in Romania regarding aquatic and paludicolous associations. The paper analyzes the aquatic and paludicolous vegetation in Banat. The author insists on the importance to analyze these associations from a theoretical and practical point of view and classifies the *Aquiherbosa* formation, elaborating an adaptation of the Abolin classification. The used method belongs to BRAUN-BLANQUET & ALECHIN, but we also took into the account the SUCACEV-ALECHIN METHOD, which refers to the vegetation stratification.

BOȘCAIU, 1966, as a result of the aquatic and paludicolous vegetation and flora research carried out at Lugoj, describes 22 vegetal associations. The fact, that HEUFFEL research on water plants did not render significant results, is justified since, during that period of time, the aquatic vegetation in the area was poorly represented. The occurrence of artificial lakes facilitated the development of numerous hydro – and helophyte associations.

The aquatic vegetation (Aquiherbosa formation, Cls. LEMNETEA) on the Ada-Kaleh island, studied by OPREA, 1968 is poorly represented. The author mentions the *Lemnetum minoris* association found in spring time in the everglades surrounding the fortresses walls. Even more poorly represented is the aquatic vegetation of the sub-layer (Cls. POTAMETEA).

Here the characteristic species *Potamogeton natans* and *Batrachium aquatile* are reminded, which float at the water surface in everglades surrounding the fortress. The paludicolous vegetation (Paludes formation) is made up by *reed plants*, belonging to the cls. PHRAGMITETEA. The following characteristic species are mentioned: *Phragmites communis, Leersia oryzoides, Glyceria plicata, Lythrum salicaria, Mentha aquatica, Rorippa amphibia*. Among grassland vegetation the grassy mezzo-hygrophilic formations are mentioned (cls. MOLINIO-ARRHENATHERETEA), of the flooded meadow area characteristic species: *Trifolium hybridum, Lythrum salicaria, Calystegia sepium, Urtica dioica, Galium aparine*. The author also remarks the presence of marsh and humid bank weed formations (cls. BIDENTETEA TRIPARTITAE), dominated by *Bidens tripartita, Polygonum hydropiper* și *P. persicaria* (which make up the *Bidentetum tripartiti* association, present in the moats around the fortress), weed formations, groves and water banks (cls. ARTEMISIETEA), where there are *Calystegia sepium, Cuscuta europaea, Althaea officinalis, Abutilon theophrasti, Glycyrrisa echinata* and hydrophilic meadow forests (cls. SALICETEA PURPUREAE), where one can find *Salix alba* și *Populus nigra*. Within the *Salici-Populetum* association, the following species were observed: *Populus alba, Amorpha fruticosa, Rosa canina, Poa pratensis, Ranunculus repens, Agropyrum repens, Solanum dulcamara*. In 1976, OPREA describes 16 aquatic and paludicolous associations in the Sînnicolaul Mare Plain.

The Beușnița-Cheile Nerei natural reservation flora and vegetation (Aninei Mountains) was studied by SCHRÖTT (1972). The author describes a few willow tree associations: *Salicetum purpureae, Salicetum triandrae, Salicetum albae-fragilis*.

A work of reference for the Banat flora and vegetation was written by COSTE (1975), the investigated territory being the Locvei Mountains. On this occasion, the author observes the presence of some aquatic and paludicolous species in the marginal meadows and alongside interior rivulets signalling the existence of alder groves, along the waters, and along the Nera and Danube rivers, of willow groves, placed in the form of interrupted borders, sufficiently ruderalized (cls. SALICETEA PURPUREAE). In meadow everglades, hygrophilic vegetation belongs to the cls. LEMNETEA, POTAMOGETONETEA, ISOETO-NANOJUNCETEA and PHRAGMITETEA. 18 aquatic and paludicolous associations are described (from the 75 total, mentioned in the area).

HOBORKA, 1980 describes 65 vegetal associations in the Dognecei mountains, of which 19 are aquatic and paludicolous, underlining the importance of the *Nymphaetum alboluteae* association phytocoenoses, present in the Nuferilor lake. The author describes willow groves which accompany watercourses, and which, due to narrow valleys, occur in the shape of clusters. The grassy meadow vegetation is constituted by associations of the cls. MOLINIO-ARRHENATHERETEA. The Câmpia Buziașului vegetation compendium (LOVASZ, 1995) comprises 30 aquatic and paludicolous associations. MATACĂ, 2005 presents the main associations observed in the Danube defile, belonging to the cls. LEMNETEA, POTAMOGETONETEA, PHRAGMITETEA and ALNETEA GLUTINOSAE, underlining the fact that a great part of these were flooded, thus not being accessible for phytosociological studies.

