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Vegetation of the natural park of Hutovo Blato (Neretva river delta, Bosnia and Herzegovina)

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In the park area stretching 74 km^2, the vegetation can be divided into 39 plant communities within the classes *Lemnetea*, *Potametea*, *Phragmito-Magnocaricetea*, *Isoëto-Nanojuncetea*, *Bidentetea tripartiti*, *Chenopodietea*, *Molinio-Arrhenatheretea*, *Querco-Fagetea* and *Paliuretea*. Although the park belongs to the Submediterranean vegetation zone, the aquatic vegetation is not significantly different from the one found in the inland Balkan Peninsula. The overall picture of vegetation in the Hutovo Blato wetland does not show serious degradation trends, despite the fact that the area is influenced by multiple human impacts.

Key words: vegetation, Hutovo Blato wetland, Neretva river delta, Bosnia and Herzegovina.

Introduction

The most extensive wetlands in the Mediterranean are alluvial flood plains, coastal lagoons, and deltas of main rivers flowing down from nearby high mountain regions (Britton & Crivelli, 1993). A typical example of such deltas is found on the eastern coast of the Adriatic Sea. The Neretva river is 218 km long, with a source located deeply in the hinterland of Bosnia and Herzegovina. Its discharge into the middle Adriatic Sea has created a vast delta whose surface area covers a total of 170 km^2 (Fig. 1). The Neretva river delta stretches through both countries, Croatia and Bosnia and Herzegovina, 30% of its area belonging to Bosnia and Herzegovina.

The Hutovo Blato wetland is one of the most important parts of the Neretva River delta in Bosnia and Herzegovina. This area was evaluated as a natural park in 1995 and intentions are to list it in the Ramsar Convention as an internationally protected wetland. The park area is situated 20 km inland from the Adriatic Sea, along the frontier between Bosnia and Herzegovina and Croatia.

Two principal types of ecosystems predominate in the park, the aquatic (60% of the total surface area of the park) and the terrestrial. The particular floristic and physiognomic features of the various plant assemblages in both ecosystems, with a special emphasis on the former that comprises the nucleus of the park, i.e. the Hutovo Blato wetland, are described below.

The vegetation cover of the Neretva river delta has been poorly investigated. Some published data exist on the water and marsh vegetation from the lower (Croatian) part of the Neretva river delta (Horvatić, 1954, 1963; Horvat et al., 1974; Ilijanić & Topić, 1998; Jasprica & Kovačić, 2000; Kovačić & Jasprica, 2000), while data on the upper reaches of the delta are scarce (Riter-Studnička, 1975; Lovrić & Rac, 1989).

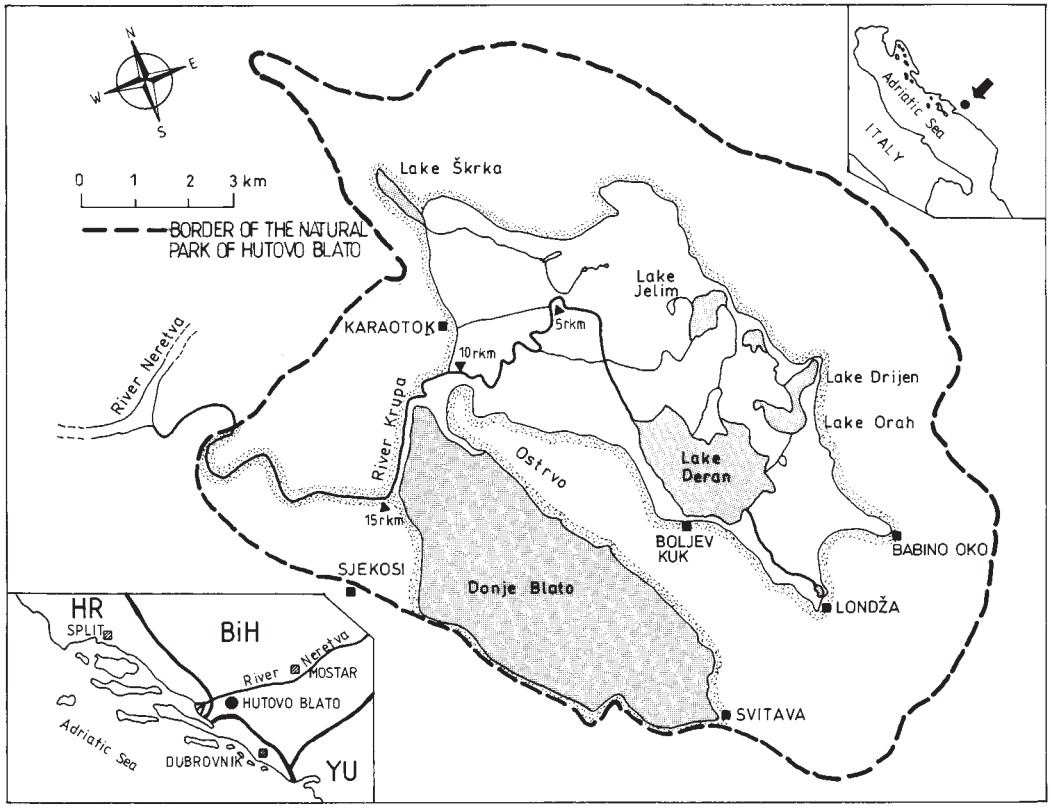

Fig. 1. The location of the natural park of Hutovo Blato.

Area of investigation

The total area of the Hutovo Blato Park covers 74 km^2. The geology consists mostly of Cretaceous and Eocene limestone (Juračić, 1998). There are six lakes in the park: Škrka, Jelim, Drijen, Orah and Deran, and Donje Blato the latter being an accumulation lake. Most of these lakes are shallow (1–2 m depth), except for Lake Jelim (max. depth of 17 m). The altitudinal range of the area is between the sea level and 3 m. The water masses of these lakes originate from numerous karstic springs that are very active from autumn to late spring. The main waterway in the wetland is the Krupa River, 20 km long. It originates in the western region of Lake Deran and flows through the plain area towards the Neretva river. 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. Almost the entire valley is flooded in this period, if not all of it. Over the last few decades, numerous anthropogenic influences have significantly changed the hydrological regime, which has also affected water quality (Štambuk-Giljanović, 1998). During winter 2000, the oxygen saturation in lakes and in the Krupa River ranged from 0.76 to 0.98. The nutrient concentrations (μmol L^{-1}) ranged for reactive silicate 27.00–67.20, reactive phosphorus 0.05–0.17, total phosphorus 0.10–0.20, ammonia 1.03–1.59, nitrite 0.03–0.07, nitrate 26.78–57.58, and total nitrogen 30.74–62.65, respectively.

