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TAXONOMY AND ECOLOGY OF PHYTOCOENOTIC DIVERSITY OF THE GROMIŽELJ WETLAND AS A SPECIAL NATURE RESERVE

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ABSTRACT

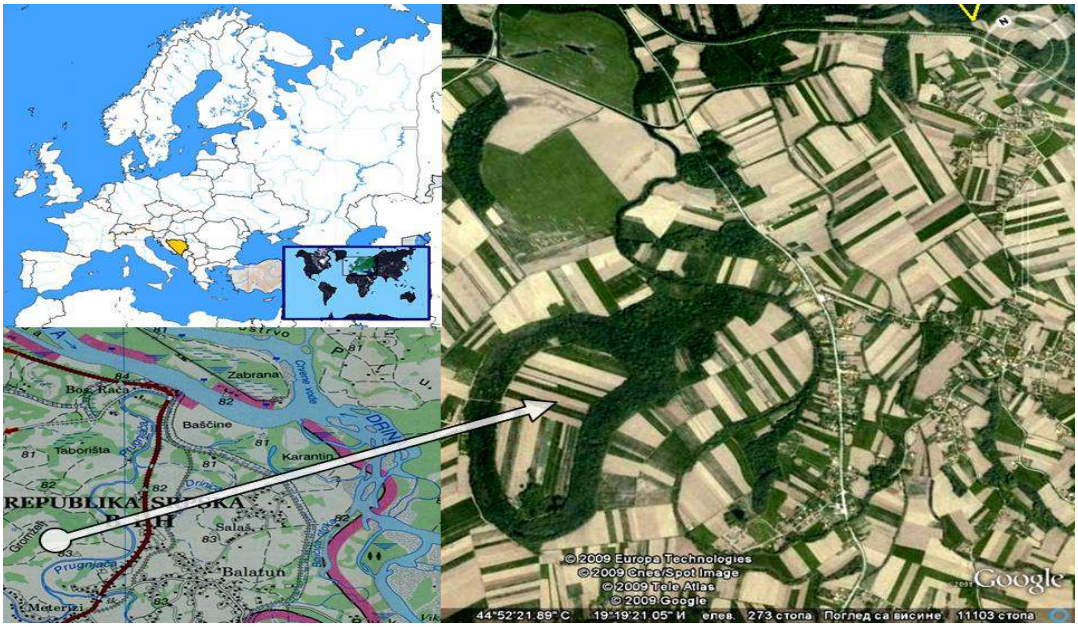
The research of the Gromiželj wetland flora as a special nature reserve includes the diversities of algae, lichens, mosses, ferns and seedlings. The Gromiželj wetland represents a lowland peat with the total area of 831 ha where 67.39 ha have the first degree protection and 763.61 ha the second degree protection. A special geomorphological structure of this lowland peat causes the diversity of a large number of plant species, particularly species that are the Balkan endemics and glacial relicts. 36 species of algae, 3 types of lichen, 8 species of mosses, 6 species of ferns and 240 species of seedlings have been identified in the wetland.

Key words: *wetland, a lowland peat, diversity, a nature reserve.*

INTRODUCTION

On the left bank of the Drina river the Special Nature Reserve of Gromiželj is placed. Gromiželj wetland is located in the area of Semberija (northeastern BiH) in the municipality of Bijeljina, Velino Selo (Map 1). The wetland itself with all its characteristics represents a lowland peat, which covers a total area of 831 ha of which 67.39 ha are under the regime of the first degree of protection, and an area of 763.61 ha in the regime of the second degree of protection. The central location is Laketića source covering the area of 1000 - 1200 m^2, with the depth of 4-5m [1].

As it is known, some of the large rivers such as the Sava and the lower course of the Drina are concentrated at the bottom of the Pannonian basin and they flow in the alluvial plains in different ways to build troughs in the form of pins and meanders, which develop into oxbow lakes with peat bogs over the time [2]. The locality of Gromiželj, from the geomorphological point of view, can be classified as a flood alluvial plain of the rivers Drina and Sava.



