Kragujevac J. Sci. 24 (2002) 83-90.

THE VASCULAR FLORA OF THE GROŠNICA RESERVOIR IN THE ŠUMADIJA REGION OF SERBIA

Marina Topuzović, Dragana Pavlović and Aca Marković

Faculty of Science, P.O. Box 60, 34000 Kragujevac, Yugoslavia

(Received April 1, 2002)

ABSTRACT. The paper presents results of research on vascular flora of the Grošnica reservoir in the Kragujevac basin. The obtained results confirm that the development of macrophytic vegetation is dependent on the time, manner, and place of reservoir formation, as well as on the extent of human influence. Analysis of floristic composition of vascular plants of this reservoir indicates presence of 69 species belonging to 26 families. True hydrophytes are represented by exeptionally few species. The floristic composition of vascular plants with life forms and floral elements is given in the paper.

INTRODUCTION

Reservoirs represent specific ecosystems that differ in many ways from natural lakes. Constructed for the most part to perform several functions (generation of electrical energy, water supply, irrigation, etc.), they represent very interesting ecosystems owing to the manner of their formation and subsequent management. Study of the macrophytes in them is an essential component of research on reservoirs.

The reservoir studied in the present paper are located in the Kragujevac basin in the Šumadija region of Serbia (Yugoslavia). The first artificial accumulation in the former Yugoslavia, the Grošnica reservoir was built in 1938.

Immediately after it′s formation, this reservoir became the object of study from several aspects, primarily because of it′s significance as sources of water supply for settlements, but also as interesting aquatic ecosystem: chemical analyses (JANKOVIĆ, 1965), microbiological investigations (ČOMIĆ et al., 1999); investigations of phytoplankton (JANKOVIĆ, 1965, MILOŠEVIĆ et al., 2000); and zooplankton (JANKOVIĆ, 1965; OSTOJIĆ, 1999, 2000).

The vascular flora of this reservoir has also been studied since it′s formation (JANKOVIĆ, 1965, VELJOVIĆ et al., 1986). JANKOVIĆ (1965) gave the first results for the Grošnica reservoir. She reported that littoral vegetation is poorly developed due to the reservoir's steep banks and considerable oscillations of its water level (10-20m annually). The indicated author recorded the presence of 26 plant species and noted the danger of overgrowth by the species *Typha latifolia* L.

The purpose of the present work was to investigate development of the vascular flora on the Grošnica reservoir as a significant factor in preservation of the stability of this aquatic ecosystem.

MATERIAL AND METHODS

We studied vascular flora of the Grošnica reservoir, which is located in the Kragujevac basin. The freshwater systems of this basin belong to the Euro-Mediterranean subregion as a natural zoogeographic whole in the framework of the Holarctic. The recent vegetation of the basin belongs to the Euro-Siberian and North American region. According to VELJOVIĆ (1967), the natural plant cover constitutes 35% of the basin, land under cultivation is constantly expanding, erosion is on the increase, and vegetation is becoming more uniform.

The Grošnica reservoir was formed on hilly terrain at an elevation of 306m above sea level. It is 1750m long, 250m wide at its broadest, and 130m wide in its narrowest part. Surface area of the lake is 21.2 ha and maximal depth is 19m (Fig. 1.). The terrain around the reservoir is subject to erosion, with numerous gulleys and steep sides. The bed consists of rocky rubble carried into the water by strong littoral abrasion. The bottom is very steeply inclined toward the dam. Specific filling is very great-300 m/km yr and measures have been taken in the sense of afforestation and partitioning. Annual mud accretion is up to 54cm (JANKOVIĆ, 1965). Because that, the reservoir has been cleaned several times. In regard to physical, chemical, and biological parameters, the Grošnica reservoir is a satisfactory mesotrophic status. With respect to representation and abundance of heterotrophic bacteria, the Grošnica reservoir is on the I-II boundary (OSTOJIĆ, 2000).