The climate is mostly warm and dry. The mean annual air temperature is 14.7 °C (data for Karaotok station for the period 1946–1976, recorded by Meteorological and Hydrological Service of Bosnia and Herzegovina). The highest daily average temperature is 24.6 °C in July, and the lowest one falls below 6.0 °C in January. The absolute minimum temperature (−9.6 °C) was recorded in January, and the absolute maximum (42.0 °C) in August. The total annual precipitation is 1148

mm. The highest quantity of rainfall is in the period from November to February. In the period from June to August the rainfall quantity is 152 mm. Southern winds prevail in the park region. They are particularly frequent in autumn and spring. In winter, the frequent northern wind called "bura" significantly decreases the relative air humidity. This area has 2300 hours of sunshine approximately per year. Phytogeographically, this area belongs to the Submediterranean vegetation zone of hop and oriental hornbeam forests (the *Ostryo-Carpinion orientalis* alliance), mainly communities of shrub forests of pubescent oak and oriental horn-beam (the *Querco-Carpinetum orientalis* association).

Methods

Field investigations were carried out throughout the years 2000 and 2001. Methods of the Zürich-Montpellier school (Braun-Blanquet, 1964) were applied for analyses of vegetation in the field and for a synthesis of phytocoenological relevés. Characteristic species of the association (Char. Ass.), alliance, order and class (Char. All., O., Cl.), as well as the dominant and important companions (Comp.), are listed in the phytocoenological tables, based on 6–12 vegetation records for each association. Degree of presence is noted for each species (I-V). A total of 344 phytocoenological relevés were done in more than 50 localities in the park, which encompassed its entire area. The nomenclature of syntaxa follows Horvat et al. (1974) modified by Trinajstić (1991) and Balátova-Tuláčková et al. (1993). The nomenclature of taxa follows Pignatti (1982). Nutrient concentrations and dissolved oxygen in the lakes and the Krupa River were measured using standard methods (Apha et al., 1995).

Results

Syntaxonomic survey of plant communities

Class *LEMNETEA* R. Tx. 1955
- Order *Lemnetalia minoris* R. Tx. 1955
  - Alliance *Lemnion minoris* R. Tx. 1955
    - 1. Ass. *Lemno-Utricularietum vulgaris* Soó (1928) 1938
  - Alliance *Lemnion trisulcae* Den Hartog et Segal 1964
    - 2. Ass. *Lemnetum trisulcae* Knapp et Stoppers 1962
- Order *Hydrocharietalia* Rübel 1933
  - Alliance *Hydrocharition* Rübel 1933
    - 3. Ass. *Hydrocharietum morsus-ranae* van Langendonck 1935

Class *POTAMETEA* R. Tx. et Preising 1942
- Order *Potametalia* W. Koch 1926
  - Alliance *Nymphaeion albae* Oberd. 1957
    - 4. Ass. *Myriophyllo-Nupharetum* W. Koch 1926
    - 5. Ass. *Nymphoidetum peltatae* Oberd. et Th. Müller 1960
    - 6. Ass. *Hottonietum palustris* R. Tx. 1937
  - Alliance *Potamion eurosibiricum* W. Koch 1926
    - 7. Ass. *Potameto-Najadetum* Horvatić et Micevski 1960
    - 8. Ass. *Ceratophyllo-Potametum crispi* Horvatić et Micevski 1960
    - 9. Ass. *Ranunculo-Callitrichetum vernae* Bajić 1978
    - 10. Ass. *Elodeetum canadensis* Eggler 1933
    - 11. Ass. *Potametum natantis* Lkšić. et Pavlović 1976

Class *PHRAGMITO-MAGNOCARICETEA* Klika in Klika et Novák 1941
- Order *Phragmitetalia* W. Koch 1926
  - Alliance *Phragmition* W. Koch 1926
    - 12. Ass. *Phragmitetum australis* Soó 1927 nom. mut. propos.
    - 13. Ass. *Scirpetum lacustris* Chouard 1924
    - 14. Ass. *Scirpetum tabernaemontani* Pass. 1964
    - 15. Ass. *Bolboschoenetum maritimi* Br.-Bl. 1931
    - 16. Ass. *Typhetum angustifoliae* Pignatti 1953
    - 17. Ass. *Iris pseudacorus* comm.
  - Alliance *Magnocaricion* W. Koch 1926
    - 18. Ass. *Mariscetum serrati* Zobrist 1935 (=*Cladietum marisci*)
    - 19. Ass. *Hydrocotyle-Caricetum elatae* Horvatić 1962
    - 20. Ass. *Phalaridetum arundinaceae* Libbert 1931
    - 21. Ass. *Cyperetum longi* Micevski 1957
  - Alliance *Glycerio-Sparganion* Br.-Bl. et Sissingh 1942
    - 22. Ass. *Sparganio-Cyperetum longi* Horvatić 1939

Class *ISOËTO-NANOJUNCETEA* Br.-Bl. et R. Tx. 1943 Order *Isoëtetalia* Br.-Bl. 1931
- Alliance *Fimbristylion dichotomae* Horvatić 1954
  - 23. Ass. *Cypero-Paspaletum digitarii (=distichi)* Horvatić 1954
  - 24. Ass. *Dichostyli-Fimbristyletum dichotomae* Horvatić 1954
  - 25. Ass. *Paspaleto-Leersietum oryzoidis* Bajić 1978

