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The Marshland Vegetation (Phragmito-Magnocaricetea, Isoëto-Nanojuncetea) and Hydrology in the Hutovo Blato Natural Park (Neretva River Delta, Bosnia and Herzegovina)

By

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With 3 Figures

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Summary

JASPRICA N., CARIĆ M. & BATISTIĆ M. 2003. The marshland vegetation (Phragmito-Magnocaricetea, Isoëto-Nanojuncetea) and hydrology in the Hutovo Blato Natural Park (Neretva River delta, Bosnia and Herzegovina). – Phyton (Horn, Austria) 43 (2): 281–294, 3 figures. – English with German summary.

The natural park of Hutovo Blato, Bosnia and Herzegovina, is one of the most important parts of the upper reaches of the Neretva River delta. In total, 11 plant communities of Phragmito-Magnocaricetea, and three plant communities of Isoëto-Nanojuncetea were noted, based on 64 phytocoenological relevés. Of all the associations of the Phragmition alliance, the stands of the Scirpetum lacustris colonize the areas with deepest waters – 0.5–1 m. The association Phalaridetum arundinaceae develops on the dryest habitats on the external margins and in terrain depressions along the Krupa River. The communities of the Isoëto-Nanojuncetea class represent annual pioneer vegetation on soils with temporary flooding in the period from autumn to early spring. Regulation of the Neretva River waters, where a few hydropower plants have been built in the upper reaches, can have an impact on the vegetation growth and distribution in the wetland. Among other factors, the survival of vegetation will depend greatly on the water level in the wetland that has decreased

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over recent years, owing to the general change in the hydrological regime. The final outcome will be the destruction of habitats.

Zusammenfassung

JASPRICA N., CARIĆ M. & BATISTIĆ M. 2003. Marschlandvegetation (Phragmito-Magnocaricetea, Isoëto-Nanojuncetea) und Hydrologie im Naturpark Hutovo Blato (Neretva-Delta, Bosnien und Herzegowina). – Phyton (Horn, Austria) 43 (2): 281–294, 3 Abbildungen. – Englisch mit deutscher Zusammenfassung.

Der Naturpark Hutovo Blato in Bosnien und Herzegowina ist einer der vegetationskundlich bedeutendsten Teile am Oberlauf der Neretva. Aufgrund von 64 phytocoenologischen Aufnahmen sind insgesamt 11 Pflanzengemeinschaften der Klasse Phragmito-Magnocaricetea und drei Pflanzengemeinschaften der Klase Isoëto-Nanojuncetea festgestellt worden. Unter allen Gesellschaften des Verbandes Phragmition besiedelt das Scirpetum lacustris die Flächen mit den höchsten Wasserständen: 0.5–1 m. Auf den trockensten Habitaten entwicklen sich Bestände der Assoziation Phalaridetum arundinaceae und zwar auf dem äußeren Uferrand und in den Senken entlang der Krupa. Die Gemeinschaften der Klasse Isoëto-Nanojuncetea stellen einjährige Pionier-Vegetation auf Böden, die vom Herbst bis zum Anfang des Frühjahrs überschwemmt werden. Die Regulation der Wassermenge der Neretva durch einige Wasserkraftwerke, die an deren Oberlauf erbaut worden sind, beeinflußt die Entwicklung und die Verteilung der Vegetation im Marschland. Neben anderen Faktoren wird die Erhaltung dieser Vegetation vom Wasserspiegel im Marschland abhängen, der aufgrund der Veränderung der hydrologischen Verhältnisse in den letzten Jahren immer mehr sinkt. Das Endresultat wird die Vernichtung dieser bedeutenden Habitate sein.

1. Introduction

The Neretva River delta (total area of 170 km^2) is situated on the eastern coast of the Middle Adriatic Sea. It extends over two countries, both Croatia and Bosnia and Herzegovina. 30% of its area belongs to Bosnia and Herzegovina. The natural park of Hutovo Blato (74 km^2, Fig. 1) is one of the most important parts of the Neretva River delta in Bosnia and Herzegovina (REDŽIĆ & al. 1992). It was listed in the Ramsar Convention as an internationally protected wetland in 2001.

Helophytic marshy vegetation is the most widespread and ecologically important vegetation type in the Neretva River delta (HORVAT & al. 1974, LAKUŠIĆ & al. 1977, LOVRIĆ & RAC 1989). During the past decades, there has been a significant loss of wetland habitats due to different kinds of human activity, mostly in the lower part (Croatia) of the Neretva River delta (GLAMUZINA & al. 2001). Now, this area has many marshy plant communities that are fragmentarily developed (ILIJANIĆ & TOPIĆ 1998).

In recent investigations, no considerable attention has been drawn to the vegetation in the marshland of the upper (Bosnia and Herzegovina) Neretva River delta. The aim of this paper is to describe the particular

floristic and physiognomic features of the plant communities of the classes Phragmito-Magnocaricetea and Isoëto-Nanojuncetea in the Hutovo Blato Natural Park, with a special emphasis on the relationship between vegetation and hydrological conditions.

2. Features of the Hutovo Blato Natural Park

There are six shallow (max. depth 1–2 m) lakes in the park: Škrka, Jelim, Drijen, Orah, Deran and Donje Blato. Except of Donje Blato which is an accumulation lake, parts of the bottom of these lakes represent a cryptodepression. The water masses of the lakes originate mostly from numerous subterranean karstic springs, which are situated along the perimeter edges. They are very active in autumn and early spring. Deran Lake collects waters coming from the lakes Jelim, Drijen and Orah, and the Londža Channel. Additionally, the Hutovo Blato basin is supplied by superficial waters originating from the Neretva River. Those waters find their way flowing through the Krupa river-bed. The Krupa River (20 km long), the main waterway in the park, forms in the western region of Lake Deran. The Krupa River does not have its own source, but it collects water from all of the lakes and directs it towards the Neretva River. The maximum water level and the flow of the Krupa River is five meters and 176 m^3 s^{-1}, respectively (Goluža 2002). In autumn and winter, the water level of the Neretva River rises rapidly, due to disproportions between the quantity of water flowing from the upper reaches of the Neretva River and the capacity of its basin in its lower reaches. This, in turn, changes the hydrographic orientation of the Krupa River, which deflects the water into Hutovo Blato basin. In this period, most of the entire valley is flooded, if not completely. The water level of the Neretva River (data for near Metković station for the period 1968–1998, recorded by Croatian Meteorological and Hydrological Service), varied between 65–124 cm (average 91 ± 13 cm). In autumn and winter, the water level of the Neretva River rises rapidly (Fig. 2).