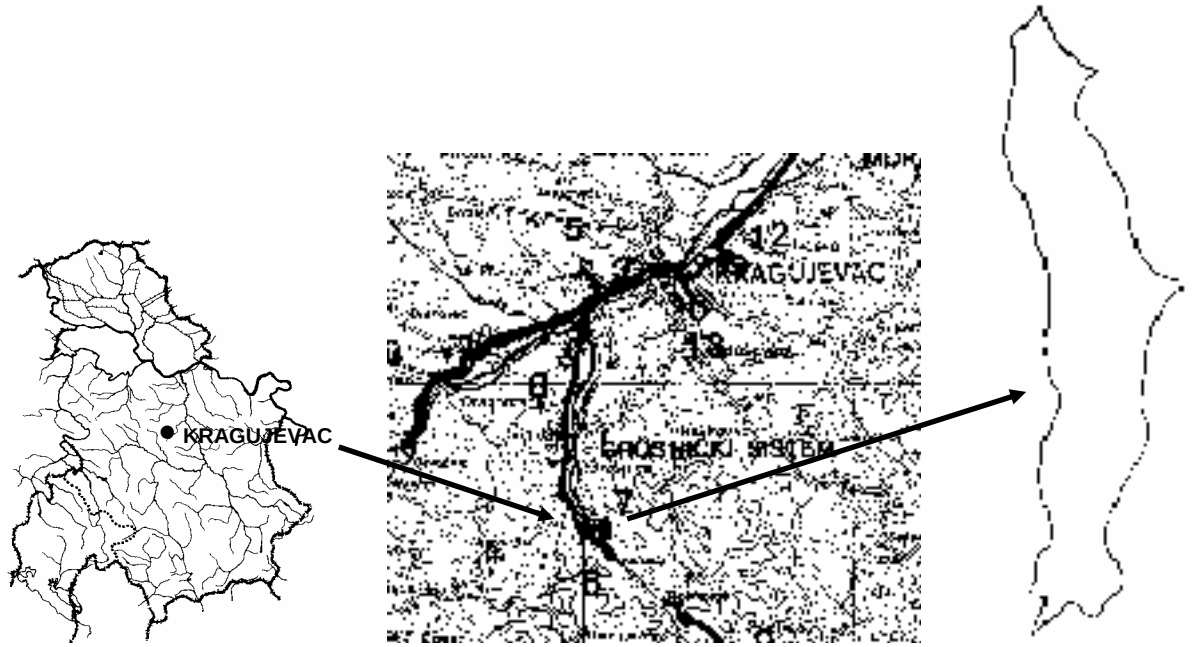

Fig. 1. Grošnica reservoir

Floristic investigation of vascular plants was carried out during the period 1999-2001. The collected plant material was herbarized or conserved in 4% formaldehyde and determined from JOSIFOVIĆ (1971) and according to JAVORKA & CHAPODY (1975). Ecological grouping of plants in regard to habitat moisture and other ecological factors was done according to KOJIĆ et al. (1997). Division into life forms was performed according to DIKLIĆ (1984), while floral elements were classified according to GAJIĆ (1984) and STEVANOVIĆ (1995).

RESULTS AND DISCUSION

The Grošnica reservoir was formed on favorable hilly terrain and has the appearance of a gorge with very steep sides. Its banks are subject to constant erosion and carrying away of rocky material, with the result that they do not afford a basis for development of swampy and aquatic vegetation. This is also helped by considerable variation of the water level (as much as 10-20m annually). In contrast to the wider area of the Grošnica basen, where the human influence caused large erosion of the terrain, human influence sourrounding the reservoir itself is minimal: there are no industrial concerns, settlements, or cultivated fields in the vicinity, the banks of the reservoir being entirely wooded. All these factors act favorably to promote slow aging of the lake.

In the wider surroundings of the lake, forest vegetation of the left bank hosts a *Fagetum montanum* (Rudski 1949) Jov. 1967. association, and the one on the right bank hosts *Quercetum confertae-cerris* Rudski 1940 and *Querco Carpinetum moesiacum* Rudski (1940) 1949 associations. Afforestation with species *Robinia pseudoacacia* L. has been carried out in a protective zone 5m wide. Along the shoreline, species *Salix alba* L. and *Cornus sanguinea* L. are present where the Grošnica river flows into the lake. In view of the appearance of the reservoir's banks and the conditions prevailing on them, it is understandable that true hydrophytes are represented by exceptionally few species (Tab.1).

The composition of vascular flora of the Grošnica reservoir is given in Table 1, from which it can be seen that 69 species are present, predominantly ones that are European (21 %) and Euroasian (16 %) floral elements.

An hemicriptophites (43,5%) and geophytes (20,3%) are dominant floristic among life forms.