Class *BIDENTETEA TRIPARTITI* R. Tx. et al. in R. Tx. 1950
Order *Bidentetalia tripartiti* Br.-Bl. et R. Tx. ex Klika et Hadač 1944
Alliance *Bidention tripartiti* Nordhagen 1940 em. R.Tx. in Poli et R.Tx. 1960
26. Ass. *Bidentetum tripartiti* W. Koch 1926
27. Ass. *Leersio-Bidentetum* (W. Koch 1926) Poli et R. Tx. 1960
Alliance *Menthion pulegii* Lkšić. 1973
28. Ass. *Menthetum pulegii* Lkšić. 1973
Class *CHENOPODIETEA* Br.-Bl. 1951
Order *Chenopodietalia* Br.-Bl. (1931) 1936
Alliance *Chenopodion muralis* Br.-Bl. (1931) 1936
29. Ass. *Urtico-Sambucetum ebuli* Br.-Bl. 1936
30. Ass. *Carduo-Silybetum mariani* Trinajstić 1979
Alliance *Hordeion* Br.-Bl. (1931) 1947
31. Ass. *Scolymo-Marubietum incani* Horvatić et Hodak 1965
Class *MOLINIO-ARRHENATHERETEA* R. Tx. 1937
Order *Trifolio-Hordeetalia* Horvatić 1963
Alliance *Trifolion resupinati* Micevski 1957
32. Ass. *Hordeeto-Caricetum distantis* Micevski 1957
33. Ass. *Poeto-Trifolietum fragiferi* Micevski 1968
Class *QUERCO-FAGETEA* Br.-Bl. et Vlieger 1937
Order *Quercetalia pubescentis*Br.-Bl. (1931) 1932
Alliance *Ostryo-Carpinion orientalis* Horvat (1954) 1958 (incl. *Paliuro-Petterion* p.p. Fukarek 1962)
34. Ass. *Querco-Carpinetum orientalis* Horvatić 1939 (incl. *Petterietum ramentacae* Fukarek 1962, *Juniperetum oxycedrii* Fukarek 1962, *Punicetum hercegovinicum* Fukarek 1962)
35. Ass. *Quercetum trojanae* Em. 1958
Order *Populetalia* Br.-Bl. 1931
Alliance *Salicion* (Soó) Oberd. 1953
36. Ass. *Salicetum purpureae* Wendbg. 1952
Alliance *Viticion agni-casti* Lkšić. 1980
37. Ass. *Periploco-Viticetum agni-casti* Lkšić. 1980
38. Ass. *Rubo-Viticetum agni-casti* Lkšić. et al. 1980
Class *PALIURETEA* Trinajstić 1978
Order *Paliuretalia* Trinajstić 1978
Alliance *Paliurion adriaticum* Trinajstić 1978
39. Ass. *Paliuretum adriaticum* Horvatić 1958

Aquatic and marsh vegetation

Ass. *Lemno-Utricularietum vulgaris* Soó 1928 (1938) develops in shallow channels and depressions at many localities throughout the park. Its floristic composition is poor. The predominant species is *Utricularia vulgaris* (Tab. 1).

Ass. *Lemnetum trisulcae* Knapp et Stoppers 1962 develops under conditions of low light intensity. It lies under the water surface, making a layer several centimeters thick in shallow stagnant water, especially during summer. The association is only present together with the species *Lemna minor* (Tab. 1). *Lemna minor* covers the water surface, while *L. trisulca* floats directly underneath.

Ass. *Hydrocharietum morsus-ranae* van Langendonck 1935 develops along the shallower drainage channels around Lake Škrka from June to August. The floristic composition is relatively rich owing to a group of companions (Tab. 1).

Ass. *Myriophyllo-Nupharetum* W. Koch 1926 is a very widespread community that develops in deep stagnant waters. Most frequently, it

Table 1. The vegetation of the class *Lemnetea*.

Associations	1	2	3
Number of relevés	6	8	6
Char. Ass.			
Utricularia vulgaris L.	IV	.	.
Lemna trisulca L.	I	V	.
Hydrocharis morsus-ranae L.	.	.	V
Char. All., O., Cl.			
Lemna minor L.	I	III	.
Comp.			
Chara hispida L.	I	.	II
Nitella sp.	II	.	.
Schoenoplectus lacustris (L.) Palla	.	I	.
Potamogeton pussilus L.	.	.	III
Alisma plantago-aquatica L.	.	.	II
Nuphar lutea (L.) Sm.	.	.	II
Myriophyllum verticillatum L.	.	.	I
Potamogeton lucens L.	.	.	I

1 *Lemno-Utricularietum vulgaris*, 2 *Lemnetum trisulcae*, 3 *Hydrocharietum morsus – ranae*, (1 *Lemnion minoris*, 2 *Lemnion trisulcae*, *Lemnetalia minoris*, 3 *Hydrocharition*, *Hydrocharietalia*)

Table 2. The vegetation of the class *Potametea*.

Associations	1	2	3	4	5	6	7	8
Number of relevés	12	6	6	10	12	10	9	7
Char. Ass.								
Nymphaea alba L.	V	.	.	.	.	.	I	.
Myriophyllum verticillatum L.	II	.	.	.	.	II	.	.
Nymphoides peltata (Gmel.) Kuntze	.	V	.	.	.	.	.	.
Hottonia palustris L.	.	.	V	.	.	.	.	.
Najas marina L.	I	.	.	V	.	.	.	.
Potamogeton crispus L.	III	.	.	.	V	III	.	.
Callitriche palustris L.	.	.	.	.	.	V	.	.
Elodea canadensis Michx.	.	.	.	.	.	.	V	.
Potamogeton natans L.	I	.	.	.	.	.	.	V
Char. All., O., Cl.								
Ceratophyllum demersum L.	IV	.	II	V	IV	II	.	.
Nuphar lutea (L.) Sm.	IV	II	III	.	.	.	I	I
Polygonum amphibium L.	.	III	.	.	.	II	.	.
Myriophyllum spicatum L.	III	.	.	III	.	.	.	.
Potamogeton pectinatus L.	III	.	.	III	.	.	.	.
Potamogeton fluitans Roth.	II	.	.	.	IV	.	.	.
Potamogeton pussilus L.	.	.	.	.	V	III	.	.
Ceratophyllum submersum L.	III	.		.	.	.	.	.
Najas minor All.	II	.	.	.	.	II	.	.
Potamogeton lucens L.	III	.	.	I	.	.	.	.
Ranunculus trichophyllus Chaix	.	.	.	.	.	V	.	.
Callitriche stagnalis Scop.	.	.	.	.	.	II	.	.
Potamogeton perfoliatus L.	.	.	.	IV	.	.	.	.
Potamogeton acutifolius Link	II	.	.	.	.	.	.	.
Hippuris vulgaris L.	I	.	.	.	.	.	.	.
Zannichelia palustris L.	I	.	.	.	.	.	.	.
Comp.								
Chara hispida L.	.	.	.	.	I	V	.	.
Veronica beccabunga L.	.	.	.	.	.	II	.	I
Fontinalis antipyretica L.	.	.	.	.	.	IV	.	.
Rorippa amphibia (L.) Besser	.	.	.	.	.	III	.	.
Lemna trisulca L.	.	.	.	.	.	III	.	.
Alisma plantago-aquatica L.	.	.	.	.	.	II	.	.
Sium latifolium L.	.	.	.	.	.	II	.	.
Utricularia vulgaris L.	II	.	.	.	.	.	.	.
Paspalum paspaloides (Michx.) Scribner	.	.	.	.	.	.	.	I