From the geological point of view, the park consists mostly of Cretaceous and Eocene limestone (Juračić 1998). The climate is mostly warm and dry. The average annual air temperature and precipitation is 14.7° C and 1,148 mm, respectively (data for Karaotok station for the period 1946–1976, recorded by Meteorological and Hydrological Service of Bosnia and Herzegovina). Based on the overall data gathered for the Karaotok station, the absolute minimum temperature (–9.6° C) was recorded in January 1929, and the absolute maximum (42.2° C) in August 1922. The highest quantity of rainfall is in the period from November to February (Fig. 2). The total rainfall quantity is 152 mm from June to August. In this period, the water level of the most lakes is below 0,5 m. Southern winds prevail in the park. This area has approximately

2,300 hours of sunshine per year. Phytogeographically, this area belongs to the sub-Mediterranean vegetational zone of the Ostryo-Carpinion orientalis alliance (TRINAJSTIĆ 1995).

3. Material and Methods

This study is based on several collections and field observations carried out by the authors between March and September 2000. A total of 64 phytocoenological relevés have been done on 40 localities in the park (Fig. 1), which encompassed its entire area. Data collection in the field follows the approach of the Zürich-Montpellier school (BRAUN-BLANQUET 1964). For estimating the abundance/dominance the modified scale of BARKMAN & al. 1964 is used. Category 2 was subdivided into 2M, 2A, 2B. They are abbreviated as M, A and B in the tables. To analyse the communities we constructed a matrix of 64 relevés for 105 species. Data processing was performed with the Syn-Tax 5.0 software package (PODANI 1993). To classify the relevés the mean linkage was used as agglomeration criterion and percentage difference as measure of dissimilarity. The nomenclature of syntaxa follows HORVAT & al. 1974 modified by TRINAJSTIĆ 1991, and BALÁTOVA-TULÁČKOVÁ & al. 1993. The nomenclature of taxa follows PIGNATTI 1982.

Localities of relevés

Data are ordered as follows: number or relevés, locality name, rkm (River Krupa kilometer), area of sampling plot (m^2), vegetation cover in % of total area of sampling plot, date of sampling.

Table 1, Phragmition.

1. Karaotok, 18 m^2, 100%, 25-3-2000.
2. Lake Škrka, 25 m^2, 100%, 12-5-2000.
3. Lake Deran (Boljev Kuk), 25 m^2, 90%, 10-6-2000.
4. Donje Blato, Svitava, 25 m^2, 100%, 20-5-2000.
5. Lake Jelim, 25 m^2, 100%, 3-7-2000.
6. Lake Deran, 25 m^2, 90%, 3-7-2000.
7. Karaotok, 25 m^2, 75%, 10-6-2000.
8. Donje Blato, 20 m^2, 90%, 20-5-2000.
9. River Krupa, 3 rkm, 25 m^2, 100%, 10-6-2000.
10. Lake Orah, 25 m^2, 100%, 3-7-2000.
11. Lake Jelim, 25 m^2, 80%, 3-7-2000.
12. River Krupa, 5 rkm, 25 m^2, 85%, 22-7-2000.
13. Babino oko, 25 m^2, 90%, 22-7-2000.
14. Londža, 20 m^2, 90%, 10-6-2000.
15. Lake Škrka, 40 m^2, 100%, 20-5-2000.
16. Lake Škrka, 25 m^2, 90%, 20-5-2000.
17. Babino oko, 25 m^2, 90%, 10-6-2000.
18. River Krupa 5.5 rkm, 25 m^2, 85%, 22-7-2000.
19. Lake Jelim, 15 m^2, 90%, 3-7-2000.
20. Karaotok, 15 m^2, 100%, 22-7-2000.

Table 2, Phragmition.

1. Karaotok, 25 m^2, 80%, 10-6-2000.
2. Karaotok, 25 m^2, 80%, 10-6-2000.
3. River Krupa, 8.5 rkm, 20 m^2, 90%, 5-8-2000.
4. Lake Deran (western part), 12 m^2, 90%, 22-7-2000.
5. Lake Deran (northern part), 9 m^2, 100%, 10-6-2000.
6. Lake Drijen, 6 m^2, 100%, 5-8-2000.

Table 3, Magnocaricion.

1. Lake Deran (northern part), 20 m^2, 80%, 5-8-2000.
2. Lake Deran (southern part), 25 m^2, 90%, 5-8-2000.
3. Lake Jelim, 25 m^2, 90%, 5-8-2000.
4. River Krupa, 4.5 rkm, 50 m^2, 90%, 22-7-2000.
5. Lake Škrka, 40 m^2, 90%, 11-6-2000.
6. River Krupa, 5.5 rkm, 40 m^2, 100%, 22-7-2000.
7. River Krupa, 6 rkm, 40 m^2, 95%, 22-7-2000.
8. Lake Jelim, 20 m^2, 90%, 5-8-2000.
9. Babino oko, 25 m^2, 100%, 5-9-2000.
10. Donje Blato, Ostrvo, 25 m^2, 80%, 20-5-2000.
11. River Krupa, 10.5 rkm, 25 m^2, 80%, 24-9-2000.
12. River Krupa, 12 rkm, 25 m^2, 100%, 24-9-2000.
13. River Krupa, 12.5 rkm, 25 m^2, 100%, 24-9-2000.
14. Lake Škrka, 20 m^2, 90%, 10-6-2000.
15. Karaotok, 20 m^2, 90%, 10-6-2000.
16. Lake Škrka, 25 m^2, 90%, 11-6-2000.
17. Karaotok, 25 m^2, 90%, 12-5-2000.
18. River Krupa, 10.5 rkm, 25 m^2, 90%, 22-7-2000.
19. Lake Jelim, 15 m^2, 90%, 22-7-2000.
20. River Krupa, 12 rkm, 15 m^2, 100%, 5-9-2000.