Map 1. Location of the Gromiželj wetland

These various conditions the terrain genesis caused a great variety of species diversity in the flora of this area. The aim of this paper is to present taxonomic and ecological characteristics of the diversity of aquatic and marsh flora in the Gromiželj wetland.

MATERIALS AND METHODS

Sampling has been carried out at the two sites in the wetland that are remoted about 2 km. During the summer months there is very little water in the wetland, while in the autumn-winter period the amount of water increases due to abundant rainfall, but also due to increasing of the Sava river water level, into which the wetland flows. In the field, the samples have been stored in the labelled and marked vials with algological materials, and the identification and determination of Cyanophyta and Chlorophyta species were performed in the laboratory [3], while the determination of Bacillariophyta was done only after making a durable preparation according to the Hustedt method [4] and depending on the material according to modified Jerković method [5]. The determination of the species was carried out under a binocular microscope "Zeiss" with a magnification up to 1,500 [6,7,8,9].

During the field research a part of vascular plant species is listed and determined in the field, and another part has been herbarized, and then determined and taxonomically processed. The collection of plants is carried out during the spring, summer and fall. The material is mostly collected in wetlands, aquatic and forest habitats, as well as in ruderal bordering cultivated habitats. Taxon determination is based on the available, valid and relevant literature [10,11,12,13,14,15,16,17].

RESULTS AND DISCUSSION

The Gromiželj is a very interesting and rare wetland habitat for a large number of plant species, and also animals, which are not the subject of our research. In the literature there are not enough data on the floristic research of this wetland. Only three species are listed in Flora BiH identified near Bijeljina and Rača, which are Hottonia palustris L., Utricularia vulgaris L. and Glycyrrhiza echinata L. [16], [18]. Weed flora of the Pannonian basin of the Republic of Srpska in Bijeljina explores Šumatić [14], who identifies 85 species of weeds.

Preliminary research of the wetland started after the identification and determination of the relict fish Mrguda (Umbra krameri, Walbaum) in the Laketić source located in the central part of wetland and so far the only proven habitat of the fish Mrguda in BiH [19]. This is followed by the research of both flora and fauna in the Gromiželj wetland [20,21,22].

Our research, which is the subject of this work comprised a survey of the Gromiželj wetland flora. Identification and determination of vascular plants were carried out during 2015 and 2016, with the determination of algae carried out in 2016.

Within this research of species diversity of vascular flora in the Gromiželj wetland we identified: 3 species of Lichenophyta, 8 species of Bryophyta, 6 species of Pteridophyta and 240 species of Spermatophyta.

FLORA DIVERSITY OF THE GROMIŽELJ WETLAND

Bacillariophyta: Achnanthes lanceolata (Brebisson) Grunow ssp. lanceolata var. lanceolata (slika 1a); Aulacoseira granulata var. granulata (Ehrenberg) Simonsen, Cymbella silesiaca Bleisch in Rabenhorst, Cymbella lanceolata (Ehrenberg) Kirchner, Cocconeis placentula var. placentula Ehrenberg, Cocconeis placentula var. lineata (Ehrenberg) Van Heurck, Cyclotella meneghiniana Kiitzing, Diatoma vulgaris Bory, Fragilaria ulna var. ulna (Nitzsch) Lange-Bertalot, Eunotia bilunaris var. bilunaris (Ehrenberg) Mills, Eunotia parallela var. angusta Grunow, Gomphonema parvulum var. parvulum f.parvulum Kiitzing (slika 1d), Gomphonema clavatum Ehrenberg, Hantzschia amphioxys (Ehrenberg) Grunow, Meridion circulare var. circulare (Greville) C. A. Agardh, Navicula bacillum Ehrenberg, Navicula contenta Grunow, Navicula nivalis Ehrenberg (slika 1e), Navicula cuspidata (Kiitzing) Kiitzing, Navicula cryptocephala Kiitzing, Navicula elginensis var. elginensis (Gregory) Ralfs in Pritchard, Navicula gallica var. Gallica (W. Smith) Lagerstedt (slike 1b i 1c), Navicula cincta (Ehrenberg) Ralfs in Pritchard, Navicula mutica var. mutica Kiitzing, Navicula reinhardtii (Grunow) Grunow in Cleve et Moller, Nitzschia amphibia f. amphibia Grunow, Nitzschia hantzschiana Rabenhorst, Nitzschia palea (Kiitzing) W. Smith, Nitzschia linearis var. linearis (Agardh) W. Smith, Pinnularia viridis (Nitzsch) Ehrenberg, Rhoicosphenia abbreviata (C.Agardh) Lange-Bertalot, Surirella angusta Kiitzing; *Chlorophyta*: Chlorococcum humicolum (Naeg) Rabenhorst, Characium acuminatum A. Braun in Kiitzing, Mougeotia genuflexa (Roth) C. Agardh; *Cyanophyta*: Oscillatoria limosa (Roth) C. Agardh; *Lichenophyta*: Xanthoria parietina (L.) Th. Fr., Parmelia sulcata Taylor, Evernia prunastri (L.) Ach.; *Bryophyta*: Marchantia polymorpha L., Riccia fluitans L., Ricciocarpus natans (L.) Corda, Polytrichum juniperinum Hedw., Brachythecium glaerosum (Bruch ex Spruce) Schimp., Calliergonella cuspidata (Hedw.) Loeske, Funaria hygrometrica Hedw., Isothecium sp., *Pteridophyta*: Equisetum arvense L., E.ramosissimum Desf., Thelypteris palustris Schott., Dryopteris filix-mas (L.) Schott., Salvinia natans (L.) All., Azolla filiculoides Lam.

