

Original Scientific paper
10.7251/AGREN2502075M
UDC 581.9(497.6)

ECOLOGICAL CHARACTERISTICS OF THE VASCULAR MACROPHYTE FLORA OF THE PROTECTED HABITAT "TIŠINA"

Zoran MATIĆ¹, Natasa MARIC², Sladjana PETRONIC²

¹Faculty of Technology, University of East Sarajevo, Zvornik, Bosnia and Herzegovina

²Faculty of Agriculture, University of East Sarajevo, East Sarajevo, Bosnia and Herzegovina

*Corresponding author: natasa.bratic@yahoo.com

ABSTRACT

The paper presents the ecological characteristics of the vascular macrophyte flora of the protected habitat "Tišina". This area territorially belongs to the municipality of Šamac (Bosnia and Herzegovina). The protected habitat covers an area of 196.49 hectares and is located at an altitude of 85 m. The previous investigation of the flora of this area recorded the presence of 49 macrophytes. Ecological indices are provided according to Ellenberg, while data on life forms are taken from Oberdorfer. The research established the dominance of species in the submontane belt of temperate broad – leaved forests. The most abundant species are those on frequently flooded soils, and in terms of the chemical reaction of the soil, it can be concluded that there is a dominance of plants that grow mainly on basic soils. Regarding nutrient relationships, mesotrophic plants and plants from habitats moderately rich in nitrogen minerals are equally represented. In the studied area, there is a significant presence of species that require full daylight and those that are tolerant to shade. The most present in the studied area are sub-oceanic and oceanic-sub-oceanic species. In relation to the ecological index for salinity, most macrophytes in the research area are halophobic. Analysis of the biological spectrum of macrophytes revealed the dominance of hydrophytes.

Keywords: *Macrophytes, Tišina, ecological indices, life forms.*

INTRODUCTION

The protected habitat "Tišina" is located in the northern part of Bosnia and Herzegovina and belongs to the municipality of Šamac (Map 1). The total area of the protected habitat is 196.49 hectares. It is located at an altitude of 85 m. The area of the municipality of Šamac geographically belongs to the southern edge of the Pannonian plain, in the area called Posavina. The relief is predominantly plain. Dominant type of soil is black soil, rich in humus. The climate is humid continental with clearly defined seasons. The average amount of precipitation is about 700-800 mm. The average temperature is around 10.7 °C.



Map 1. Location of the protected habitat "Tišina" (1:25,000)

Tišina - swamp-pond complex consists of Velika Tišina and Mala Tišina, as well as Odmut pond and the occasional Žandrak watercourse. This area represents one of the few continental ponds and swamps of natural origin, in the floodplain of the Sava River. It can be said that Velika Tišina, Mala Tišina and Odmut make up the river arm of the Sava. Velika Tišina, pond, shaped like a horseshoe, has a length of about 2.5 km with an average width of about 200-300 m. Odmut pond is characterized by its impermanent and changing shape.

The oldest data related to the research of the Tišina flora date from Sendtner, Formanek, Protić (1928) and Maly, who collected plant material in the area of the Velika Tišina pond and made an inventory of the flora. Detailed studies of the flora were carried out by Bjelčić (1956), she recorded 150 plant species. The Republic Institute for the Protection of Cultural, Historical and Natural Heritage of the Republic of Srpska carried out multidisciplinary research that lasted from 2010-2011. year. On this occasion, the vascular flora was treated in detail. 236 species were identified and classified into 3 classes, 179 genera and 71 families. The diversity of the vascular flora of the Tisin Protected Habitat was studied by Maric and Petronic (2020). Habitat types of European importance in the area of the Tisin protected habitat were given by Bratic et al. (2016).

In 1985, the municipality of Šamac (then Bosanski Šamac) declared the Tišina pond a "natural rarity". In 2019, the Government of the Republic of Srpska passed the Decision on the passing of the protected area of category IV, "Protected habitat of Tišina", which was published in the Official Gazette of the RS no. 83/19. According to the Law on Nature Protection, a protected habitat is an area that includes one or

more types of natural habitats important for the preservation of one or more populations of wild species and their communities.

A total of 236 species of plants, 130 species of birds, 8 species of amphibians, 4 species of reptiles and 21 species of fish were registered within the Tišina and Odmuť complex (Kovacevic et al. 2019).