Table 4, Glycerio-Sparganion.

1. Karaotok, 25 m^2, 90%, 20-8-2000.
2. Lake Škrka, 25 m^2, 80%, 7-9-2000.
3. Babino oko, 25 m^2, 80%, 20-8-2000.
4. Londža, 25 m^2, 90%, 20-8-2000.
5. Lake Jelim, 25 m^2, 90%, 5-8-2000.

Table 5, Fimbristylion dichotomae.

1. Londža, 20 m^2, 80%, 3-9-2000.
2. Lake Deran (southern part), 25 m^2, 90%, 3-9-2000.
3. Babino oko, 25 m^2, 100%, 3-9-2000.
4. River Krupa, 15 rkm, 25 m^2, 95%, 10-8-2000.
5. Lake Deran (southeastern part), 40 m^2, 100%, 5-8-2000.
6. River Krupa, 15.5 rkm, 40 m^2, 100%, 10-8-2000.
7. Donje Blato, near village of Sjekosi, 40 m^2, 95%, 7-9-2000.
8. Lake Jelim, 20 m^2, 90%, 7-9-2000.
9. Babino oko, 25 m^2, 100%, 3-9-2000.
10. Lake Drijen, 25 m^2, 85%, 22-8-2000.
11. Londža, 40 m^2, 100%, 20-8-2000.
12. Babino oko, 40 m^2, 100%, 3-9-2000.
13. Babino oko, 25 m^2, 90%, 3-9-2000.

4. Results

In the park, we determined 14 communities documented by 64 phytocoenological relevés. The alliances Phragmition, Magnocaricion and Glycerio-Sparganion are represented by 11 communities, and the Fimbristylion dichotomae alliance is represented by three communities:

Phragmito-Magnocaricetea KLIKA in KLIKA et NOVÁK 1941
Phragmitetalia W. KOCH 1926
Phragmition W. KOCH 1926
1. Phragmitetum australis SOÓ 1927 nom. mut. propos.
2. Scirpetum lacustris CHOUARD 1924
3. Scirpetum tabernaemontani PASS. 1964

4. Bolboschoenetum maritimi Br.-Bl. 1931
5. Typhetum angustifoliae Pignatti 1953
6. *Iris pseudacorus*-community

Magnocaricion W. Koch 1926

7. Mariscetum serrati Zobrist 1935 (= Cladietum marisci)
8. Hydrocotyle-Caricetum elatae Horvatić 1962
9. Phalaridetum arundinaceae Libbert 1931
10. Cyperetum longi Micevski 1957

Glycerio-Sparganion Br.-Bl. et Sissingh 1942

11. Sparganio-Cyperetum longi Horvatić 1939

ISOËTO-NANOJUNCETEA Br.-Bl. et R. Tx. 1943

Isoëtetalia Br.-Bl. 1931

Fimbristylion dichotomae Horvatić 1954

12. Cypero-Paspaletum digitarii (=distichi) Horvatić 1954
13. Dichostyli-Fimbristyletum dichotomae Horvatić 1954
14. Paspaleto-Leersietum oryzoidis Bajić 1978

Of all the associations in the Phragmition alliance (Tables 1 and 2), the stands of Scirpetum lacustris colonize the deepest waters (0.5–1 m, Fig. 3).

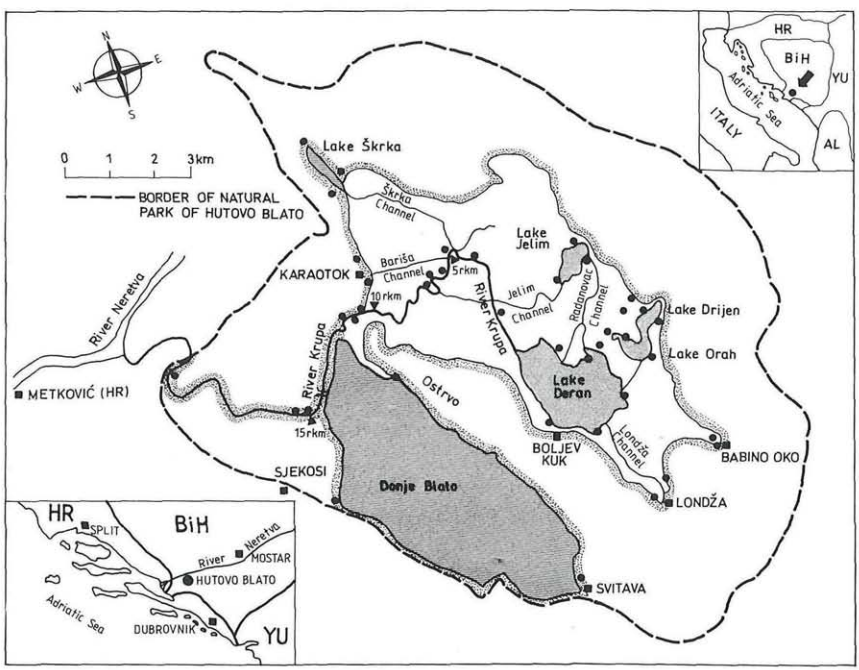

Fig. 1. Location and map of the study area. – Abbreviations: HR: Croatia, BiH: Bosnia and Herzegovina, YU: Yugoslavia, AL: Albania, rkm: River Krupa kilometer, shaded area: lakes, dotted area: border between dry land and marsh, ●: sampling localities, ■: towns and villages.

Table 1. Phragmition W. Koch 1926.
The indicating species of communities are noted in bold.