1 *Myriophyllo-Nupharetum*, 2 *Nymphoidetum peltatae*, 3 *Hottonietum palustris*, 4 *Potameto-Najadetum*, 5 *Ceratophyllo-Potametum crispi*, 6 *Ranunculo-Callitrichetum vernae*, 7 *Elodeetum canadensis*, 8 *Potametum natantis*, (1–3 *Nymphaeion albae*, 4–8 *Potamion eurosibiricum*, *Potametalia*)

covers a surface area between 25 and 40 m^2. The community is characterized by a carpet of large leaves and flowers of the species *Nuphar lutea* and *Nymphaea alba*. Also, *Myriophyllum verticillatum* and *Ceratophyllum demersum* are common species (Tab. 2).

Ass. *Nymphoidetum peltatae* Oberd. et Th. Müller 1960 is sparsely distributed on the border of the park. It colonizes shallow stagnant waters (0.5–1.0 m depth) in the summertime. Usually, there is 100% coverage by the characteristic species *Nymphoides peltata*, with no other species apparent (Tab. 2). This community was found, along with the association *Hydrocharidi-Nymphoidetum peltatae*, in the lower Neretva river delta (Ilijanić & Topić, 1998).

Ass. *Hottonietum palustris* R. Tx. 1937 appears sometimes sporadically in Lake Deran. The dominant species *Hottonia palustris* was accompanied by *Nuphar lutea* and *Ceratophyllum demersum* (Tab. 2).

Ass. *Potameto-Najadetum* Horvatić et Micevski 1960 is quite a rare community. It develops in the shallower and warmer river branches, and in slowly fluctuating waters. The *Potameto-Najadetum* is species-poor. The *Najas marina*,

Potamogeton perfoliatus and *Ceratophyllum demersum* species are the most important constituent species (Tab. 2).

Ass. *Ceratophyllo-Potametum crispi* Horvatić et Micevski 1960 can be found frequently within the Submediterranean vegetation zone (Horvatić, 1963). It spreads along trenches and channels with slow fluctuating waters, and along marsh edges. The community is rare in Hutovo Blato and is made up of few species. The floristic composition is shown in Table 2.

Ass. *Ranunculo-Callitrichetum vernae* Bajić 1978 develops near springs and slow fluctuating waters in May. The dominant species are *Ranunculus trichophyllus* and *Callitriche palustris* (Tab. 2). The bryophyte *Fontinalis antipyretica* and the charophyte *Chara hispida* are companions with the greatest constancy.

Ass. *Elodeetum canadensis* Eggler 1933 is very common in Donje Blato, in channels with fast fluctuating water. The dominant and characteristic species of the association is *Elodea canadensis* (Tab. 2).

Ass. *Potametum natantis* Lkšić. et Pavlović 1976 appears sporadically in the drainage channels in Donje Blato. Also, it colonizes mesotrophic stagnant water on the border of the park, near the Neretva river. The floristic composition is shown in Table 2.

Ass. *Phragmitetum australis* Soó 1927 belongs to the most frequent reed communities in the studied area. It grows around lakes (depth of 0.3–0.5 m) in dense and occasionally impenetrable stands. They can be easily recognized on account of the complete plant coverage by *Phragmites australis*. The community entails numerous species (Tab. 3). The participation of the following species is considered essential: *Calystegia sepium*, *Galium palustre*, *Sium latifolium*, *Schoenoplectus triqueter* and *Cladium mariscus*. *Phragmitetum australis* often represents the first silting stage of standing waters.

Ass. *Scirpetum lacustris* Chouard 1924 colonize the deepest waters (0.5–1 m) in reeds. *Scirpetum lacustris* is species-poor (Tab. 3). *Schoenoplectus lacustris* dominates in the community, and *Rorippa amphibia* and *Polygonum amphibium* participate significantly in the floristic composition. The community stands are found scattered over the entire studied area in oxbows in the form of small patches.

Ass. *Scirpetum tabernaemontani* Pass. 1964 develops on moist and weakly salinized soils. Generally, it covers relatively limited areas, most of the northeastern periphery of Gornje Blato. It is best developed on the shores of the lakes Škrka and Jelim. The surface covered by this plant community varies locally from 25 to 40 m^2. The floristic composition is shown in Table 3.

Ass. *Bolboschoenetum maritimi* Br.-Bl. 1931 grows in the mild terrain depressions. It is one of the pioneer helophytic communities, which indicates a terrestrialization process of the periodically flowing arms. The floristic composition is shown in Table 3.

Ass. *Typhetum angustifoliae* Pignatti 1933 develops in waters up to 0.3 m in depth. The ecological optimum of *Typha* is in the standing waters located outside dikes (in the Karaotok area). In this community, there are almost no water vegetation plants (Tab. 3).

The *Iris pseudacorus* community occurs on moist long-flooded habitats, where it builds homogeneous patches or strips, which are a part of a mosaic complex of *Phragmition* communities. It grows in drainage ditches in Lake Deran in water depths of 0.3–0.5 m. It is mostly only fragmentarily developed (Tab. 3).

Ass. *Mariscetum serrati* Zobrist 1935 is very widespread in the park in standing waters whose maximum depth is up to 0.2 m. The community is of great ecological importance, as it is a valuable habitat for nesting birds. The floristic composition is shown in Table 3.

Ass. *Hydrocotyle-Caricetum elatae* Horvatić 1962 occurs in the larger depressions. The water level in the community varies from 0.2–0.4 m. Of all the marsh communities in the wetland, this community has the greatest number of species (Tab. 3). The community has many similarities with the inland community *Caricetum elatae*, but it can still be quite clearly differentiated by the presence of characteristic and differential species (i.e. *Cyperus longus*, *Althaea officinalis*, *Samolus valerandi* and others).

Ass. *Phalaridetum arundinaceae* Libbert 1931 grows on the external margins of the Krupa River branches and in terrain depressions on sandy or muddy soils. Its habitats are temporarily flooded. Balátová-Tuláčková (1968) considered large differences in the groundwater level during the year to be characteristic of this community. Except for the dominating *Phalaris arundinacea*, *Alisma plantago-aquatica* occurs constantly in this community alongside other species of bordering communities *Cyperetum longi* and *Sparganio-Cyperetum longi* (Tab. 3).