The number of identified species is certainly into the function of the autumn-winter aspect since their number is mainly much smaller due to environmental factors that are at a given moment evident (water temperature, light, chemistry of the environment, etc.), and the abundance of their population is far lower comparing to the spring-summer aspect of their presence in these biotopes. The largest number of identified and determinate species belongs to ß-mesosaprobic indicators of water quality according Sladeček [23] and SEV [24].

Taking into account the dominance of Spermatophyta flora in the Gromiželj wetland we will attempt to point out the formation of forest communities in this special nature reserve, as well as identified and determined seedling species.

The two forest communities that characterize this peat are specalized as follows: Alnetum glutinosae Vuk. 1956. and Salicetum cinereae Zol. 1931. [25]. The depression of the Laketić source in which a peat bog is formed has been surrounded by clean hygrophilous community of Alnetum glutinosae

Vuk. 1956. which is a relict and originated in colder and wetter climate during the interglacial holocenne and pleistocene periods, onto which the community of Salicetum cinereae Zol. 1931. has been sporadically linked [25]. Community Salicetum cinereae Zol. 1931. syndynamically is associated with herbaceous vegetation of cane, rush and high sedges, and successively goes towards woody vegetation and community of Alnetum glutinosae Vuk. 1956. (Figures 2 and 3).

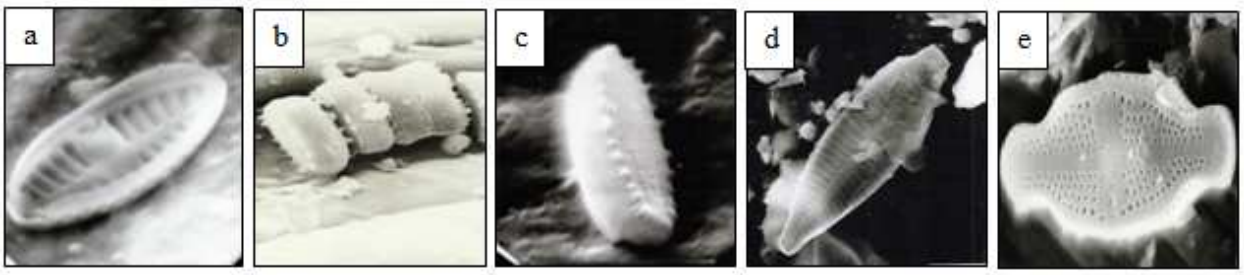


Figure 1. Bacillariophyta
a. Achnanthes lanceolata (Brebisson) Grunow ssp. lanceolata var. lanceolata
b., c. Navicula gallica var. gallica (W. Smith) Lagerstedt
d. Gomphonema parvulum var. parvulum f.parvulum Kiitzing
e. Navicula nivalis Ehrenberg