	Phragmitetum australis						Scirpetum lacustris						Scirpetum tabernaemontani						Bolboschoenetum maritimi						
Relevé No.	1	2	3	4	5	C	6	7	8	9	10	C	11	12	13	14	15	C	16	17	18	19	20	C
Number of species	12	14	18	20	17	**16.2**	9	8	6	3	5	**6.2**	11	10	5	8	6	**7.8**	18	3	0	1	7	**11.8**
Phragmites australis	**5**	**5**	**M**	**5**	**4**	**V**	+	.	.	.	.	I	.	.	.	.	+	I	+	.	.	.	.	I
Calystegia sepium	+	**4**	**1**	**B**	+	**V**	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Schoenoplectus lacustris	.	.	+	.	.	I	**3**	**4**	**4**	**5**	**5**	**V**	.	.	.	.	.	.	.	.	+	.	+	II
S. tabernaemontani	.	.	.	.	.	.	.	.	.	.	.	.	**3**	**M**	**4**	**3**	**5**	**V**	.	+	+	.	+	III
Rorippa amphibia	.	.	.	.	.	.	**M**	**M**	+	**1**	**A**	**V**	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum amphibium	.	.	+	.	+	II	**A**	**1**	+	**1**	.	**IV**	.	.	.	.	.	.	.	.	.	.	.	.
Juncus subnodulosus	.	.	.	.	.	.	.	.	.	.	.	.	**1**	+	**A**	**1**	.	**IV**	.	.	.	.	.	.
Bolboschoenus maritimus	.	.	.	.	.	.	.	.	.	.	.	.	1	+	+	.	.	III	**3**	**3**	**4**	**3**	**5**	**V**
Agrostis stolonifera	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	**1**	+	+	+	.	**IV**
Gratiola officinalis	.	.	.	+	+	II	.	.	.	.	.	.	.	.	.	.	+	I	**1**	.	**B**	**A**	+	**IV**
Schoenoplectus triqueter	.	.	+	A	+	III	.	.	+	.	+	II	.	.	.	.	.	.	.	.	.	.	.	.
Cyperus longus	.	.	+	.	.	I	.	.	.	.	.	.	+	+	.	.	.	II	.	1	+	.	+	III
Baldellia ranunculoides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	A	1	1	.	.	III
Cladium mariscus	.	.	+	+	+	III	.	.	.	.	.	.	1	1	+	.	.	III	.	.	.	.	.	.
Samolus valerandi	.	.	+	+	.	II	.	.	.	.	.	.	+	+	.	+	.	III	+	.	.	.	+	II
Galium palustre	.	+	A	+	.	III	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	1	.	III
Eleocharis palustris			.	.	+	I	.	.	.	.	.	.	+	1	.	+	.	III	+	1	+	.	.	III
Sparganium erectum	.	.	+	.	+	II	B	+	+	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.
Sium latifolium	.	.	+	+	A	III	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Mentha aquatica	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+			II	1	+	.	+	.	III
Thelypteris palustris	.	.	.	+	+	II	.	.	.	.	.	.	+	+	.	+	.	III	.	.	.	.	.	.
Ranunculus lingua	.	.	.	.	.	.	.	+	+	.	+	III	.	.	.	.	.	.	1	1	.	.	.	II
Hydrocotyle vulgaris	.	.	.	+	+	II	.	.	.	.	.	.	.	.	.	+	.	I	1	.	+	1	.	III
Lythrum salicaria	.	.	+	.	.	I	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	III
Alisma plantago-aquatica	.	.	+	.	+	II	.	.	.	.	.	.	.	.	.	.	+	I	1	.	+	1	.	III
Carex elata	+	+	.	.	.	II	.	.	.	.	.	.	+	1	.	1	.	III	.	.	.	.	.	.
Oenanthe aquatica	.	.	+	+	.	II	1	+	.	.	.	II	.	.	.	.	.	.	.	.	.	+	.	I
Lysimachia nummularia	+	.	.	.	+	II	.	.	.	.	.	.	.	.	.	.	+	I	.	.	.	.	.	.
Juncus articulatus	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	+	1	.	.	.	II
Paspalum paspaloides	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	II	+	1	.	.	.	II
Typha angustifolia	.	.	.	1	B	II	.	.	.	.	.	.	.	.	.	.	.	.	+	.	.	.	.	I
Juncus anceps	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	+	.	III
Typha latifolia	.	.	1	1	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lysimachia vulgaris	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Myosotis scorpioides	.	.	.	+	+	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Euphorbia palustris	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Leucojum aestivum	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Lycopus europaeus	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Rumex pulcher	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Althaea officinalis	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Potentilla reptans	+	1	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chenopodium polyspermum	1	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Polygonum hydropiper	.	.	.	.	.	.	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.

C – constancy class. With constancy class I only: *Chenopodium album* 1:+; *Taraxacum palustre* 1:+; *Daucus carota* 2:+; *Plantago media* 2:+; *Aristolochia rotunda* 2:+; *Cirsium arvense* 2:+; *Salix purpurea* 4:+; *Iris pseudacorus* 4:+, 16:+; *Stachys palustris* 4:+, 12:+, 20:+; *Epilobium parviflorum* 5:1; *Solanum dulcamara* 5:+; *Caltha palustris* 6:+; *Phalaris arundinacea* 10:+; *Mentha pulegium* 11:+; *Butomus umbellatus* 19:+.

A long-term hydrophase is a major characteristic of their habitats. *Schoenoplectus lacustris* does not colonize the emerged deeper zones in Hutovo Blato basin.

Phragmitetum australis and *Iris pseudacorus* communities colonize stands with a water depth of 0.3–0.5 m. Phragmitetum australis constitutes the dominant helophytic community in the park, growing around lake perimeters in dense and occasionally impenetrable stands. A decrease in depth, in the contact zones on the landward side, increases the number of accompanying species of Magnocaricion (Mariscetum serrati). The *Iris*

Table 2. Phragmition W. Koch 1926.
The indicating species of communities are noted in bold.