MATERIALS AND METHODS

The study utilized existing literature data, which showed the diversity of the vascular flora (Kovacevic et al. 2019; Maric i Petronic, 2020). Ecological indices were given according to Ellenberg (Borhidi, 1993), while data on life forms were taken according to Oberdorfer (2001). Indicator values of plant species according to Ellenberg (Borhidi, 1995) were represented by indices for basic ecological parameters, such as temperature, moisture, soil reaction, nitrogen content in the soil, light intensity, continentality, and salinity. Ecological indices according to Ellenberg are given on scales of 1 to 9, or 1 to 12 (moisture index). Species names were adjusted according to the nomenclature from Euro+Med PlantBase (2006–2024).

RESULTS AND DISCUSSION

Previous research on the flora (Kovacevic et al. 2019; Maric i Petronic, 2020) of the Protected Habitat "Tišina" recorded 49 macrophytes. An overview of macrophytes with ecological indices and life forms are given in Table 1.

Table 1. Overview of macrophytes within the Protected Habitat "Tišina"

No.	Plant species	Ecological indicator values							Life form
		T B	WB	R B	N B	LB	K B	SB	
1.	<i>Alisma plantago-aquatica</i> L.	5	10	6	8	7	4	0	Hyd, G
2.	<i>Butomus umbellatus</i> L.	6	10	6	7	6	5	0	Hyd, G
3.	<i>Carex flava</i> L.	5	9	8	4	8	2	0	H
4.	<i>Carex pseudocyperus</i> L.	6	10	6	5	7	3	0	Hyd (H)
5.	<i>Carex riparia</i> Curtis	7	10	7	4	7	3	0	Hyd (H)
6.	<i>Ceratophyllum demersum</i> L.	7	12	8	8	6	4	0	Hyd, G
7.	<i>Eleocharis palustris</i> (L.) R. Br.	6	10	7	5	8	5	1	Hyd, G
8.	<i>Epilobium parviflorum</i> Schreb.	5	9	7	5	7	3	0	H (Ch)
9.	<i>Equisetum palustre</i> L.	4	9	6	3	7	5	0	G
10.	<i>Glyceria maxima</i> (Hartm.) Holmb.	5	10	8	7	9	4	0	Hyd, G
11.	<i>Hydrocharis morsus-ranae</i> L.	6	11	7	7	7	4	0	Hyd
12.	<i>Iris pseudacorus</i> L.	6	9	6	7	7	3	0	Hyd

13.	<i>Lemna gibba</i> L.	6	11	7	8	7	3	0	Hyd, T
14.	<i>Lemna minor</i> L.	5	11	7	6	7	3	0	Hyd, T
15.	<i>Lemna trisulca</i> L.	5	11	7	6	8	3	0	Hyd, T
16.	<i>Lycopus europaeus</i> L.	6	9	6	7	7	5	0	Hyd, G
17.	<i>Lycopus exaltatus</i> L.	6	9	6	6	7	6	0	H, Hyd
18.	<i>Lycopus exaltatus</i> L. f.	6	9	6	6	7	6	0	Hyd, G
19.	<i>Lysimachia nummularia</i> L.	6	7	8	4	5	4	0	H
20.	<i>Lysimachia vulgaris</i> L.	5	8	6	4	6	5	0	H
21.	<i>Lythrum salicaria</i> L.	5	9	7	4	7	5	1	H
22.	<i>Mentha aquatica</i> L.	5	9	7	4	7	3	0	H (Hyd)
23.	<i>Myriophyllum spicatum</i> L.	5	12	8	5	5	4	0	Hyd
24.	<i>Myriophyllum verticillatum</i> L.	5	9	7	4	7	3	0	Hyd, G
25.	<i>Najas marina</i> L.	7	12	7	6	5	4	1	Hyd
26.	<i>Nuphar lutea</i> (L.) Sm.	6	11	7	8	8	4	0	Hyd
27.	<i>Nymphaea alba</i> L.	7	11	7	7	8	3	0	Hyd
28.	<i>Oenanthe aquatica</i> (L.) Poir.	6	10	7	5	7	5	0	Hyd
29.	<i>Persicaria dubia</i> (Stein) Fourr.	6	9	7	7	7	3	0	T
30.	<i>Persicaria hydropiper</i> (L.) Delarbre	5	9	7	5	7	4	0	T
31.	<i>Persicaria hydropiper</i> (L.) Delarbre	5	9	7	5	7	4	0	T
32.	<i>Persicaria lapathifolia</i> (L.) Delarbre	6	8	6	8	6	4	0	T
33.	<i>Phragmites australis</i> (Cav.) Steud.	5	10	7	5	7	4	1	Hyd, G
34.	<i>Potamogeton crispus</i> L.	5	12	7	6	6	3	1	Hyd
35.	<i>Potamogeton natans</i> L.	4	12	7	4	6	5	0	Hyd, T
36.	<i>Ranunculus repens</i> L.	5	8	6	6	6	4	1	H
37.	<i>Rorippa amphibia</i> (L.) Besser	6	10	8	8	7	7	0	Hyd (H)
38.	<i>Rumex hydrolapathum</i> Huds.	7	10	7	7	7	3	0	Hyd, H
39.	<i>Schoenoplectus lacustris</i> (L.) Palla	5	10	7	7	8	3	2	Hyd, G
40.	<i>Schoenoplectus lacustris</i> subsp. <i>glaucus</i> (Sm.) Bech.	7	10	8	6	8	6	3	Hyd, G
41.	<i>Sium latifolium</i> L.	6	10	7	8	7	4	0	Hyd
42.	<i>Sparganium erectum</i> L.	6	10	6	5	7	4	0	Hyd
43.	<i>Spirodela polyrhiza</i> (L.) Schleid.	-	-	-	-	-	-	-	Hyd, T
44.	<i>Typha angustifolia</i> L.	7	10	7	7	8	5	1	Hyd