In regard to moisture, mesophytes (43,4%) and submesophytes (28,9%) are dominant, whereas true hydrophytes are few species. Mesophytes adapted to temporary floating and nearness of water occur on the terrestic and limnose phases of the vertical profile along the banks. The appearance of *Najas minor* All. among submersed plants is recorded only sporadically. Indicating preparation of the substrate for more luxurient development of the rest of the flora, this species should be suppressed.

Table 1. Review of vascular flora of the Grošnica reservoir with floral elements, life forms and ecological index

Plant species	Floral Elements	Life form	Ecological index H	S	N	L	T
PTERIDOPHYTA							
Fam. **Equisetaceae**							
Equisetum telmateia Erhart..	Cirk.	G	4	3	2	4	3
SPERMATOPHYTA							
MAGNOLIOPSIDA							
Fam. **Ranunculaceae**							
Ranunculus repens L.	Euras.	H	4	3	3	3	3
Ranunculus ficaria L.	Subse.	G	3	3	4	3	3
Fam. **Urticaceae**							
Urtica dioica L.	Euras.	H	4	3	5	3	3
Parietaria officinalis L.	Smed.	H	3	4	4	3	4
Fam. **Polygonaceae**							
Polygonum amphibium L.	Subcirk.	G	5	3	4	3	3
Polygonum aviculare L.	Cosm.	T	3	3	4	4	3
Rumex obtusifolius L..	Subse.	H					
Rumex acetosa L.	Eur.	H	3	3	3	4	3
Fam. **Violaceae**							
Viola silvestris Lam.	Euras.	H	3	3	3	2	3
Fam. **Brassicaceae**							
Alliaria officinalis Andr.	Euras-subocean-Smed	H	3	3	4	3	3
Barbarea vulgaris R. Br.	Euras.	TH	3	3	3	4	3
Capsella bursa-pastoris (L.) Medic.	Cosm.	TH	2	3	3	4	3
Diplotaxis muralis (L.) DC	Smed (-Subatl)	TH	2	4	3	4	4
Roripa sylvestris (L.) Bess.	Euras.	H	4	4	3	4	4
Stellaria media (L.) Vill.	Cosm.	TH	3	3	4	3	3
Fam. **Salicaceae**							
Salix alba L.	Subeur.	P	4	4	4	3	3
Fam. **Primulaceae**							
Anagallis arvensis L.	Cosm.	T	3	3	3	3	3
Lysimachia vulgaris L.	Euras.	H	4	3	3	3	3
Fam. **Euphorbiaceae**							
Euphorbia cyparissias L.	Eur.	H	2	3	2	4	3
Euphorbia salicifolia Host.	Eur.	H	3	3	3	3	4
Euphorbia falcata L.	Med.	T	2	4	3	4	4
Fam. **Rosaceae**							
Potentilla reptans L.	Eur.	H	3	3	2	3	3
Rosa canina L.	Subse.	NP	3	3	2	3	3
Rubus caesium L.	Subj.sib.	NP	4	3	5	3	4
Fam. **Fabaceae**							
Vicia cracca L.	Eur.	H	3	3	3	4	3
Ononis spinosa L.	Subse.	ZC	2	3	2	4	5
Medicago lupulina L.	Eurassubocean-Smed.	TH	2	4	3	3	4
Fam. **Geraniaceae**							
Geranium molle L.	Med-Smed (-Subatl)	TH	2	3	3	4	3
Fam. **Cornaceae**							
Cornus sanguinea L.	Eur.	NP	3	4	3	3	3