During 2005-2008, we closely studied the flora and vegetation of the four most important barrier lakes in the Timiș county. Their vegetation is represented by 29 vegetal associations. The analyzed phytocoenoses are mezzo-hygrophilic, hygrophilic and hydrophilic. The *Leersietum oryzoides* Krause 1955 em. Pass. 1957, *Najadetum minoris* Ubrizsy 1948, 1961 and *Ceratophylletum demersi* (Soó 1927) Hild 1956 associations are rare in Banat. The *Trapetum natantis* V. Kárpati 1963, *Potametum natantis* Soó 1927, *Eleocharidetum acicularis* W. Koch 1926 emend. Oberd. 1957, *Najadetum minoris* Ubrizsy 1948, 1961, *Salicetum albae*

Issler 1926 em. Soó 1957 associations have to be mentioned, since they are a part of the habitats, carrying a high preservation value.

Below, we would like to list the most important aquatic and paludicolous associations in Banat, 46 in number, specifying their cenotaxonomy classification and the authors who described them. To these we add 13 more humid meadow and weed formation associations that are briefly discussed. The number of aquatic and paludicolous associations in Banat varies according to the studied area dimensions, as well as the system used by the authors (table 2). Our list refers to associations belonging to the cls. LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957, POTAMOGETONETEA Tx. et Prsg. 1942, LITTORELLETEA R. Tx. 1947, ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943, PHRAGMITETEA Tx. et Prsg. 1942 și SALICETEA PURPUREAE Morr 1958, 1960.

The most important aquatic and paludicolous associations in Banat (SORAN, 1956, BOȘCAIU, 1965, 1966, OPREA *et al*., 1970, GRIGORE, 1971, SCHRÖTT, 1972, COSTE, 1974, VICOL, 1974, RACLARU, ALEXAN, 1976, OPREA, 1976, ARVAT, 1977, HOBORKA, 1980, LOVASZ, 1995, ARSENE, *et al*. 2005, MATACĂ, 2005, NEACȘU, 2008, DRĂGULESCU, 2013):

1. *Acoretum calami* Eggl. 1933/Phragmition W. Koch 1926/Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/ OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974. The association has been reported as new coenotaxon for our country at Porțile de Fier, by ȘTEFUREAC & ROMAN (*** 1972, *Atlas complex Porțile de Fier*).
2. *Aegopodio-Alnetum* Kárpáti et Jurko 1961/Alnion glutinosae (Malcuit 1929) meyer-Dress 1930/Alnetalia glutinosae Tx. 1937/ALNETEA GLUTINOSAE Br.-Bl. et Tx. 1934/COSTE, 1974, HOBORKA 1980
3. *Amorphaetum fruticosae* (Borza 1954) nova as. prov/Salicion triandrae Muller et Gors. 1958/Salicetalia purpureae Moor 1958/SALICETEA PURPUREAE Morr 1958, 1960/COSTE, 1974
4. *Bolboschoenetum maritimi* Soó 1927/Bolboschoenion maritimi Soó 1947/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOCȘAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, LOVASZ, 1995, DRĂGULESCU, 2013
5. *Caricetum acutiformis-ripariae* Soó 1927, 1930/Magnocaricion W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOȘCAIU, 1965, RACLARU, ALEXAN, 1973, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, ARSENE *et al.*, 2005, NEACȘU, 2008
6. *Caricetum gracilis* (Graebn. et Hueck 1931) Tx. 1937/ Magnocaricion W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, COSTE, 1974
7. *Caricetum vulpinae* Now. 1927/Magnocaricion W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, DRĂGULESCU, 2013
8. *Ceratophylletum demersi* (Soó 1927) Hild 1956/Ceratophyllion Den Hartog et Segal 1964/Hydrocharietalia Rübel 1933/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/ MATACĂ, 2005, NEACȘU, 2008
9. *Ceratophyllo-Hydrocharitetum* I. Pop 1962/Hydrocharition Rüb. 1933/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/BOȘCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, HOBORKA, 1980, ARSENE *et al.*, 2005