These communities are formed on marsh land, which is a long float, and permanently under the influence of groundwater. According to physiognomy, the community Salicetum cinereae Zol. 1931. is a low, bushy often very dense community, where as supporting indicator species occur hydrophytes: Caltha palustris L. and Glyceria fluitans L. [26]. In the flooded part of the forest of black alder and ash trees the community Urtico kioviensis-Salicetum cinereae [25] appears in fragments. The land consists of various variants of wetlands, very humid (gley) substrate, which is long-lastingly under the influence of high groundwater. As a species that differentiates this community of wading willow trees the Urtica kioviensis Rogow has been taken, which belongs to the Pontic-Pannonian floral element [25].

Figures 2. and 3. The depression of the Laketić source in which a peat bog and the relict hygrophilous community of Alnetum glutinosae Vuk. 1956.

Usually these are gley and swampy-gley soils, which are saturated with water most of the year. Characteristic and differential species of the community Alnetum glutinosae Vuk. 1956. legally appear in azonal disjunctions of these communities in the wider area of Pannonia. The most characteristic species of this community ascertained in the field are: Thelypteris palustris Schott and Caltha palustris L. [27]. Fern Thelypteris palustris Schott (Figure 4) is very important for the association both physiognomically and ecologically. It develops in shallow water and in open places in the community, where creates a whole facies, ie. forms soil clumps and sludge building upon them, in the lower part of the stem, in which, together with marsh ferns, Rumex hydrolapathum Hudson sporadically occurs. In

the location of the Gromiželj turf forms may be seen, where, among the ferns, as a subdominant species Carex pseudocyperus L. appears (Figure 5) [25].

Figures 4. and 5. Marsh ferns species Thelypteris palustris Schott. and Carex pseudocyperus L.

The sporadic presence of small groups of Quercus robur L. in ash forests in the wider area shows us that the current clean community Alnetum glutinosae Vuk. 1956. is of secondary origin, i.e. resulting from hydrophilic alliance Alno-Quercetum roboris Horv. 1938. [25] by long-term cutting of the main species Quercus robur L. and Fraxinus angustifolia Vahl.

Black alder is present in the depressions around Semberije in the forms of small groups where they could establish peatland, but there are usually around them the complexes oak-ash forests that had been cut and thus the depressions with black alder remained as independent surfaces. Emergent band is made up of Typha angustifolia L. where the sporadic occurrence of Phragmites communis Tvin. can be noted on the contact of wood and peatland. This indicates the started vegetation succession in accordance with the mineralization of peat. A bulrush is the habitat of relict glacial period species Urtica kioviensis Rogow which is the Pannonian endemic species whose southern areal boundary ends in peri-Pannonian region (Figure 6). This nettle is the indicator species for lowland peat formed in the fossil river beds. In the flooded zone the whole area covered by species Hottonia palustris L. may be noted (Figure 7), which is an indicator species of wetland vegetation within the forest from the class Alnatea glutinosae. Its taxonomic and phytogeographic importance in the flora of the Balkans is that belongs to oligotype relict lineage Hottonia encompassing also vicar North American species of H. inflata Elliott. These distant phytogeographic relationships indicate the relic species ie. its affiliation to the elements of arctoterciar aquatic flora.

Figure 6. Urtica kioviensis Rogow

Figure 7. Hottonia palustris L.

Nowadays Hottonia palustris L. is an element of azonal aquatic vegetation in the moderate middle European climate, avoiding the extremes of the far north and the Mediterranean. According to Butorac [28] Hottonia palustris L. in BiH is in the category of vulnerable species (VU) by the IUCN. On the site along with this there are more species: Caltha palustris L, Sium latifoliumL., Sparganium erectum L., Mentha aquatica L., Alisma plantago-aquatica L., Eleocharis palustris (L.) Roem & Schult, Juncus articulatus L., Butomus umbellatus L. et al. In the coastal region, the emerging vegetation is developed, dominated by Typha angustifolia L.. Oenanthe aquatica (L.) Poir., Iris L. pseudacoris, Schoenoplectus lacuster (L.) Palla are sporadically occurring, and Phragmites communis Tvin in small groups. On muddy surfaces after the withdrawal of water between emersion area and free water the individual samples of plant species Bolboschoenus maritimus (L.) Palla, Cyperus fuscus L., Pycreus rotundus (L.) Hayek, Sagittaria sagittifolia L., Myosoton aquaticus (L.) Moench can be noticed, specifically distinguished by the presence of the rare species Cyperus michelianus (L.) Delile (Figure 8).