Ass. *Cyperetum longi* Micevski 1957 is a relatively species-rich community, colonizing large areas in depressions, mostly in the western and

Table 3. The vegetation of the class *Phragmito-Magnocaricetea*.

Associations	1	2	3	4	5	6	7	8	9	10	11
Number of relevés	12	12	12	12	7	6	12	12	7	12	12
Char. Ass.											
Phragmites australis (Cav.) Trin.	V	.	.	I	.	.	II	I	.	.	.
Schoenoplectus lacustris (L.) Palla	I	V	.	.	.	.	.	II	I	.	.
Schoenoplectus tabernaemontani (Gmel.) Palla	.	.	V	III	.	.	.	II	.	I	II
Bolboschoenus maritimus (L.) Palla	.	.	III	V	.	.	.	I	I	.	II
Typha angustifolia L.	I	.	.	.	V	.	II	I	.	I	.
Iris pseudacorus L.	I	.	.	.	.	V	.	III	.	.	.
Cladium mariscus (L.) Pohl.	I	.	II	.	.	.	V	III	.	.	.
Carex elata All.	.	.	III	.	.	.	.	V	.	I	.
Phalaris arundinacea L.	.	.	.	.	.	.	.	II	V	.	.
Cyperus longus L.	.	.	II	III	.	.	I	IV	.	V	IV
Sparganium erectum L.	.	III	.	.	.	.	.	I	.	.	V
Char. All., O., Cl.											
Oenanthe aquatica (L.) Poiret	II	II	.	I	III	I	.	II	I	I	II
Lythrum salicaria L.	I	.	.	III	III	II	II	IV	III	II	II
Mentha aquatica L.	.	.	II	III	.	III	III	IV	IV	III	II
Alisma plantago-aquatica L.	II	.	I	III	III	.	.	III	V	III	III
Galium palustre L.	III	.	.	III	.	III	III	IV	I	I	.
Sium latifolium L.	III	II	.	.	.	.	III	II	III	.	III
Ranunculus lingua L.	.	III	.	II	.	I	.	III	.	I	II
Stachys palustris L.	.	.	.	.	III	V	III	IV	III	.	II
Lycopus europaeus L.	II	.	.	.	IV	.	II	III	.	I	II
Hydrocotyle vulgaris L.	II	.	I	III	.	.	III	V	.	.	.
Calystegia sepium (L.) R. Br.	V	.	.	.	IV	.	.	IV	.	II	.
Thelypteris palustris Schott	II	.	III	.	.	.	III	V	.	.	.
Rorippa amphibia (L.) Bess.	.	V	.	.	III	IV	.	.	III	.	.
Euphorbia palustris L.	II	.	.	.	.	.	.	V	III	III	.
Typha latifolia L.	II	.	.	.	III	.	.	II	.	.	.
Ranunculus ophioglossifolius Vill.	.	.	.	.	.	.	.	.	.	III	V
Schoenoplectus triqueter (L.) Palla	III	II	.	.	.	.	.	.	.	.	.
Peucedanum palustre (L.) Moench	.	.	.	.	.	.	.	III	.	.	.
Butomus umbellatus L.	.	.	.	.	.	.	.	.	.	.	II
Nasturtium officinale R. Br.	.	.	.	.	.	.	.	.	.	.	IV
Epilobium parviflorum Schreber	.	.	.	.	.	.	.	.	.	.	IV
Comp.											
Agrostis stolonifera L.	.	.	.	IV	III	.	I	III	III	II	II
Lysimachia vulgaris L.	II	.	.	.	III	III	II	V	.	II	.
Samolus valerandi L.	II	.	III	II	.	.	III	IV	.	III	.
Polygonum amphibium L.	II	IV	.	.	III	IV	.	III	II	.	.
Gratiola officinalis L.	II	.	I	IV	.	.	II	IV	II	.	.
Eleocharis palustris (L.) R. et S.	I	.	III	III	.	.	.	III	.	II	.
Myosotis scorpioides L.	II	.	.	.	.	.	.	IV	III	I	IV
Paspalum paspaloides (Michx.) Scribner	.	.	II	II	.	.	.	.	III	.	III
Althaea officinalis L.	II	.	.	.	.	.	.	IV	III	III	.
Teucrium scordium L.	.	.	.	.	.	.	III	V	II	III	.
Juncus articulatus L.	II	.	.	II	.	.	II	III	.	.	.
Pulicaria vulgaris Gaertner	.	.	.	.	.	.	II	II	.	IV	.
Berula erecta (Hudson) Coville	.	.	.	.	.	.	.	I	.	II	V
Baldellia ranunculoides (L.) Parl.	.	.	.	III	.	.	.	II	.	.	.
Lysimachia nummularia L.	II	.	I	.	.	.	.	.	.	.	.
Chenopodium polyspermum L.	II	.	.	.	.	I	.	.	.	.	.
Polygonum hydropiper L.	.	II	.	.		I	.	.	.	.	.
Cirsium arvense (L.) Scop.	.	.	.	.	III	V	.	.	.	.	.
Eupatorium cannabinum L.	.	.	.	.	.	.	III	II	.	.	.
Leucojum aestivum L.	II	.	.	.	.	.	.	.	.	.	.
Potentilla reptans L.	II	.	.	.	.	.	.	.	.	.	.
Juncus subnodulosus Schrank	.	.	IV	.	.	.	.	.	.	.	.

Table 3. (continued)

Associations	1	2	3	4	5	6	7	8	9	10	11
Number of relevés	12	12	12	12	7	6	12	12	7	12	12
Juncus anceps Laharpe	.	.	.	III	.	.	.	.	.	.	.
Bidens tripartita L.	.	.	.	.	.	I	.	.	.	.	.
Molinia arundinacea Schrank	.	.	.	.	.	.	II	.	.	.	.
Solanum dulcamara L.	.	.	.	.	.	.	II	.	.	.	.
Scutellaria galericulata L.	.	.	.	.	.	.	.	V	.	.	.
Nymphaea alba L.	.	.	.	.	.	.	.	IV	.	.	.
Caltha palustris L.	.	.	.	.	.	.	.	II	.	.	.
Sonchus arvensis L.	.	.	.	.	.	.	.	II	.	.	.
Polypogon monspeliensis (L.) Desf.	.	.	.	.	.	.	.	.	III	.	.
Veronica beccabunga L.	.	.	.	.	.	.	.	.	.	.	III
Veronica anagallis-aquatica L.	.	.	.	.	.	.	.	.	.	.	III
Leersia oryzoides (L.) Swartz	.	.	.	.	.	.	.	.	.	.	II
Hippuris vulgaris L.	.	.	.	.	.	.	.	.	.	.	II