10. *Cyperetum flavescentis* W. Koch 1926/Nanocyperion W. Koch 1926/ Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/GRIGORE, 1971, HOBORKA, 1980, LOVASZ, 1995, DRĂGULESCU, 2013
11. *Cypero-Juncetum* Soó et Csűrös 1944/Nanocyperion W. Koch 1926/Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/COSTE, 1974
12. *Glycerietum maximae* (Now. 1930) Hueck 1931/Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOŞCAIU, 1966, GRIGORE, 1971, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, ARSENE *et al.*, 2005, MATACĂ, 2005, NEACŞU, 2008
13. *Glycerietum plicatae* Oberd. (1952) 1957/Glycerio-Sparganion Br.-Bl. et Siss. 1942/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, COSTE, 1974
14. *Glycerio-Sparganietum neglecti* (Br.-Bl.) 1925 W. Koch 1926/Glycerio-Sparganion Br.-Bl. et Siss. 1942/Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/ PHRAGMITETEA Tx. et Prsg. 1942/SORAN, 1956, BOŞCAIU, 1965, OPREA *et al*., 1970, GRIGORE, 1971, LOVASZ, 1995
15. *Heleocharetum acicularis* Hvč. 1933 = *Eleocharidetum acicularis* W. Koch. 1926 em. Oberd. 1957/Nanocyperion W. Koch 1926/Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/BOŞCAIU, 1966, GRIGORE, 1971, LOVASZ, 1995, NEACŞU, 2008
16. *Heleocharetum palustris* Schennik. 1919/Bolboschoenion maritimi Soó 1947/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/COSTE, 1974, NEACŞU, 2008, DRĂGULESCU, 2013 = *Alismati-Eleocharetum* M. Kw. et Mathe 1967/ Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, OPREA, 1976, LOVASZ, 1995
17. *Hydrochari-Stratiotetum* (Langend. 1935) Westhoff 1942/Hydrocharition Rüb. 1933/ Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/GRIGORE, 1971, MATACĂ, 2005
18. *Iretum pseudacori* Eggler 1933/Phragmition W. Koch 1926/Phragmitetalia (W. Koch 1926) Tx. et Prsg./PHRAGMITETEA Tx. et Prsg. 1942/ LOVASZ, 1995, ARSENE *et al.*, 2005, NEACŞU, 2008
19. *Juncetum bufonii* I. Morariu 1956/Nanocyperion W. Koch 1926/Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/GRIGORE, 1971, HOBORKA, 1980, LOVASZ, 1995
20. *Leersietum oryzoides* Krause 1955 em. Pass. 1957/Phalarido-Glycerion Pass. 1964/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/ NEACŞU, 2008
21. *Lemnetum minoris* (Oberd. 1957) Th. Müll. et Görs 1960/Lemnion minoris W. Koch et Tx. 1954 ap. Oberd. 1957/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/ LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/BOŞCAIU, 1966, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, ARSENE *et al.*, 2005, MATACĂ, 2005, NEACŞU, 2008, DRĂGULESCU, 2013
22. *Lemno minoris-Spirodeletum* W. Koch 1954 = *Spirodeletum pollyrrhizae* W. Koch 1954/ Lemnion minoris W. Koch et Tx. 1954 ap. Oberd. 1957/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/BOŞCAIU, 1966, OPREA, 1976, MATACĂ, 2005, NEACŞU, 2008