Fam. **Oenotheraceae**							
Epilobium parviflorum (Schreb)With	Subeur.	H	4	3	3	4	3
Fam. **Apiaceae**							
Pastinaca sativa L.	Eur.	TH	3	4	3	4	3
Aegopodium podagraria L.	Euras.	G	3	3	4	2	3
Fam. **Gentianaceae**							
Centaurium umbelatum Gilib.	Eurmed.	TH	3	3	3	4	3
Fam. **Convolvulaceae**							
Calystegia sepium (L.)Br.	Euras-Smed	G	4	4	4	3	3
Fam. **Scrophulariaceae**							
Linaria vulgaris Mill .	Subse.	H	3	3	3	4	3
Verbascum pulverulentum Vill.	Atl-Med.	TH	2	4	3	4	5
Scrophularia nodosa L.	Euras.	H	3	3	3	2	3
Veronica baccabunga L.	Subeur.	H	5	3	4	3	3
Veronica chamaedrys L.	Eur.	G	3	3	3	3	3
Fam **Plantaginaceae**							
Plantago altissima L.	Eur.	H	4	3	2	4	4
Plantago major L.	Eur.	H	3	3	3	4	3
Fam. **Lamiaceae**							
Balota nigra L.	Subpont.	G	3	3	4	4	4
Glechoma hederacea L.	Eur.	H	3	3	3	3	3
Mentha aquatica L.	Eur.	G	5	3	3	3	3
Mentha longifolia (L)Nath.	Subse.	G	4	4	4	3	3
Stachys palustris L.	Cirk.	G	4	4	5	4	4
Lycopus europaeus L.	Euras.	G	5	3	3	3	3
Fam. **Verbenace**							
Verbena officinalis L.	Cosm.	TH	2	3	4	4	3
Fam. **Asteraceae**							
Achillea millefolium L.	Eur.	H	2	3	3	4	3
Crepis paludosa (L.) Mnch.	Euras.	H	4	4	3	3	2
Crepis foetida L.	Smed-Subatl.	TH	2	3	3	4	4
Centaurea jacea L.	Subeur.	H	3	3	3	4	3
Cirsium arvense (L.) Scop.	Euras.	G	3	3	4	4	4
Erigeron canadensis L.	Cosm.	TH	2	3	3	4	4
Eupatorium cannabinum L.	Subse	H	4	4	3	3	3
Inula britanica L.	Subse.	H	4	4	3	3	4
Pulicaria dysenterica (L.) Bernh.	Subse	G	4	3	3	4	3
Stenactis annua (L.)Nees.	Adv.	TH	3	3	3	4	4
Tanacetum vulgare L.	Eur.	H	3	3	3	4	3
Taraxacum officinale Web.	Eur.	H	3	3	4	4	3
Xanthium strumarium L.	Med-kont.	T	3	3	4	4	5
LILIOPSIDA							
Fam. **Najadaceae**							
Najas minor All..	Subeur.	A	6	4	2	3	4
Fam. **Juncaceae**							
Juncus conglomeratus L.	Cirk.	H	4	2	3	4	3
Juncus effusus L.	Subcirk.	H	4	2	3	3	3
Fam. **Poaceae**							
Agrostis alba L.	no-Euras (-Smed)	H	4	3	3	4	3
Poa anua L.	no-Euras-med	T	3	3	4	4	3
Setaria glauca (L.)	Cosm.	T	2	3	3	4	4

Fam.**Typhaceae**							
Typha latyfolia L.	Cosm.	G	5	3	3	4	4

Where the river flows into the lake, the flotant species *Polygonum amphibium* L. is dominant. It is massively present and forms a muddy meadow causing the lake to be overgrown in its shallowest part. The emersed plant species *Typha latifolia* L., which mentioned by JANKOVIĆ (1965) on this place, can now be found some 50m up the river.

In regard to soils sour, neutrophylic (72%) and plants in transition to basophylic species (20%) are dominant; in regard to content ammonium in soil, mesotrophic (56,5%) and plants in transition to eutrophic species (24,6%) are dominant (Tab.1).

In regard to light, plants in transition to heliophites (49,2%) and semisciophites (40,5%) are dominant; in regard to temperature, mesotherms (66,6%) and plants in transition to termophilic species (23,1%) are dominant (Tab.1).

The most of the species belongs to the weed vegetations: wet class Bidentetea tripartiti Tx., Lohm.et Prsg.1950, and temperate wet and temperate worm class Chenopodietea albae Br.-Bl.1951. em. Lohm.et Tx. 1961.

The weed species are found around all waters, especially around stagnant and slowrunning waters. The origin of these species on these terrains can be from surrounding terciar vegetation of the cultivated areas and around human settlements; from the seeds brought by the water, or it could be natural- because of the larger amount of water in the soil and the bad air regime in it; or by decomposement of either the plant parts or the whole older plants with the low mineralization level. In the case of the Grošnica reservoir, the species whose seeds were brought by water are dominant, due to steep banks and forest surrounding.

CONCLUSIONS

The time and manner of formation of the Grošnica reservoir, together with the extent of human influence on them, is reflected in the presence and composition of vascular flora. Due to its steep mudless banks, considerable oscillations of the water level, and protection from human influence, the Grošnica reservoir has a poorly developed vascular flora. It is represented for the most part by mesophytes on the terrestic and limnose part of the profile, whereas true hydrophytes are few. Sporadic occurrence of *Najas minor* All. confirms increase of nutrients in the sediment and implies appearance of more luxurient vegetation in the future. Overgrowth by *Polygonum* constitutes a threat to the shallowest part of the lake.