1 *Phragmitetum australis*, 2 *Scirpetum lacustris*, 3 *Scirpetum tabernaemontani*, 4 *Bolboschoenetum maritimi*, 5 *Typhetum angustifoliae*, 6 comm. *Iris psuedacorus*, 7 *Mariscetum serrati*, 8 *Hydrocotyle-Caricetum elatae*, 9 *Phalaridetum arundinaceae*, 10 *Cyperetum longi*, 11 *Sparganio-Cyperetum longi*, (1–6 *Phragmition*, 7–10 *Magnocaricion*, 11 *Glycerio-Sparganion*, *Phragmitetalia*)

northern parts of the park. The water level in this community varies most frequently between 0–0.2 m. The species *Cyperus longus* is dominant and gives the community a characteristic physiognomy (Tab. 3).

Ass. *Sparganio-Cyperetum longi* Horvatić 1939 grows in brook beds, drainage channels, trenches and deeper runlets. It forms small patches and strips. The habitats are flooded from spring to summer. The water level remains high (up to 0.4 m) in summer. The soils are swampy with a thick layer of organogenous material. The community contributes considerably to the terrestrialization of water-bodies. The floristic composition is shown in Table 3.

Ass. *Cypero-Paspaletum digitarii (=distichi)* Horvatić 1954 grows on habitats that are regularly flooded in summer. It forms narrow strips around Lake Deran. It borders with the ass. *Dichostyli-Fimbristyletum dichotomae*. In both associations, the accompanying species neophyte *Paspalum paspaloides* has great constancy (Tab. 4).

Ass. *Dichostyli-Fimbristyletum dichotomae* Horvatić 1954 is found around lakeshores. The soils are sandy, with pH 7.1. The habitats are quite wet, even during summer. *Mentha pulegium* appears in great constancy in the relevés (Tab. 4). In dryer habitats, it usually builds a separate community – *Menthetum pulegii*.

Ass. *Paspaleto-Leersietum oryzoidis* Bajić 1978 is recognized near springs in the Londža area. The surface covered by this community is 0.5 km^2. The soils are organogenously marshy, less wet than the previous two associations. Ecology of this community should be studied in more detail, considering that the *Leersia oryzoides* is a rare species of the Balkan Peninsula (Horvat et al., 1974). The floristic composition is shown in Table 4.

Terrestrial vegetation

Ruderal vegetation

Ass. *Bidentetum tripartiti* W. Koch 1926 covers the shoreline edges that dry out during summer, and which are submerged again in fall. It develops along the shores of the Krupa River and lakes in Gornje Blato, while it is rare in Donje Blato (Tab. 5).

Ass. *Leersio-Bidentetum* (W. Koch 1926) Poli et R. Tx. 1960 develops as a belt 1.5 m wide, with interruptions of marsh vegetation. Most frequently, it borders with the former community or willow wood. The hydrological regime of this community's habitat varies from flowing or stagnant waters to only visible wetness. The floristic composition is shown in Table 5.

Ass. *Menthetum pulegii* Lkšić. 1973 occupies wet soils and habitats similar to or identical to the associations of the *Fimbristylion dichotomae* alliance. The greatest stands are found between the terrestrial and marsh vegetation in the northern section of the park. The community is dominated by *Mentha pulegium* (Tab. 5).

Ass. *Urtico-Sambucetum ebuli* Br.-Bl. 1936 is closed plant community of tall hemicrypto-

Table 4. The vegetation of the class *Isoëto-Nanojuncetea*.

Associations	1	2	3
Number of relevés	10	10	6
Char. Ass.			
Paspalum paspaloides (Michx.) Scribner	V	IV	III
Veronica anagalloides Guss.	V	.	II
Lotus tenuis W. et K.	V	.	III
Crypsis alopecuroides (Pill. et M.) Schrader	II	IV	.
Fimbristylis dichotoma (L.) Vahl.	II	V	.
Cyperus flavescens L.	IV	V	.
Cyperus michelianus (L.) Delile	I	V	.
Xanthium strumarium L.	III	.	.
Char. Ass. O., Cl.			
Cyperus fuscus L.	III	III	.
Juncus bufonius L.	III	.	.
Comp.			
Mentha pulegium L.	IV	IV	III
Mentha aquatica L.	II	II	III
Ludwigia palustris (L.) Elliott	II	I	II
Centaurium pulchellum (Swartz) Druce	II	II	III
Echinochloa crus-galli (L.) Beauv.	I	III	III
Veronica anagallis-aquatica L.	I	III	.
Veronica beccabunga L.	I	II	.
Juncus compressus Jacq.	III	II	.
Juncus articulatus L.	II	III	.
Cyperus longus L.	II	II	.
Polygonum aviculare L.	I	II	.
Polygonum persicaria L.	I	III	.
Rorippa sylvestris (L.) Besser	II	III	.
Alisma plantago-aquatica L.	II	III	.
Rumex pulcher L.	II	II	.
Setaria glauca (L.) Beauv.	II	II	.
Lycopus europaeus L.	II	III	.
Teucrium scordium L.	II	I	.
Trifolium resupinatum L.	II	.	III
Plantago bellardii All.	IV	.	III
Senecio paludosus L.	II	.	II
Polygonum lapathifolium L.	IV	.	II
Polygonum hydropiper L.	II	.	II
Polygonum mite Schrank	I	.	II
Trifolium fragiferum L.	.	III	III
Agrostis stolonifera L.	.	III	III
Plantago major L.	.	IV	II
Bidens tripartita L.	IV	.	.
Equisetum palustre L.	IV	.	.
Eleocharis quinqueflora (Hartm.) Swartz	IV	.	.
Eleocharis palustris (L.) R. et S.	II	.	.
Lythrum salicaria L.	II	.	.
Baldellia ranunculoides (L.) Parl.	II	.	.
Pulicaria vulgaris Gaertner	II	.	.
Cyperus serotinus Rottb.	.	I	.
Leersia oryzoides (L.) Swartz	.	.	IV

1 *Cypero-Paspaletum digitarii (=distichi)*, 2 *Dichostyli-Fimbristyletum dichotomae*, 3 *Paspaleto-Leersietum oryzoidis*, (1–3 *Fimbristylion dichotomae*, *Isoëtetalia*)

Table 5. The vegetation of the class *Bidentetea tripartiti*.