23. *Lemno-Utricularietum vulgaris* Soó 1928/Hydrocharition Rüb. 1933/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/SORAN, 1956, BOȘCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, HOBORKA, 1980
24. *Lindernio-Isolepetum* I. Morariu 1943/Nanocyperion W. Koch 1926/Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/SORAN, 1956, GRIGORE, 1971
25. *Myriophyllo-Potamogetonetum* Soó 1934/Potamogetonion W. Koch 1926 em. Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/SORAN, 1956, BOȘCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, NEACȘU, 2008
26. *Najadetum minoris* Ubrizsy 1948, 1961/Potamogetonion W. Koch 1926 em. Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/NEACȘU, 2008
27. *Nymphaeetum albo-luteae* Now. 1928/Nymphaeion Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/BOȘCAIU, 1966, GRIGORE, 1971, HOBORKA, 1980
28. *Parvipotamogetono-Zannichellietum* W. Koch 1926/ Potamogetonion W. Koch 1926 em. Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/SORAN, 1956, BOȘCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, LOVASZ, 1995
29. *Phalaridetum arundinaceae* Libb. 1931/Magnocaricion W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg./PHRAGMITETEA Tx. et Prsg. 1942/BOȘCAIU, 1966, GRIGORE, 1971, COSTE, 1974, VICOL, 1974, LOVASZ, 1995, NEACȘU, 2008, DRĂGULESCU, 2013
30. *Polygono-Potamogetonetum* Soó 1964/Nymphaeion Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/BOȘCAIU, 1966, GRIGORE, 1971, OPREA, 1976, HOBORKA, 1980, MATACĂ, 2005, NEACȘU, 2008, DRĂGULESCU, 2013
31. *Potamogetono-Ceratophylletum* I. Pop 1962/Potamogetonion W. Koch 1926 em. Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/GRIGORE, 1971
32. *Pulicario-Menthetum pulegii* Slav. 1951/Verbenion supinae Slav. 1951/ Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br.-Bl. et Tx. 1943/BOȘCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, DRĂGULESCU, 2013
33. *Ranunculetum aquaticae* Gehn 1961/Nymphaeion Oberd. 1957/Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/GRIGORE, 1971, HOBORKA, 1980, LOVASZ, 1995
34. *Ranunculetum lateriflori* I. Pop 1962/ Nanocyperion W. Koch 1926/Nanocyperetalia Klika 1935/ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943/GRIGORE, 1971
35. *Rorippo-Oenanthetum aquaticae* (Soó 1927) Lohm. 1950 = *Oenanthe-Rorippetum aquaticae* Lohm. 1950 / Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, COSTE, 1974, LOVASZ, 1995
36. *Salicetum albae-fragilis* Issler 1926 em. Soó 1957/Salicion albae Soó 1930 (Tx. 1955) Müller et Görs 1958/Salicetalia purpureae Moor 1958/SALICETEA PURPUREAE

Morr 1958, 1960/SCHRÖTT, 1972, COSTE, 1974, HOBORKA, 1980, LOVASZ, 1995, NEACŞU, 2008, DRĂGULESCU, 2013

37. *Salicetum purpureae* Soó 1934 Wendelb.-Zelinka 1952/Salicion triandrae Muller et Gors. 1958/Salicetalia purpureae Moor 1958/SALICETEA PURPUREAE Morr 1958, 1960/SCHRÖTT, 1972, COSTE, 1974, OPREA, 1976, HOBORKA, 1980
38. *Salicetum triandrae* Malcuit 1929/Salicion triandrae Muller et Gors. 1958/Salicetalia purpureae Moor 1958/SALICETEA PURPUREAE Morr 1958, 1960/SCHRÖTT, 1972, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995
39. *Salvinio-Hydrocharitetum* Oberd. 1957/Hydrocharition Rüb. 1933/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/BOŞCAIU, 1966, GRIGORE, 1971
40. *Salvinio-Spirodeletum* Slav. 1956/Lemnion minoris W. Koch et Tx. 1954 ap. Oberd. 1957/ Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/GRIGORE, 1971, HOBORKA, 1980, MATACĂ, 2005, DRĂGULESCU, 2013
41. *Schoenoplectetum lacustris* Eggl. 1933/Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOŞCAIU, 1966, GRIGORE, 1971, LOVASZ, 1995, ARSENE *et al.*, 2005, NEACŞU, 2008
42. *Scirpetum tabernaemontani* Pass. 1964/Bolboschoenion maritimi Soó 1947/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/GRIGORE, 1971, OPREA, 1976
43. *Scirpo-Phragmitetum* W. Koch 1926 *medioeuropaeum* Tx. 1941/Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOŞCAIU, 1966, OPREA *et al*., 1970, GRIGORE, 1971, COSTE, 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, ARSENE *et al.*, 2005, MATACĂ, 2005, NEACŞU, 2008, DRĂGULESCU, 2013
44. *Trapetum natantis* Th. Müll. et Görs 1960/Nymphaeion Oberd. 1957/ Potamogetonetalia W. Koch 1926/POTAMOGETONETEA Tx. et Prsg. 1942/BOŞCAIU, 1966, GRIGORE, 1971, MATACĂ, 2005, NEACŞU, 2008
45. *Typhetum angustifoliae-latifoliae* (Eggl. 1933) Schmale 1939/Phragmition W. Koch 1926/ Phragmitetalia (W. Koch 1926) Tx. et Prsg. 1942/PHRAGMITETEA Tx. et Prsg. 1942/BOŞCAIU, 1966, GRIGORE, 1971, COSTE, 1974, LOVASZ, 1995, HOBORKA, 1980, ARSENE *et al.*, 2005, MATACĂ, 2005, NEACŞU, 2008, DRĂGULESCU, 2013
46. *Wolffietum arrhizae* Mijaw. et J. Tx. 1960/Lemnion minoris W. Koch et Tx. 1954 ap. Oberd. 1957/Lemnetalia W. Koch et Tx. 1954 ap. Oberd. 1957/LEMNETEA W. Koch et Tx. 1954 ap. Oberd. 1957/BOŞCAIU, 1966, GRIGORE, 1971