Relevé No.	1	2	3	4	5	6
Number of species	10	7	5	14	7	6
Typha angustifolia	**3**	**3**	**4**	.	.	.
Iris pseudacorus	**.**	**.**	**.**	**4**	**5**	**5**
Rorippa amphibia	+	.	.	1	1	+
Polygonum amphibium	+	.	.	+	+	+
Stachys palustris	+	+	.	+	A	1
Cirsium arvense	.	.	+	1	+	+
Lysimachia vulgaris	.	+	.	A	+	.
Calystegia sepium	+	+	+	.	.	.
Lycopus europaeus	+	+	+	.	.	.
Typha latifolia	.	+	1	.	.	.
Mentha aquatica	.	.	.	A	.	+
Galium palustre	.	.	.	1	+	.
Oenanthe aquatica	+	.	.	+	.	.
Lythrum salicaria	+	.	.	+	.	.
Rumex hydrolapathum	+	.	.	.	.	.
Agrostis stolonifera	+	.	.	.	.	.
Alisma plantago-aquatica	.	+	.	.	.	.
Polygonum hydropiper	.	.	.	+	.	.
Ranunculus lingua	.	.	.	+	.	.
Chenopodium polyspermum	.	.	.	+	.	.
Bidens tripartita	.	.	.	+	.	.

1-3: Typhetum angustifoliae (avg. **7.3** species),
4-6: *Iris psuedacorus* comm. (avg. **9** species)

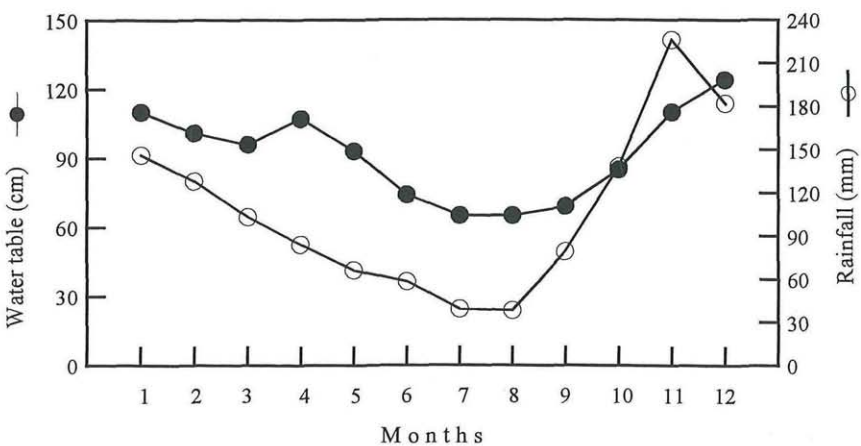

Fig. 2. The average monthly water level in the Neretva River (Metković station, 1968-1998) and rainfall in Hutovo Blato Natural Park (Karaotok station, 1946-1976, according to the Meteorological and Hydrological Services of Croatia, and Bosnia and Herzegovina).

Table 3. Magnocaricion W. Koch 1926.
The indicating species of communities are noted in bold.

	Mariscetum serrati						Hydrocotyle-Caricetum elatae						Phalaridetum arundinaceae						Cyperetum longi					
Relevé No.	1	2	3	4	5	C	6	7	8	9	10	C	11	12	13	14	15	C	16	17	18	19	20	C
Number of species	14	11	10	0	0	11.2	25	31	28	21	1	29	10	6	6			11.8	9	9	11	10		12
Cladium mariscus	**3**	**4**	**4**	**4**	**4**	V	+	+	1	.	.	III	.	.	.	.	.	.	.	.	.	.	.	.
Hydrocotyle vulgaris	1	+	.	+	.	III	**1**	**1**	**B**	+	**5**	V	.	.	.	.	.	.	.	.	.	.	.	.
Carex elata	.	.	.	.	.	.	**3**	**B**	**3**	**B**	**3**	V	.	.	.	.	.	.	+	.	.	.	+	II
Thelypteris palustris	.	+	1	1	.	III	**1**	**1**	**1**	+	**B**	V	.	.	.	.	.	.	+	.	.	.	.	.
Lysimachia vulgaris	+	.	.	+	.	II	+	**3**	+	+	**3**	V	.	.	.	.	.	.	+	+	.	.	.	II
Teucrium scordium	+	.	+	+	.	III	+	**1**	**1**	+	**1**	V	.	+	+	.	.	II	+	1	.	+	.	III
Euphorbia palustris	.	.	.	.	.	.	+	+	+	**1**	**1**	V	.	1	1	+	.	III	1	+	.	1	.	III
Scutellaria galericulata	.	.	.	.	.	.	+	**1**	+	+	**1**	V	.	.	.	.	.	.	.	.	.	.	.	.
Phalaris arundinacea	.	.	.	.	.	.	.	+	.	+	.	II	**3**	**4**	**5**	**3**	**4**	V	.	.	.	.	.	.
Alisma plantago-aquatica	.	.	.	.	.	.	.	+	+	.	A	III	**1**	**A**	**1**	**1**	**1**	V	+	1	+	.	.	III
Mentha aquatica	1	.	1	.	+	III	1	+	1	1	.	IV	**1**	+	**1**	**1**	.	IV	+	.	1	.	+	III
Cyperus longus	.	.	.	+	.	I	+	1	+	.	A	IV	.	+	.	+	.	II	**4**	**4**	**5**	**4**	**4**	V
Pulicaria vulgaris	.	.	+	.	+	II	+	+	.	.	.	II	.	.	.	.	.	.	**+**	**+**	**+**	**.**	**A**	**IV**
Galium palustre	.	+	+	.	+	III	1	+	1	1	.	IV	.	+	.	.	.	I	.	.	.	+	.	I
Typha angustifolia	+	1	B	.	.	III	+	.	.	+	1	II	.	.	.	.	.	.	+	.	+	.	.	II
Calystegia sepium	.	.	.	.	.	.	+	+	.	1	+	IV	.	.	.	.	.	.	1	.	+	.	.	II
Sium latifolium	+	+	.	.	+	III	+	.	+	.	.	II	.	+	+	.	+	III	.	.	.	.	.	.
Phragmites australis	1	.	+	1	.	III	.	+	+	.	1	III	.	.	.	.	.	.	+	.	.	+	.	.
Molinia arundinacea	.	+	.	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Gratiola officinalis	1	.	+	.	.	II	1	+	+	1	.	IV	1	.	1	.	.	II	.	.	.	.	.	.
Samolus valerandi	+	+	.	.	+	III	.	1	+	1	1	IV	.	.	.	.	.	.	1	1	.	+	.	III
Stachys palustris	.	.	+	+	+	III	.	+	B	+	+	IV	+	+	.	+	.	III	.	.	.	.	.	.
Solanum dulcamara	+	+	.	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Eupatorium cannabinum	+	+	.	.	+	III	+	.	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Juncus articulatus	.	.	+	.	+	II	1	.	1	.	+	III	.	.	.	.	.	.	.	.	.	.	.	.
Lythrum salicaria	+	.	.	+	.	II	+	.	+	+	+	IV	.	+	+	.	+	III	+	.	1	.	.	II
Agrostis stolonifera	.	.	.	.	+	I	.	+	+	.	+	III	.	1	+	.	A	III	.	.	.	+	+	II
Lycopus europaeus	+	+	.	.	.	II	.	+	+	.	+	III	.	.	.	.	.	.	.	.	.	+	.	I
Rorippa amphibia	.	.	.	.	.	.	.	.	.	.	.	.	+	.	1	.	+	III	.	.	.	.	.	.
Polygonum amphibium	.	.	.	.	.	.	+	+	.	+	.	III	.	+	.	+	.	II	.	.	.	.	.	.
Althaea officinalis	.	.	.	.	.	.	.	+	+	+	1	IV	1	.	1	+	.	III	1	.	+	1	.	III
Myosotis scorpioides	.	.	.	.	.	.	+	+	.	+	+	IV	+	.	+	.	+	III	.	+	.	.	.	I
Nymphaea alba	.	.	.	.	.	.	+	+	.	1	A	IV	.	.	.	.	.	.	.	.	.	.	.	.
Polypogon monspeliensis	.	.	.	.	.	.	.	.	.	.	.	.	+	1	+	.	.	III	.	.	.	.	.	.
Iris pseudacorus	.	.	.	.	.	.	+	.	.	+	+	III	.	.	+	.	+	II	.	.	.	+	+	II
Oenanthe aquatica	.	.	.	.	.	.	.	+	+	.		II	+	.	.	.	.	I	.	.	.	.	+	I
Schoenoplectus lacustris	.	.	.	.	.	.	.	+	.	+	+	III	.	+	.	.	.	I	.	.	.	.	.	.
S. tabernaemontani	.	.	.	.	.	.	.	.	.	+	+	II	.	.	.	.	.	.	1	.	.	+	A	III
Bolboschoenus maritimus	.	.	.	.	.	.	.	.	+	.	1	II	.	+	+	.	.	II	.	.	.	.	.	.
Paspalum paspaloides	.	.	.	.	.	.	.	.	.	.	.	.	.	1	+	.	+	III	.	.	.	.	.	.
Ranunculus lingua	.	.	.	.	.	.	.	+	.	+	+	III	.	.	.	.	.	.	.	.	+	.	.	I
R. ophioglossifolius	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	B	.	+	III
Eleocharis palustris	.	.	.	.	.	.	.	+	+	.	+	III	.	.	.	.	.	.	+	+	.	.	.	II
Sparganium erectum	.	.	.	.	.	.	+	.	+	.	+	III	.	.	.	.	.	.	.	.	.	.	.	.
Peucedanum palustre	.	.	.	.	.	.	.	+	.	1	A	III	.	.	.	.	.	.	.	.	.	.	.	.
Berula erecta	.	.	.	.	.	.	.	.	.	.	1	I	.	.	.	.	.	.	1	.	1	.	.	II
Baldellia ranunculoides	.	.	.	.	.	.	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Caltha palustris	.	.	.	.	.	.	+	.	+	.	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Typha latifolia	.	.	.	.	.	.	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	.	.	.
Sonchus arvensis	.	.	.	.	.	.	.	.	.	+	1	II	.	.	.	.	.	.	.	.	.	.	.	.