Associations	1	2	3
Number of relevés	10	6	10
Char. Ass.			
Leersia oryzoides (L.) Swartz	.	V	.
Mentha pulegium L.	.	.	V
Char. All., O., Cl.			
Polygonum lapathifolium L.	IV	III	I
Bidens tripartita L.	V	IV	.
Bidens cernua L.	IV	II	.
Polygonum hydropiper L.	IV	IV	.
Polygonum mite Schrank	IV	I	.
Echinochloa crus-galli (L.) Beauv.	IV	I	.
Ranunculus sceleratus L.	III	I	.
Pulicaria vulgaris Gaertner	IV	.	I
Chenopodium glaucum L.	III	.	.
Abutilon teophrasti Med.	II	.	.
Atriplex latifolia Wahlenb.	II	.	.
Comp.			
Roripa sylvestris (L.) Besser	III	I	.
Mentha aquatica L.	.	III	I
Lycopus europaeus L.	.	III	I
Chenopodium album L.	II	.	.
Rumex pulcher L.	II	.	.
Sonchus oleraceus L.	II	.	.
Setaria glauca (L.) Beauv.	II	.	.
Xanthium strumarium L.	.	III	.
Lythrum salicaria L.	.	II	.
Myosotis scorpioides L.	.	II	.
Sparganium erectum L.	.	II	.
Iris pseudacorus L.	.	I	.
Alisma plantago-aquatica L.	.	I	.

1 *Bidentetum tripartiti*, 2 *Leersio-Bidentetum*, 3 *Menthetum pulegii*, (1–3 *Bidention tripartiti*, *Bidentetalia tripartiti*)

phyte herbs. It is medium species rich. It occurs on sunny or semi-shaded, nitrogen rich habitats, mostly near villages in the eastern section of the park. Table 6 shows the floristic composition.

Ass. *Carduo-Silybetum mariani* Trinajstić 1979 is sporadic and floristically medium rich plant community (Tab. 6). It develops on dump-sites.

Ass. *Scolymo-Marubietum incani* Horvatić et Hodak 1965 distributed in the Illyrian-Adriatic Karst area (Horvatić & Hodak, 1965), and occurs here in a few localities, mostly on the margins of roads and along paths. The floristic composition is shown in Table 6.

Meadow vegetation

The meadow vegetation is not spread over the entire territory of the park. There are two meadow

Table 6. The vegetation of the class *Chenopodietea*.

Associations	1	2	3
Number of relevés	10	12	12
Char. Ass.			
Sambucus ebulus L.	IV	.	.
Urtica dioica L.	V	.	.
Bromus sterilis L.	III	II	.
Galium aparine L.	III	I	.
Silybum marianum (L.) Gaertner	.	V	.
Marrubium incanum Desr.	.	.	V
Scolymus hispanicus L.	.	.	V
Lepidium graminifolium L.	.	.	II
Char. All., O., Cl.			
Ecbalium elaterium (L.) Rich. f.	III	I	.
Rumex pulcher L.	I	I	.
Sonchus oleraceus L.	I	I	.
Sisymbrium officinale (L.) Scop.	.	II	IV
Carduus pycnocephalus L.	.	III	II
Hordeum leporinum Link	.	I	IV
Malva sylvestris L.	.	I	II
Chenopodium murale L.	II	.	.
Amaranthus retroflexus L.	II	.	.
Poa annua L.	I	.	.
Conyza canadensis (L.) Cronq.	I	.	.
Ballota nigra L.	.	III	.
Foeniculum vulgare Miller	.	I	.
Plumbago europaea L.	.	I	.
Solanum tuberosum L.	.	I	.
Malva parviflora L.	.	I	.
Setaria virids (L.) Beauv.	.	.	IV
Digitaria sanguinalis (L.) Scop.	.	.	IV
Comp.			
Convolvulus arvensis L.	IV	II	.
Lamium maculatum L.	II	.	.
Plantago lanceolata L.	I	.	.
Verbena officinalis L.	I	.	.
Parietaria diffusa M. et K.	I	I	.
Papaver rhoeas L.	.	I	.
Rubus dalmaticus Tratt.	.	I	.
Petrorhagia saxifraga (L.) Link	.	.	V
Cynodon dactylon (L.) Pers.	.	.	V
Dactylis hispanca Roth	.	.	IV
Catapodium rigidum (L.) Hubbard	.	.	IV
Bromus hordeaceus L.	.	.	III
Lotus corniculatus L.	.	.	III
Sedum sexangulare L.	.	.	II
Geranium molle L.	.	.	II
Eryngium amethystinum L.	.	.	I

1 *Urtico-Sambucetum ebuli*, 2 *Carduo-Silybetum mariani*, 3 *Scolymo-Marrubietum incani*, (1–2 *Chenopodion muralis*, 3 *Hordeion*, *Chenopodietalia*)

communities in the park, ass. *Hordeeto-Caricetum distantis* Micevski 1957 and *Poeto-Trifolietum fragiferi* Micevski 1968. They occur along the lake shores and are mown regularly once a year. The floristic composition of these communities is shown in Table 7.

Table 7. The vegetation of the class *Molinio-Arrhenatheretea*.

Associations	1	2
Number of relevés	10	7
Char. Ass.		
Hordeum secalinum Schreber	V	.
Carex distans L.	V	.
Carex divisa Hudson	II	.
Trifolium fragiferum L.	.	V
Char. All., O., Cl.		
Trifolium resupinatum L.	II	II
Agrostis alba Auct.	III	I
Poa sylvicola Guss.	I	V
Lotus corniculatus L.	II	III
Orchis laxiflora Lam.	III	II
Bromus racemosus L.	II	II
Potentilla reptans L.	I	II
Orchis palustris Jacq.	I	II
Trifolium pratense L.	I	I
Trifolium repens L.	I	II
Lysimachia nummularia L.	.	II
Equisetum palustre L.	.	I
Daucus carota L.	.	I
Comp.		
Cynodon dactylon (L.) Pers.	II	I
Cichorium intybus L.	I	I
Taraxacum officinale Weber	I	I
Geranium dissectum L.	I	.
Galium verum L.	I	.
Sonchus asper (L.) Hill.	.	II
Medicago arabica (L.) Hudson	.	II
Sherardia arvenisis L.	.	I

1 *Hordeeto-Caricetum distantis*, 2 *Poeto-Trifolietum fragiferi*, (1–2 *Trifolion resupinati*, *Trifolio-Hordeetalia*)

Forest formations

Ass. *Querco-Carpinetum orientalis* Horvatić 1939 appears on karstic slopes around lakes. The most important constituent species are the deciduous small-sized trees *Carpinus orientalis* Mill. and *Ostrya carpinifolia* Scop. Many species of Mediterranean evergreen holm-oak forests (*Fraxino orni-Quercetum ilicis*) are present, due to the strong influence of the Mediterranean climate and negligible above sea level heights (to 432 m). These forests have been greatly affected by anthropogenic influences, so we can find all its fragmentary or completely developed regressive stages. The degradation is exceptionally great in the southeastern part of the park. The floristic composition of the community in this area and other localities in southern Bosnia and Herzegovina are well known and published elsewhere (cf. Lakušić et al., 1978).