Other associations:

OPREA *et al*., 1970 describe, at Satchinez, at Rîtul Mare, near the village, the *Nymphoidetum peltatae* (Allorge 22) Oberd. et Müller 60 association. For Banat, there is no other signalling of this association. COLDEA, 1977 presents the significant *Nymphoides peltata* phytocoenoses, similar to those described in the Danube Delta, the Munteniei Plain and the Crişurilor Plain by POPESCU *et al*., 1984 and POP, 1968. DRĂGULESCU, 2013 signals in the Timişului basin the *Juncetum effusi* Soó (1931) 1949 and *Junco-Menthetum longifoliae* Lohm 1953 associations (last one described also by NICOLIN, 2004, in the same area). At Satchinez, a frequent association is that of *Rubo-Salicetum cinereae* (ARSENE *et al.*, 2005), which offers shelter and nestling to local birds. Phytocoenoses of this association are present, on non-representative surfaces, in the Liebling, Sânandrei, Surduc lakes area (NEACŞU, 2008). In the

Danube defile, MATACĂ, 2005 describes the *Frangulo-Salicetum cinereae* Malc. 1929 association. The same author identifies the *Telekio speciosae-Alnetum incanae* Coldea (1986) 1990 and *Stellario nemorum-Alnetum glutinosae* (Kästner 1938) Lohmeyer 1957 associations.

Along the banks or in periodically flooded depressions, on nitrogen rich soils, the mezzo-hygrophilic *Polygono hydropiperi-Bidentetum* (GRIGORE, 1971, COSTE, 1974, OPREA, 1976, LOVASZ, 1995, NEACȘU, 2008, DRĂGULESCU, 2013) association develops. In humid meadows, there frequently occur the *Agrostidetum stoloniferae* (Ujvarovsi 1941) Burduja *et al.* 1956 (BOȘCAIU, 1965, OPREA *et al*., 1974, OPREA, 1976, HOBORKA, 1980, LOVASZ, 1995, NICOLIN, 2004, NEACȘU, 2008), *Alopecuretum pratensis* Nowinski 1928 (BOȘCAIU, 1965, SCHRÖTT, 1972, OPREA, 1976, LOVASZ, 1995, NICOLIN, 2004, NEACȘU, 2008) associations. On nutrient rich soils, near banks, one can encounter phytocoenoses from weed formation associations: *Echinochloo-Polygonetum lapathifolii* (Ujvárosi 1940) Soó et Csűrös (1944) 1947 (GRIGORE, 1971, OPREA, 1976, LOVASZ, 1995, NEACȘU, 2008), *Conietum maculati* I. Pop 1968 (GRIGORE, 1971, COSTE, 1974, OPREA, 1976, LOVASZ, 1995, NEACȘU, 2008), *Urtico-Sambucetum ebuli* Br.-Bl. (1936) 1952 (GRIGORE, 1971, COSTE, 1974, OPREA, 1976, LOVASZ, 1995, ARSENE et al. 2005, NEACȘU, 2008).