C – constancy class. With constancy class I only: *Carex pseudocyperus* 8:3; *C. riparia* 20:+.

pseudacorus community builds homogeneous patches or stripes, which are part of the mosaic complex of Phragmition communities.

The floristic composition of Magnocaricion- and Glycerio-Sparganion- communities is shown in the tables 3 and 4. The communities Typhetum angustifoliae, Sparganio-Cyperetum longi and Hydrocotyle-Caricetum elatae occur in larger depressions with a water depth from 0.2–0.4 m. The Hydrocotyle-Caricetum elatae is the most species-rich (45) of all

Table 4. Glycerio-Sparganion BR.-BL. et SISSINGH 1942.
The indicating species of communities are note in bold.

	Sparganio-Cyperetum longi					
Relevé No.	1	2	3	4	5	C
Number of species	10	15	16	19	13	14.6
Sparganium erectum	**A**	**1**	+	**1**	**A**	**V**
Berula erecta	**A**	**B**	**1**	**1**	**A**	**V**
Ranunculus ophioglossifolius	**B**	+	+	**1**	**1**	**V**
Nasturtium officinale	**B**	.	**1**	+	+	**IV**
Epilobium parviflorum	+	**1**	.	+	+	**IV**
Myosotis scorpioides	.	+	+	+	+	IV
Cyperus longus	1	+	A	+	.	IV
Veronica beccabunga	.	+	A	1	.	III
V. anagallis-aquatica	+	.	1	+	.	III
Bolboschoenus maritimus	.	+	.	+	+	III
Sium latifolium	+	.	+	.	+	III
Alisma plantago-aquatica	+	.	+	.	+	III
Schoenoplectus tabernaemontani	.	+	.	+	1	III
Paspalum paspaloides	.	+	+	+	.	III
Ranunculus lingua	.	+	.	+		II
Butomus umbellatus	.	+	.	+	.	II
Oenanthe aquatica	.	+	+	.	.	II
Mentha aquatica	1	.	.	1	.	II
Hippuris vulgaris.	.	.	+	+	.	II
Agrostis stolonifera	.	.	+	+	.	II
Lycopus europaeus	.	+	.	.	+	II
Stachys palustris	.	+	+	.	.	II
Lythrum salicaria	.	.	+	+	.	II

C - constancy class. With constancy class I only: *Calystegia sepium* 4:+; *Juncus articulatus* 5:+; *Nymphaea alba* 5:1.

the marsh communities in the wetland. In the northern part of the park, stands of this community are in contact with Mariscetum serrati, and in less wet habitats with Bidention tripartiti, Menthion pulegii (Bidentetea tripartiti) or Fimbristylion dichotomae communities. The ecological optimum of *Typha angustifolia* is in standing water located outside dikes (in the Karaotok area).