45.	<i>Typha latifolia</i> L.	6	10	7	8	8	5	1	Hyd
46.	<i>Utricularia australis</i> R. Br.	6	12	7	5	7	5	0	Hyd
47.	<i>Utricularia vulgaris</i> L.	6	12	7	5	7	5	0	Hyd
48.	<i>Veronica anagallis-aquatica</i> L.	6	9	7	7	7	3	0	Hyd, G
49.	<i>Veronica beccabunga</i> L.	5	10	7	6	7	3	0	Hyd, G

The ecological analysis of macrophytes in the studied area was conducted based on ecological indices for temperature, soil moisture, soil reaction, mineral nitrogen content in the soil, light regime, continentality and salinity (Table 2).

Table 2. Indicator value of ecological indices of the macrophyte flora of the researched area

Values	Ecological indices															
	TB		WB		RB		NB		LB		CB		SB		TB	
	N o	%	N o	%	N o	%	N o	%	N o	%	N o	%	N o	%	N o	%
0	-	-	-	-	-	-	-	-	-	-	-	-	38	79.1 7	-	79.1 7
1.	-	-	-	-	-	-	-	-	-	-	-	-	8	16.6 7	-	16.6 7
2.	-	-	-	-	-	-	-	-	-	-	1	2.08	1	2.08	-	2.08
3.	-	-	-	-	-	-	1	2.08	-	-	16	33.3 3	1	2.08	-	2.08
4.	2	4.17	-	-	-	-	8	16.6 7	-	-	15	31.2 5	-	-	2	-
5.	18	37.5	-	-	-	-	11	22.9 2	3	6.25	12	25	-	-	18	-
6.	21	43.7 5	-	-	12	25	9	18.7 5	7	14.5 8	3	6.25	-	-	21	-
7.	7	14.5 8	1	2.08	29	60.4 2	11	22.9 2	28	58.3 3	1	2.08	-	-	7	-
8.	-	-	3	6.25	7	14.5 8	8	16.6 7	9	18.7 5	-	-	-	-	-	-
9.	-	-	14	29.1 7	-	-	-	-	1	2.08	-	-	-	-	-	-
10.	-	-	17	35.4 2	-	-	-	-	-	-	-	-	-	-	-	-
11.	-	-	6	12.5	-	-	-	-	-	-	-	-	-	-	-	-
12.	-	-	7	14.5 8	-	-	-	-	-	-	-	-	-	-	-	-
Σ	48	100	48	100	48	100	48	100	48	100	48	100	48	100	48	100
$\bar{x}$	5.69		9.94		6.90		5.94		6.96		4.06		0.27		5.69	

The analysis of ecological indices for temperature indicates the dominance of species with an ecological index TB6 (43.75%). These are plant species of the submontane broad leaved forest belt. Species of the montane mesophilous broad-leaved forest

belt (TB5) also have significant representation (37.5%). The species of the thermophilous forest or woodland belt (TB7) (14.58%) and species of the montane needle-leaved forest or taiga belt (TB4) (4.17%) are not significantly represented. The mean value of the ecological index for temperature is 5.69, which means that the macrophytes of the studied area are predominantly mesothermal species.