Table 2

Research regarding the aquatic and paludicolous vegetation, in Banat

No.	Autors	Areas studied	No. of associations
1.	SORAN, 1956	Liebling, Banat	5
2.	BOȘCAIU, 1965, 1966	Lugoj, Sebeșului Meadow, Banat	31
3.	OPREA *et al*., 1970	Satchinez	10
4.	ARSENE *et al*., 2005	Satchinez	11
5.	GRIGORE, 1971	Timiș-Bega interfluve	35
6.	SCHRÖTT, 1972	Cheile Nerei	3
7.	COSTE, 1974	Locvei Mountains	18
8.	OPREA, 1976	Sînnicolaul Mare Plain	16
9.	ARVAT, 1977	Timiș, Pogoniș, Bârzava	32
10.	HOBORKA, 1980	Dognecei Mountains	19
11.	LOVASZ, 1995	Buziașului Plain	30
12.	NEACȘU, 2008	Surduc, Pișchia, Liebling, Sânandrei	29
13.	DRĂGULESCU, 2013	Timiș river	63
14.	MATACĂ, 2005	Porțile de Fier	11

From the point of view of the cenotaxonomy classification, we can express the following observations:

- the *Heleocharetum acicularis* Hvč. 1933 (*Eleocharidetum acicularis* W. Koch. 1926 em. Oberd. 1957) association is included in the cls. ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943, by BOȘCAIU, 1966 and GRIGORE, 1971. In the barrier lake vegetation compendium form the Timiș county (NEACȘU, 2008), we opted for the inclusion in the cls. LITTORELLETEA R. Tx. 1947 (ord. Littorelletalia W. Koch 1926, al. Eleocharition acicularis Pietsch 1967), according to COLDEA, 1997, SANDA *et al.*, 1998. COLDEA states that some authors classify the association as ISOËTO-NANOJUNCETEA Br. -Bl. et Tx. 1943, due to the presence in the association of numerous species belonging to this class, to the detriment of the ones belonging to LITTORELLETEA R. Tx. 1947, the cause being the anthropic impact.
- SANDA *et al.*, 2008 propose classification modifications for some asscoiations, depending on characteristic species, regarding orders and alliances (e.g. *Lemno-Utricularietum, Phalaridetum arundinaceae, Ranunculetum aquaticae*). The same

authors specify that some phytosociologists prefer to describe aquatic associations of reduced volume, due to floristic homogeneity.

- according to COLDEA, 1997, SANDA *et al.*, 2008 significant *Typha angustifolia* rush phytocoenoses, belong to the *Typhaetum angustifoliae* Pign. 1953 association, and the significant *Typha latifolia* ones, to the *Typhaetum latifoliae* G. Lang 1973 association. This classification is used by ARSENE *et al.*, 2005, MATACĂ, 2005, NEACȘU, 2008, DRĂGULESCU, 2013. In older papers, they are registered as *Typhaetum angustifoliae-latifoliae* (Eggl. 1933) Schmale 1939 (BOȘCAIU, 1966, GRIGORE, 1971, COSTE, 1974, HOBORKA, 1980). In SANDA *et al.*, 1980 all three associations are mentioned as common in these parts. The same three associations are described by LOVASZ, 1995 in the Buziașului Plain.
- GRIGORE, 1971 differentiates within the *Salici-Populetum* (Tx.1931) Mej-Dress 1936 association (depicted by OPREA, 1976, in the Sînnicolaul Mare Plain), the sub-association amorphosum fruticosae, in the Timiș-Bega interfluve area, similar to the one described along the Danube by MORARIU & DANCIU (1970). COSTE, 1974, describes in the Locvei Mountains the *Amorphaetum fruticosae* association (Borza 1954) nova as. prov.
- we chose to use the classic vegetal association names, due to synonymy related issues.

The aquatic and paludicolous vegetation of the community important sites from the Romanian Banat is partially known (there are sites whose standard forms, do not contain any habitat). The aquatic and paludicolous vegetation outside the protected areas is only vaguely known, generally as association enumerations.

Table 3 brings forth habitats from humid areas in NATURA 2000 sites. The ROSCI 0115 Satchinez Marsh site does not contain any aquatic vegetation association or habitat.