Ass. *Quercetum trojanae* Em. 1958 develops in the form of small trees and shrubs. The Herzegovina-Dalmatian part of the disjunctive area of Macedonian oak is developed within pubescent-oak and oriental horn-beam forest. The community is fragmentarily developed and species-poor. In the park, this association is composed (six relevés) of the following species: Char. Ass.: *Quercus trojana* Webb (I), Char. All., O., Cl.: *Celtis australis* L. (II), *Acer monspessulanum* L. (II), *Petteria ramentacea* (Sieb.) Presl. (II), *Frangula rupestris* (Scop.) Schur (I), *Pistacia terebinthus* L. (I), Comp.: *Clematis flammula* L. (I), and others.

Ass. *Salicetum purpureae* Wendbg. 1952 borders between marshy and water communities, mostly along the Krupa River. The ground layer of this scrub vegetation is completely covered with herbaceous, mostly marsh plants. The floristic composition (six relevés) was as follows: Char. Ass.: *Salix purpurea* L. (V), *Salix alba* L. (I), Char. All., O., Cl.: *Fraxinus angustifolia* Vahl (I), Comp.: *Caltha palustris* L. (IV), *Carex elata* All. (III), *Lycopus europaeus* L. (III), *Leucojum aestivum* L. (II), *Solanum dulcamara* L. (II), *Galium palustre* L. (II), *Myosotis scorpioides* L. (II), *Stachys palustris* L. (I), *Euphorbia palustris* L. (I), *Mentha aquatica* L. (I), *Polygonum hydropiper* L. (I), and others.

Ass. *Periploco-Viticetum agni-casti* Lkšić. 1980 is the most thermophilic scrub community along the eastern coast of the South Adriatic, from the Neretva river to the Bojana River (Lakušić, 1980). It takes over the edge of the marsh itself, which separates the marsh vegetation from the terrestrial ones in the north and northeastern part of the park (Tab. 8).

Ass. *Rubo-Viticetum agni-casti* Lkšić. et al. 1980 appears in dryer places than the former community. It is mostly composed of xerophytes (Tab. 8).

Ass. *Paliuretum adriaticum* Horvatić 1958 originates from deciduous pubescent oak and oriental horn-beam forests due to degradation processes. The floristic composition (six relevés) was as follows: Char. Ass.: *Paliurus australis* Gaertner (V), Char. All., O., Cl.: *Punica granatum* L. (IV), *Rubus dalmaticus* Tratt. (IV), *Rhamnus intermedia* S. et H. (II), Comp.: *Euphorbia spinosa* L. (V), *Teucrium chamaedrys* L. (IV), *T. polium* L. (IV), *Satureja montana* L. (IV), *Eryngium amethystinum* L. (III), *Brachypodium pinnatum* (L.) Beauv. (III), *Petrorhagia saxifraga* (L.) Link (II), *Dactylis hispanica* Roth (II), *Carlina corymbosa* L. (I), *Phillyrea latifolia* L. (I), and others.

Table 8. The vegetation of the alliance *Viticion agnicasti*.

Associations	1	2
Number of relevés	9	6
Char. Ass.		
Periploca graeca L.	V	.
Char. All., O., Cl.		
Vitex agnus-castus L.	V	V
Ulmus laevis Pall.	I	.
Populus nigra L.	I	.
Comp.		
Humulus lupulus L.	IV	.
Vitis vinifera L. subsp. *sylvestris* (Gmel.) Hegi	II	.
Hedera helix L.	II	.
Solanum dulcamara L.	I	.
Rubus dalmaticus Tratt.	.	V
Asparagus acutifolius L.	.	II
Ruscus aculeatus L.	.	II
Cyclamen repandum S. et S.	.	I
Lonicera implexa Aiton	.	I

1 *Periploco-Viticetum agni-casti*, 2 *Rubo-Viticetum agni-casti*, (1–2 *Populetalia*, *Querco-Fagetea*)

Discussion and Conclusions

The results of two-year survey on the vegetation of the natural park of Hutovo Blato can be summarized as follows:

1. There are various types of biotopes in the area, conditioning the diversity of plant communities. The vegetation consists of 39 plant communities belonging to the classes *Lemnetea*, *Potametea*, *Phragmito-Magnocaricetea*, *Isoëto-Nanojuncetea*, *Bidentetea tripartiti*, *Chenopodietea*, *Molinio-Arrhenatheretea*, *Querco-Fagetea* and *Paliuretea*.
2. The largest part of this area is covered by the association *Phragmitetum australis* and by communities of the alliance *Magnocaricion*. Although the park belongs to the Submediterranean vegetation zone, the aquatic vegetation is not significantly different from the one found in the inland Balkan Peninsula. Valuable marsh plant communities provide suitable biotopes for the breeding and resting of water birds.
3. The *Fimbristylion dichotomae* communities are especially valuable because of the rare and endangered Bosnia and Herzegovina plants, e.g. *Ludwigia palustris*, *Veronica anagalloides, Baldellia ranunculoides* etc. (Šilić, 1996).
4. The overall picture of the vegetation in the Hutovo Blato wetland does not show serious degradation processes. However, regulating the flow of the Neretva river, where a few hydropower

plants have been built in its upper reaches, can have an impact on vegetation growth and distribution in the wetland. It allows zonation of the communities (-species), which occupy different positions in relation to water depth.
5. Other potential reasons that threaten this region are seen through the intensification of agriculture (e.g. increases in nutrient inputs), which finally causes vegetation changes in wetland (Simpson et al., 1983). Therefore, human impact needs to be controlled.

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