Figure 8. Cyperus michelianus (L.) Delile

Figure 9. Utricularia vulgaris L.

The aquatic part consists of floating species: Lemna minor L., L.gibba L., Spirodella polyrhiza (L) Schleid., Salvinia natans (L.) All. and Nuphar lutea (L.) Sm., and among submerged species Myriophyllum spicatum L. Utricularia vulgaris L. and Lemna trisulca L. This wetland is the habitat of rare insectivorous plant Utricularia vulgaris L. whose number depends on the presence of primarily zooplanktons (Figure 9). The aquatic community can be characterized as Myriophyllo-Nuphaeretum W. Koch 1926. As traces of warm tertiary and warm interglacial phases sub-Mediterranean plants Clematis flammula L., Diplotaxis muralis (L.) DC., Sinapis alba L., Valerianella coronata (L.) DC, Agrostis capillaris L. et al., as well as sub-Pontic/sub-Mediterranean species Valerianella dentata (L.) Pallich remained [29].

According to the review of the list of vascular plants for Redlist of Bosnia and Herzegovina [30] endangered species were classified as follows: Thelypteris palustris Schott, Nuphar lutea (L.) Sm. and Hottonia palustris L. with the status of endangered vulnerable species (VU) by the IUCN for BiH, provided that Thelypteris palustris Schott and Hottonia palustris L. are on the list of plant taxa with a proposal for a Redlist of BiH whose presence in BiH is still uncertain, which confirms the importance of this habitat. Apart from the so far presented species of seedlings (Spermatophyta) in the flora of Gromiželj the following species also live:

Family Aristolochiaceae
Aristolochia clematitis L.
Asarum europeum L.

Family Ranunculaceae
Aconitum variegatum L.
Anemone nemorosa L.

Family Crucifereae (Brassicaceae)
Arabis glabra (L.) Bernh
Barbarea vulgaris R. Br.
Capsella bursa-pastoris (L.) Medicus
Diplotaxis muralis (L.) DC.
Sinapis alba L.
Sinapis arvensis L.

Anemone ranunculoides L.
Clematitis flammula L.
Clematitis vitalba L.
Ranunculus auricomus L.
Ranunculus fluitans Lam.
Ranunculus ficaria L.
Ranunculus repens L.

Family Umbelliferae(Apiaceae)
Aegopodium podagraria L.
Angelica sylvestris L.
Anthriscus sylvestris (L.) Hoffm.
Sanicula europea L.

Family Asteraceae
Aposeris foetida (L.) Leess.
Achillea millefolium L.
Anthemis arvensis L.
Ambrosia artemisiifolia L.
Artemisia vulgaris L.
Arctium lapa L.
Bellis perennis L.
Centaurea cyanis L.
Cirsium arvense(L.) Scop.
Cirsium oleraceum (L.) Scop.
Cirsium eriophorum (L.) Scop.
Cichorium intybus L.
Eupatorium canabinum L.
Inula britannica L.
Mycelis muralis(L.) Dumort
Sonchus arvensis L.
Sonchus oleraceus L.
Senecio vulgaris L.
Tagetes minuta L.
Taraxacum officinalle Weber
Tanacetum vulgare L.
Tussilago farfara L.
Tragopogon pratensis L.
Xanthium strumarium L.

Family Poaceae (Gramineae)
Agrostis capillarisL.
Agrostis stolonifera L.
Arrhenatherum elatius (L.) Beaur.
Bromus sterillis L.
Cynodon dactylon (L.) Pers.
Cynosurus cristatus L.
Dactylis glomerata L.
Holcus lanatus L.
Lolium perenne L.
Poa pratensis L.
Poa trivialis L.