Mariscetum serrati is very frequent in standing waters whose maximum depth is up to 0.2 m. The soil surface can be periodically dry for short periods in summer. The community is of great ecological importance, as it is a valuable habitat for nesting birds.

The water level in the stands of Scirpetum tabernaemontani, Bolboschoenetum maritimi and Cyperetum longi varies most frequently between 0–0.1(–0.2) m. Scirpetum tabernaemontani covers relatively limited areas. Most frequently, this community is in contact with Mariscetum serrati and Bolboschoenetum maritimi. Bolboschoenetum maritimi is one of the pioneer helophyte communities, which indicates a terrestrialization process of the periodically flooded ditches. The Cyperetum longi colonizes large areas in depressions, mostly in the western and northern parts of the park.

Table 5. Fimbristylion dichotomae HORVATIĆ 1954.
The indicating species of communities are noted in bold.

	Cypero-Paspaletum digitarii (=distichi)						Dichostyli-Fimbristyletum dichotomae						Paspaleto-Leersietum oryzoidis			
Relevé No.	1	2	3	4	5	C	6	7	8	9	10	C	11	12	13	
Number of species	28	21	17	21	17	**20.8**	24	16	14	13	13	**16**	23	19	7	**19.6**
Veronica anagalloides	+	+	**A**	+	**1**	**V**	.	.	.	.	.	.	+	+	.	
Lotus tenuis	+	+	+	**1**	+	**V**	.	.	.	.	.	.	1	1	A	
Bidens tripartita	+	.	+	+	+	**IV**	.	.	.	.	.	.	.	.	.	
Xanthium strumarium	+	.	+	.	+	**III**	.	.	.	.	.	.	.	.	.	
Polygonum lapathifolium	.	+	+	+	**1**	**IV**	.	.	.	.	.	.	+	+	.	
Fimbristylis dichotoma	.	1	.	+	.	II	**1**	**A**	**B**	**3**	**3**	**V**	.	.	.	
Crypsis alopecuroides	+	.	+	.	.	II	**+**	**1**	**.**	**+**	**1**	**IV**	.	.	.	
Cyperus flavescens	1	+	1	.	+	IV	**1**	**+**	**A**	**1**	**+**	**V**	.	.	.	
C. michelianus	+	.	.	.	.	I	**1**	**+**	**+**	**B**	**+**	**V**	.	.	.	
Leersia oryzoides	.	.	.	.	.	.	.	.	.	.	.	.	**A**	**B**	**A**	
Paspalum paspaloides	B	B	1	1	1	V	1	A	1	+	.	IV	**3**	**3**	**1**	
Cyperus fuscus L.	1	A	+	.	.	III	1	+	+	.	.	III	.	.	.	
C. longus	+	+	.	.	.	II	+	.	.	.	+	II	.	.	.	
C. serotinus	.	.	.	.	.	.	.	.	.	+	.	I	.	.	.	
Veronica anagallis-aquatica	.	+	.	.	.	I	.	.	+	+	+	III	.	.	.	
V. beccabunga	.	.	.	+	.	I	+	.	.	.	+	II	.	.	.	
Eleocharis quinqueflora	+	.	+	3	4	IV	.	.	.	.	.	.	.	.	.	
E. palustris	.	.	+	+	.	II	.	.	.	.	.	.	.	.	.	
Trifolium fragiferum	.	.	.	.	.	.	+	.	A	1	.	III	1	1	A	
T. resupinatum	+	+	.	.	.	II	.	.	.	.	.	.	1	1	+	
Mentha pulegium	1	+	1	+	.	IV	+	+	+	.	+	IV	1	1	+	
M. aquatica	.	+	.	+	.	II	+	.	.	+	.	II	+	+	.	
Ludwigia palustris	+	.	1	.	.	II	+	.	.	.	.	I	+	1	.	
Plantago bellardii	+	1	.	1	1	IV	.	.	.	.	.	.	+	+	+	
P. major	.	.	.	.	.	.	1	+	A	+	.	IV	+	.	+	
Juncus bufonius	.	+	+	.	+	III	.	.	.	.	.	.	.	.	+	
J. compressus	+	.	+	.	+	III	.	+	+	.	.	II	.	.	.	
J. articulatus	+	.	.	.	+	II	1	A	+	.	.	III	.	.	.	
Centaurium pulchellum	.	+	.	+	.	II	+	.	.	.	+	II	+	+	+	
Echinochloa crus-galli	+	.	.	.	.	I	+	+	+	.	.	III	+	1	+	
Equisetum palustre	+	+	.	+	+	IV	.	.	.	.	.	.	.	.	.	
Lythrum salicaria .	+	.	+	.	.	II	.	.	.	.	.	.	.	.	.	
Baldellia ranunculoides	.	.	.	+	+	II	.	.	.	.	.	.	.	.	.	
Pulicaria vulgaris	+	.	.	+	.	II	.	.	.	.	.		.	.	.	
Senecio paludosus	.	+	.	.	+	II	.	.	.	.	.	.	+	+	.	
Polygonum hydropiper	.	+	.	+	.	II	.	.	.	.	.	.	+	1	.	
P. mite	.	.	.	+	.	I	.	.	.	.	.	.	+	.	+	
P. aviculare	.	+	.	.	.	I	.	A	.	.	+	II	.	.	.	
P. persicaria	.	.	.	.	+	I	+	A	.	1	.	III	.	.	.	
Agrostis stolonifera	.	.	.	.	.	.	1	.	.	+	+	III	+	1	+	
Rorippa sylvestris	+	.	.	+	.	II	+	+	.	.	+	III	.	.	.	
Alisma plantago-aquatica	+	+	.	.	.	II	+	+	.	.	+	III	.	.	.	
Rumex pulcher	+	.	+	.	.	II	A	.	+	.	.	II	.	.	.	
Setaria glauca	1	+	.	.	.	II	A	.	.	1	.	II	.	.	.	
Lycopus europaeus	+	.	.	+	.	II	+	+	1	.	.	III	.	.	.	
Teucrium scordium	+	.	.	.	+	II	+	.	.	.	.	I	.	.	.	
Phragmites australis	+	.	.	+	.	II	.	.	.	.	.	.	.	.	.	
Epilobium palustre	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	
Galium palustre	.	.	.	.	.	.	.	.	.	.	.	.	+	+	+	
Eupatorium cannabinum	.	.	.	.	.	.	.	.	.	.	.	.	+	+	1	
Myosotis scorpioides	.	.	.	.	.	.	.	.	.	.	.	.	+	.	+	
Lysimachia vulgaris	.	.	.	.	.	.	.	.	.	.	.	.	+	+	.	