Regarding the moisture index values, the most prevalent are plants of frequently flooded soils (WB10) (35.42%). The second most common are species with an index of WB9 (29.17%) which are plants of wet, not well aerated soils. The third place (14.58%) is occupied by plants of most wholly submersed in water (WB12). Plants with floating or partly emergent leaves (WB11) are in the fourth place (12.5%), while plants of moist soils tolerating short floods with an index of WB8 (6.25%) and plants of moist soils not drying out and well aerated (WB7) (2.08%) are not significantly represented. The mean value of the moisture index is 9.94. This value indicates that macrophytes in the studied area develop in wet habitats, which is expected given that they are species of aquatic habitats.

Regarding the chemical reaction of the soil, there is a dominance of basifrequent plants, mostly on basic soils with an index RB7 (60.42%) and neutrophilic plants with an index RB6 (25%), which grow mostly on neutral soils but also in acid and basic ones, more or less indifferent plants. Plants of basiphilous sites with an index RB8 are present with 14.58%. The average value of the environmental factor for soil acidity is 6.90. Based on this, we can say that the macrophytes of the researched area predominantly inhabit basophilic habitats.

In terms of the ratio of plants to nutrients, mesotrophic plants with an index of NB5 and plants with an index of NB7 are equally represented making up 22.92%, and these are species from habitats moderately rich in nitrogen minerals. Habitat types moderately rich in nutritious nitrogen minerals (NB6) make up 18.75%. Types of submesotrophic habitats (NB4) and types of fertilized habitats (NB8) are equally present with 16.67%. The average value of the ecological factor for soil acidity is 5.94. Based on this, we can say that the macrophytes of the studied area predominantly inhabit basophilic habitats.

In terms of light as an ecological factor, half-light plants, mostly lying in full light but also shadow tolerants (LB7) have significant representation (58.33%). The second most common are light plants with photosynthetic minimum above 40% relative light intensity, less only in exceptional cases (LB8) (18.75%). Halfshadow-half-light plants with photosynthetic minimum between 10 and 40% relative light intensity (LB6), are present with 14.58% while halfshadow plants receiving more than 10% but less than 100% relative light intensity (LB5), are represented by 6.25%. Full-light plants (LB9) are not significantly represented (2.08%). The average value of ecological indices for light intensity is 6.96, indicating that the macrophytes of this area are predominantly full daylight species that are tolerant to shade.

Regarding the continentality index, species with indices CB3 (33.33%) and CB4 (31.25%) dominate. These are suboceanic species that predominantly inhabit Central Europe but reaching to East and oceanic-suboceanic species these are in whole Central Europe. Species of the intermediate type with slight suboceanic-

subcontinental character (CB5) are present with 25%. Subcontinental species (CB6) are present with 6.25%. Oceanic species with an index CB2, mainly found in Western Europe and the western part of Central Europe, and continental-subcontinental species with an index CB7 are not significantly represented (2.08%). Regarding the ecological index for salinity, most macrophytes in the studied area are halophob species (SB0) (79.17%) not occurring in salty or alkalic soils.

The analysis of the biological spectrum of macrophytes (Chart 1) established the dominance of hydrophytes (Hyd) (74%), which is expected since macrophytes are plant species of aquatic habitats. In second place are hemicryptophytes (H) (15%), whose presence coincides with the climatic conditions of the researched area, the biological spectrum of Bosnia and Herzegovina and the Balkan Peninsula (Diklić, 1984). Therophytes (T) (9%) and geophytes (G) (2%) are not significantly represented.