Family Papaveraceae
Chelidonium majus L.

Family Chenopodiaceae
Atriplex hastata L.
Chenopodium album L.
Chenopodium vulgare Gueldenst. ex Ledeb.
Family Rosaceae
Agrimonia eupatoria L.
Crategus monogyna Jacq.
Geum urbanum L.
Fragaria vesca L.
Prunus spinosa L.
Rosa canina L.

Family Malvaceae
Abutilion teophrasi Med.
Althea officinalis L.
Malva sylvestris L.

Family Araceae
Arum maculatum L.

Family Liliaceae
Convallaria majalis L**.**
Maianthemum bifolium (L.) F. W. Schmidt.

Family Rubiaceae
Cruciata laevipes Opiz.
Galium verum L.
Galium mollugo L.
Galium palustre L.
Galium uliginosum L.

Family Corylaceae
Corylus avellana L.
Carpinus betulus L.

Family Gentianaceae
Centaurium erythaea Rafn.

Family Convolvulaceae
Convolvulus arvensis L.

Family Iridaceae
Crocus neapolitanus Mord. et Lois.

Family Cyperaceae
Carex elongata L.
Carex vulpina L.
Carex digitata L.
Carex sylvatica Huds.

Family Lamiaceae (Labiatae)
Glechoma hederacea L.
Lamium album L.
Lamium maculatum L.

Papaver dubium L.
Papaver rhoeas L.

Family Scrophulariaceae
Chaenorhinum minus (L.) Willk.
Veronica arvensis L.
Veronica chamedris L.

Family Solanaceae
Datura stramonium L.

Family Cucurbitaceae
Ecballiun elaterium (L.) A. Rich.

Family Euphorbiaceae
Euphorbia amygdaloides L.
Euphorbia lathyris L.
Euphorbia palustris L.
Mercurialis perennis L.

Family Rhamnaceae
Frangula alnus Mill.

Family Amaryllidaceae
Galanthus nivalis L.

Family Leguminoseae (Fabaceae)
Galega officinalis L.
Genista tinctoria L.
Glycyrhiza glabra L.
Lathyrus pratensis L.
Medicago sativa L.
Melilotus officinalis (L.) Palls.
Ononis spinosa L.
Trifolium repens L.
Trifolium pratense L.
Vicia sepium L.
Vicia sativa L.

Family Geraniaceae
Geranium molle L.
Geranium robertianum L.

Family Portulacaceae
Portulaca oleracea L.

Family Polygonaceae
Polygonum aviculare L.
Rumex acetosa L.
Rumex crispus L.

Family Boraginaceae
Pulmonaria officinalis L.
Symphytum officinalle L.
Symphytum tuberosum L.
Lamium purpureum L.
Marubium vulgare L.
Melittis melissophyllum L.
Mentha arvensis L.
Mentha spicata L.
Salvia pratensis L.
Stachys palustris L.
Stachys recta L.
Stachys silvatica L.
Thymus pulegoides L.

Family Hydrocharitaceae
Hydrocharis morsus-ranae L.

Family Guttiferae
Hypericum perforatum L.

Family Araliaceae
Hedera helix L.

Family Balsaminaceae
Impatiens noli-tangere L.

Family Juncaceae
Juncus articulatus L.
Juncus effusis L.

Family Orchidaceae
Listera ovata (L.) R. Br.
Platanthera bifolia L.

Family Oxalidaceae
Oxalis acetosella L.

Family Salicaceae
Populus alba L.
Populus nigra L.
Salix alba L.
Salix purpurea L.
Salix fragilis L.
Salix cinerea L.

Family Caprifoliaceae
Sambucus nigra L.
Sambucus ebulis L.

Family Violaceae
Viola tricolor L.
Viola arvensis Murray

Family Urticaceae
Urtica dioica L.
Urtica kioviensis Rogow.

Family Verbenaceae

Verbena officinalis L.

Family Plantaginaceae
Plantago major L.
Plantago media L.
Plantago lanceolata L.