Without a standard Form habitat, there are:

- ROSCI 0355 Lipova Plateau -Poiana Ruscă
- ROSCI 0361 Caraș River
- ROSCI 0375 Nera River, between Bozovici and Moceriș
- ROSCI 0385 Timiș River, between Rusca and Prisaca

Still, standard-forms of these community important sites contain aquatic and/or paludicolous vegetation classes:

- N 03 Salt marshes (+ Salt pastures + Salt steppes)
- N 06 Inlans water bodies (Standing water, Ruming water)
- N 07 Bogs, Marshes, Water fringed vegetation Fens

Table 3

Humid area habitats in community important sites in Banat (NATURA 2000)

No.	Natura 2000 habitat	0031	0069	0108	0109	0115	0126	0206	0219	0226
1.	1530*					x				
2.	3130			x				x		
3.	3140							x		
4.	3150			x				x		
5.	3160			x						
6.	3220	x	x				x			x
7.	3240									x
8.	3260	x			x			x		
9.	3270				x			x		
10.	6430	(x)	(x)	x			x	x		(x)

11.	6440			x						
12.	7110									*
13.	7120									x
14.	7140									x
15.	7220*	x	x				x			x
16.	7230						x			
17.	91EO*	x	x				x	x	x	x
18.	91FO			x						
19.	92AO			x	x			x		

Legend:

Habitats:

1530 * Pannonic salt steppes and salt marshes
3130 Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea*
3140 Hard oligo-mesotrophic waters with benthic vegetation of *Chara spp*.
3150 Natural eutrophic lakes with *Magnopotamion* or *Hydrocharition* - type vegetation
3160 Natural dystrophic lakes and ponds
3220 Alpine rivers and the herbaceous vegetation along their banks
3240 Alpine rivers and their ligneous vegetation with *Salix elaeagnos*
3260 Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion*
Vegetation
3270 Rivers with muddy banks with *Chenopodion rubri* p.p. and *Bidention p.p.* vegetation
6430 Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels
6440 Alluvial meadows of river valleys of the *Cnidion dubii*
7110 * Active raised bogs
7120 Degraded raised bogs still capable of natural regeneration
7140 Transition mires and quaking bogs
7220 * Petrifying springs with tufa formation (*Cratoneurion*)
7230 Alkaline fens
91E0 * Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion, Alnion incanae, Salicion albae*)
91F0 Riparian mixed forests of *Quercus robur, Ulmus laevis* and *Ulmus minor, Fraxinus excelsior* or *Fraxinus angustifolia*, along the great rivers (*Ulmenion minoris*)
92A0 *Salix alba* and *Populus alba* galleries

Sites:

ROSCI 0031 Cheile Nerei-Beușnița
ROSCI 0069 Domogled-Cerna Valley
ROSCI 0108 Low Meadow of Mureș
ROSCI 0109 Timiș Meadow
ROSCI 0115 Satchinez Marshes
ROSCI 0126 Țarcu Mountains
ROSCI 0206 Porțile de Fier
ROSCI 0219 Rusca Montană
RO SCI 0226 Semenic-Cheile Caraşului

CONCLUSIONS

The aquatic and paludicolous flora and vegetation in Banat occupied, in the past, vast surfaces. Today, the natural humid areas are reduced to the marshes at Satchinez and some

river meadows. Since 2007, some of these are under a NATURA 2000 protection regime. Preservative interest species from the humid areas are *Lindernia procumbens* (SORAN, 1954, BOŞCAIU, 1966, NEACŞU, 2008), *Marsilea quadrifolia* (SORAN, 1954, GRIGORE, 1971), *Eleocharis carniolica* (BOŞCAIU, 1971), *Cirsium brachycephallum* (TURCEAN *et al*., 2014). The presence of invasive allogenic species is worth mentioning, namely *Amorpha fruticosa*, at lower altitudes and *Reynoutria japonica*, at higher altitudes, even in the NATURA 2000 sites. On small watercourses (which sometimes dry out in summer) and on irrigation-draining canals, typical humid area phytocoenoses stripes can be found, rarely studied in vegetation monography papers. The number of main aquatic and paludicolous associations is of 46, grassy vegetation being the best represented. To these we add some other humid meadow weed formation associations. Wooden vegetation is represented in gallery alder and willow groves (92A0), on hilly and mountain layers with oak and ash (91EO*), in the plain area.

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