C – constancy class

Phalaridetum arundinaceae grows on the external margins of the Krupa River branches and in terrain depressions on sandy or muddy soils (near Lake Škrka). Its habitats are temporarily flooded by high lake waters. Most often, it is limited to small patches between 20–50 m^2.

Isoëto-Nanojuncetea is a class of ephemeral, annual pioneer vegetation on soils with temporary flooding in the period from autumn to early spring. The Fimbristylion dichotomae communities (Table 5) are especially valuable because of the plant species, e.g. *Ludwigia palustris*, *Veronica anagalloides*, *Baldellia ranunculoides* etc., which are rare and endangered in Bosnia and Herzegovina (Šilić 1996). Cypero-Paspaletum digitarii grows on habitats regularly flooded in summer (water level is up to 0.1 m). It forms narrow stripes around the Lake Deran, it is in contact with the ass. Dichostyli-Fimbristyletum dichotomae. In both associations, the accompanying species *Paspalum paspaloides* is abundant. *Mentha pulegium* appears in great constancy in the relevés. The habitats of Dichostyli-Fimbristyletum dichotomae are quite wet even during summer. In dryer habitats, *Mentha pulegium* usually forms a separate community: Menthetum pulegii (Menthion pulegii, Bidentetalia tripartiti) (Lakušić & al. 1977). Paspaleto-Leersietum oryzoidis covers a surface area of 0.5 km^2. The soils are less waterlogged than the previous two associations. *Leersia oryzoides*, relatively rare species in this part of the Balkans (Hulina 1985), can be also found in the Hutovo Blato Natural Park on moist or wet, and in nitrogen rich habitats, as a component of the Bidention tripartiti communities, e.g. Leersio-Bidentetum.

5. Discussion and Conclusion

According to communities structure, the marshland vegetation in the Hutovo Blato natural park does not show serious degradation trends, despite the fact that the area is influenced by multiple human impacts. The importance of the Hutovo Blato wetland biotope is prominent when compared to the lower part of the Neretva River in Croatia (Ilijanić & Topić 1998). However, the correction of the Neretva River, where a few hydroelectric stations have been built in the upper reaches, the hydrologic changes in the consequence influence the vegetation growth and the distribution of the different communities in the wetland area. Habitat zonation brings about a zonation of plant communities in accordance to the water depth of the stands around the lakes (Fig. 3). These communities lay out characteristic strips that stretch from the shore line lakewards, where one community can partially encircle another type. During summer, especially in drought years, the water level of the Neretva River decreases because the water is retained in the accumulation areas of the hydroelectric reservoirs. In the period from June to September, the average monthly flow of the Neretva River is only 4-5 $m^3\ s^{-1}$ (annual average is 414 $m^3\ s^{-1}$)

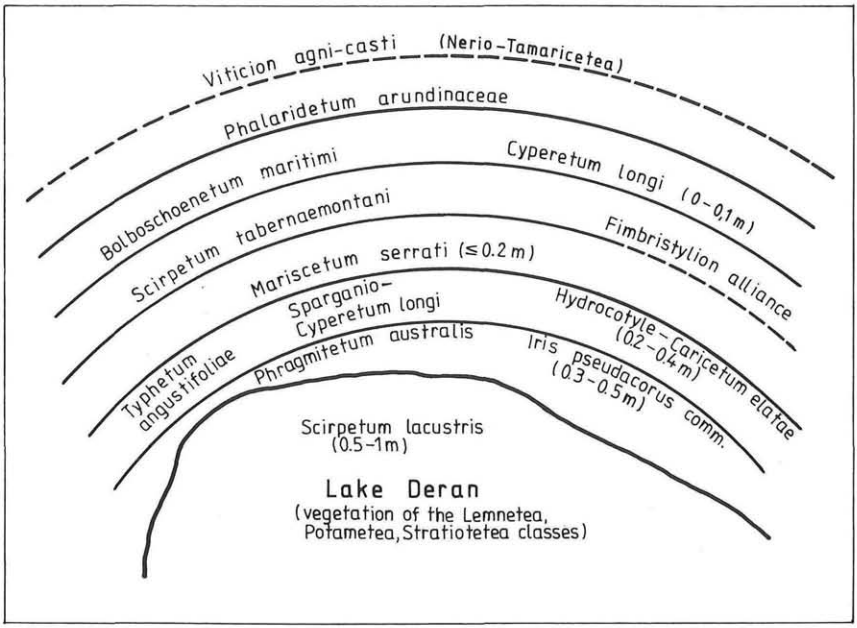

Fig. 3. The ideal zonation of communities of Phragmito-Magnocaricetea and Isoëto-Nanojuncetea classes around Lake Deran in the Hutovo Blato Natural Park.

(GLAMUZINA 1986, JURAČIĆ 1998). Also, many karstic springs located around the marsh edges, which support the region with water, run dry. So, terrestrial forms of many species can be observed in the dried-out habitats during summer. A number of communities in the Hutovo Blato Natural Park (Bolboschoenetum maritimi, Cyperetum longi, Sparganio-Cyperetum longi) contribute considerably to the terrestrialization of water-bodies. The very low water level in summer affects, and will continue to affect in future, life in this wetland, mainly through the concomitant heating of water and changes in water-quality parameters. Unfortunately, no detailed data exists about water chemistry, as one of the main factors controlling macrophyte distribution. Further studies will lead to a system of relationship between the distribution of plant communities (-species) and particular environmental variables.

6. Acknowledgements

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