Family Caryophylaceae
Saponaria officinalis L.
Stellaria graminea L.
Stellaria holostea L.
Stellaria media (L.) Vill.

Family Zannichelliaceae
Zannichellia palustris L.

Family Onagraceae
Epilobium hirsutum L.

Family Potamogetonaceae
Potamogeton natans L.

A large number of seedlings indicate the diversity, but also the specificity of micro-habitat of this lowland peat. Phytographic analysis showed that in the flora of the Gromiželj wetland, species of wide ecological valence most of which belong to the Eurasian group of floral elements are dominant. The analysis of individual forms of life presence defined its hemicryptophytic-terophytic character.

CONCLUSION

In the Gromiželj wetland a total of 32 species of Bacillariophyta, 3 species of Chlorophyta and 1 species of Cyanophyta have been identified among planktonic algae. The greatest number of identified determined species belong to the of ß-mesosaprobic water quality indicators which indicates that the water in the Gromiželj wetland belongs to the quality class II, which is characteristic of the Sava river in this part of the flow where the wetland flows into.

The floristic research of this area has shown remarkable diversity of vascular flora which is reflected in the presence of 240 plant species. The largest number of species belongs to a class Dicotyledones, and a much smaller number of species to the class Monocotiledones grouped into 47 families. Lichens are present with the 3 species, mosses with 8 species and ferns with 6 species. After field research it can be concluded that this rare preserved lowland peat deserves the protection of its biodiversity, especially when it comes to the species of international importance, endemic and relict species and species whose survival largely depends on their self protection and habitats in which they live. Two endemic species Urtica kioviensis Rogow and Hottonia palustris L. have been identified as Balkan endemic species, which are also glacial relicts. A large number of plant species have the status of threatened species by IUCN. A larger number of representatives of the wetland flora can be found on the Red List of flora in BiH. In accordance to the Nature Protection Act [31] and the Law on the Republic Administration [32] Ministry of Physical Planning, Construction and Ecology issued a decision on previous protection of "Special Nature Reserve Gromiželj", the total area of 831 ha, 763.61 ha of which is in the regime of the second degree of protection, while the area of the Laketić is into the regime of the first degree of protection. In the near future this exceptional nature reserve should be given the official status of a special nature reserve. The identified species Urtica kioviensis Rogow has not been recorede on the list of flora in BiH so far, and this research for the first time reports its presence in the flora of BiH.

According to our research from the preliminary Red List of vascular flora in Bosnia and Herzegovina there are the following registered species in the area: Thelypteris palustris Schott, Nuphar lutea (L.) Sm., Ranunculus auricomus L., Hottonia palustris L., Zanichellia palustris L., Convalaria majalis L., L. Galanthus nivalis, Platanthera bifolia (L.) LC Rich., Hydrocharis morsus-ranae L. Utricularia vulgaris L., Lemna gibba, L., Caltha palustris, Urtica kioviensis Rogow. It should be emphasized that there is the swamp nettle in the flora of Bosnia-Herzegovina, which is in the European Red List in the category of vulnerable species (VU). In order to prevent further loss of threatened species further drying out of the swamp-lowland peat and other hydro-reclamation works should be prevented, that can lead in any way to the disappearance of identified rare species. As a measure of protection and conservation of rare plant species it is necessary to control the population of competing and more

powerful opportunistic hydrophytes to avoid suppression of these rare and endangered species due succession. It is also essential to maintain optimal water regime in order to preserve and possibly restore native flora of the peatlands. Timely and adequate measures could maintain and preserve this small but significant wetland on the perimeter of the Pannonian basin in all its beauty and functionality, since it undoubtedly deserves that.

The Gromiželj wetland has much wider regional significance because it was revealed that the Special Nature Reserve of Zasavica (Republic of Serbia) and the Special Nature Reserve of Gromiželj (BiH) had once been a unique marshy peat complex whose further genesis was affected by the Drina river and its turbulent flow and frequent floods. Certainly, a major negative impact on both areas was through human interferance, which resulted in devastation and disappearance of a large part of the wetland complex, and therefore the biodiversity of Mačva (Zasavica) and Semberija (Gromiželj) has been permanently depleted [33].

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