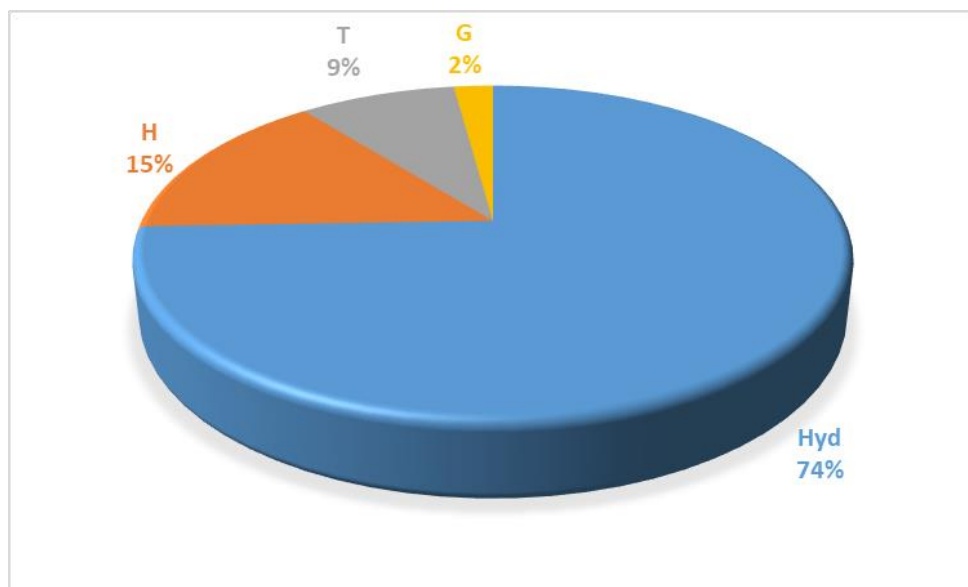


Chart 1. Biological spectrum of macrophytes

CONCLUSION

The protected habitat "Tišina" is located in the northern part of Bosnia and Herzegovina and belongs to the municipality of Šamac. The protected habitat covers an area of 196.49 hectares and is located at an altitude of 85 m. The previous investigation of the flora of this area recorded the presence of 49 macrophytes. In the macrophyte flora of the studied area, mesothermal, basic, mesotrophic, halophobic, suboceanic, and oceanic-suboceanic species dominate. Also, the most prevalent are species of wet habitats as well as species that thrive in full daylight but are tolerant of shade. The analysis of the biological spectrum of macrophytes established the dominance of hydrophytes, with hemicryptophytes being the second most common.

REFERENCES

- Bjelčić, Ž. (1954). Flora i vegetacija bare Velika Tišina kod Bosanskog Šamca. Godišnjak Biološkog instituta VII, SV, 1-2, Sarajevo.
- Borhidi A. (1995). Social behaviour types, the naturalness and relative ecological indicator values of the higher plants in the Hungarian Flora. – *Acta Bot. Hung.* 39, 97–181.
- Bratic, N., Petronic, S., Todorovic, S., Panic, G. (2016). Types of habitat and type of pond Tišina proposed for 2000 Natura area. *Nova škola*, XI (1), 251-259.
- Diklić, N. (1984). Životne forme biljnih vrsta i biološki spektar flore SR Srbije. U: Sarić M. (Ed.) *Vegetacija SR Srbije I*, Srpska akademija nauka i umetnosti, 291-316.
- Euro+Med (2006-). Euro+Med PlantBase – the information resource for Euro-Mediterranean plant diversity. Published on the Internet <http://ww2.bgbm.org/EuroPlusMed/> [accessed on 08 November 2024].
- Ljubojevic, M., Maric, N., Petronic, S. (2024). Ecological characteristics of macrophytes of the protected habitat "gromiželj" (Bosnia and Herzegovina). The XV International Scientific Agricultural Symposium "Agrosym 2024", Book of proceedings, 71-76.
- Marić, N & Petronić, S. (2020). Diversity of vascular flora in Protected habitat Tišina. *Archives for Technical Sciences* 2020, 23(1), 87-96.
- Oberdorfer E. (2001). *Pflanzensoziologische Exursionsflora für Deutschland und angrenzende Gebiete*. Eugen Ulmer Verlag, Stuttgart.
- Odluka o prostornom uređenju opštine Bosanski Šamac ("Službeni glasnik opštine Bosanski Šamac" br. 4/1985).
- Protić, Đ. (1928). Bara Velika Tišina. *Glasnik Zemaljskog Muzeja* XL, Sveska 1 (PN). Sarajevo, 1-38.
- Ковачевић, Д., Радошевић, Д., Панић, Г., Поткоњак, С., Јованић, Д., Ћурић, А. (2019). Студија заштите Заштићено станиште „Тишина“. Републички завод за заштиту културно-историјског и природног наслеђа, Влада Републике Српске, Бања Лука.
- Службени гласник Републике Српске 83/19. Одлука о проглашењу Заштићеног станишта „Тишина“. Бања Лука: Министарство За Просторно Уређење, Грађевинарство и Екологију, Влада Републике Српске.