Floristic investigation revealed the presence of a 69 species of vascular plants belonging to 26 families. Vascular flora of the Grošnica reservoir contains different floral elements, European and Euroasian

forms being represented to the greatest extent. Hemicriptophytes and geophites are the most common life forms.

- Most of the species belongs to the weed vegetations

--Hydrophilic vegetation tends to make the littoral zone of lake shallower. It is especially well developed in their initial and shallow parts, which have the characteristics of a swamp. The most significant role in overgrowth of these reservoirs is played by the species *Polygonum amphibium* L.

--The presence of macrophytes on the investigated reservoir is not excessive, with the result that they are still desirable components of the lake for biofiltration of the large influx of allochthonic nutrients, regulation of the development of phytoplankton and Cyanophyta, and competition with algae for nutrients.

--Together with other measures, monitoring of further development of the macrophytes and its regulation are needed for conservation of the investigated reservoir.

ACKNOWLEDGMENTS

This research was supported by the Ministry of Science, Technology and Development of Serbia, grant No. 1252 (project "Biomonitoring and Ecological protection of Reservoirs for water supply of Kragujevac").

References

[1] ČOMIĆ, Lj., MILOŠEVIĆ, S., ĆURČIĆ, S. (1999): *Community of bacteria in Grošnica reservoir (Serbia),* First Balkan Conference of Microbiology, Microbiology Balcanica, Plovdiv, Bulgaria., *Abstracts*, 246.

[2] DIKLIĆ, M. (1984): *Životne forme biljnih vrsta i biološki spektar flore SR Srbije*, In Sarić,M.R. (ed*)* Vegetacija SR Srbije*,* I Opšti deo. SANU, Beograd 219-316.

[3] Gajić, M.R. (1984*)*: *Florni elementi SR Srbije*. In: Sarić,M.R. (ed*)* Vegetacija SR Srbije*,* I Opšti deo, SANU, Beograd, 317-397.

[4] JANKOVIĆ, M.J. (1965): *Limnološka ispitivanja baražnog jezera kod Grošnice*. Doktorska disertacija, Univerzitet u Beogradu., 1-332.

[5] JAVORKA, S., CSAPODY, V. (1975): *Iconographia Florae Partis Austro-Orientalis Europae Centralis,* Academiai Kiado, Budapest.

[6] JOSIFOVIĆ, M. (1970-1980): (ed) *Flora SR Srbije I-X*. SANU, Beograd.

[7] KOJIĆ, M., POPOVIĆ, R., KARADŽIĆ, B., *Vaskularne biljke Srbije kao indikatori staništa*, Institut za istraživanja u poljoprivredi »Srbija«, Institut za biološka istraživanja »Siniša Stanković«, Beograd, (1997)

[8] MILOŠEVIĆ, S., RANKOVIĆ, B., ČOMIĆ, Lj. (2000): *Composition and dynamics of phyto-plankton in Grošnica reservoir (Serbia).* Second Balkan Botanical Congress, Istanbul.. *Abstracts* 173.

[9] OSTOJIĆ, A., SIMIĆ, V. (1999): *Cyclomorphosis in Daphnia cucullata f. kahlbergensis Schoedler1886 (Cladocera) of the Grosnica Reservoir,* Arch.Biol.Sci. 51, No 1, 51-57.

[10] OSTOJIĆ, A. (2000): *Uporedno ekološka studija zooplanktona akumulacija Grošnica i Gruža,* Doktorska disertacija, Univerzitet u Beogradu., 186pp.

[11] STEVANOVIĆ, V. (1995): *Biogeografska podela teritorije Jugoslavije*. In: STEVANOVIĆ, V., VASIĆ, V. (ur) 1995: Biodiverzitet Jugoslavije sa pregledom vrsta od međunarodnog značaja, Biološki fakultet i Ekolibri, Beograd,

[12] VELJOVIĆ, V. (1967): *Vegetacija okoline Kragujevca*, Glasnik Prirodnjačkog muzeja, Ser.B, 22, 1-180.

[13] VELJOVIĆ, V., MARKOVIĆ, A., VUKOMANOVIĆ, V. (1986): *Dijagnostički značaj pojave makrofitske flore i vegetacije u novoformiranim akumulacionim jezerima*, Konferencija »Zaštita voda 86«, Kragujevac, Zbornik radova, 82-86.