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Macrophytes in the Veleka River, Bulgaria: Species Diversity and Assessment of the Ecological Status

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Abstract. Thirty-seven aquatic macrophyte species from three taxonomic groups (pteridophytes, bryophytes, spermatophytes) were registered at four sites along Veleka River in the period 2009-2020. Hydrophytes and bryophytes dominated macrophyte assemblages. Macrophyte-based assessment resulted in good and high ecological status. Based on the results it was suggested the lower Veleka River to be regularly studied in order to maintain its good ecological status and to monitor the highly invasive *Elodea canadensis* and *Elodea nuttallii*.

Key words: aquatic macrophytes, invasive macrophytes, ecological status.

Introduction

Veleka River is the largest and the longest river in Strandzha Mountain, Southeastern part of Bulgaria. It springs into Turkish territory through many karst springs;, runs through primary forest ecosystems within the natural park Strandzha and flows into the Black Sea, near the village of Sinemorets. Its watershed covers an area of 1054.6 km^2 of which 788 km^2 on the territory of Bulgaria (Lizama-Rivas & Koleva-Lizama, 2017).

A strong reduction in river flow during 1991-2007 was reported with 44% decline in mean annual volumes (Lizama-Rivas & Koleva-Lizama, 2017). In addition, in the area of Veleka River the forecast for change in the flow is the spring flow to decrease to 30%, summer to 35% (Environmental Assessment Report of the draft Cross-Border Cooperation Programme 2021-2027, 2021).

Biological literature data for Veleka River canyon are scarce. Algae cenoses were studied in 2010–2012 (Velichkova & Kiryakov, 2014), as well as the two native freshwater turtles (*Emys orbicularis* and *Mauremys rivulata*) were studied in 2010–2014 (Popgeorgiev et al., 2017) and again in 2021 (Mollov et al., 2021).

Macrophytes – the major primary producers in rivers, food and refuge for macroinvertebrates and fish, are one of the biological elements for assessing the ecological status. There were no published data for macrophyte communities along Veleka River in Bulgaria and the current study aimed to contribute to the knowledge of aquatic flora in the river.

Material and Methods

The data was collected during the period 2009 to 2020 years and covered 3

different river types (R4, R10 and R16) and 4 sites (Fig.1). Aquatic macrophytes were studied along a 100 m sections and records were made at species level. The nomenclature followed Hill et al. (2006) for mosses and Euro + Med (Euro+Med PlantBase, 2022) for vascular plants. The abundance was registered using a five-level scale (Kohler, 1978): 1 = very rare, 2 = infrequent, 3 = common, 4 = frequent, 5 = abundant, predominant.

The database contained also abiotic data featuring site characteristics (altitude, channel width and level, flow velocity, etc.) and some basic physio-chemical characteristics (pH, temperature, electrical conductivity). Abiotic parameters flow velocity, shading, mean water level were determined in a semi-quantitative way as described in Gecheva et al. (2021).

Reference Index (RI) and ecological quality ratio (EQR) were calculated after Gecheva et al. (2013).

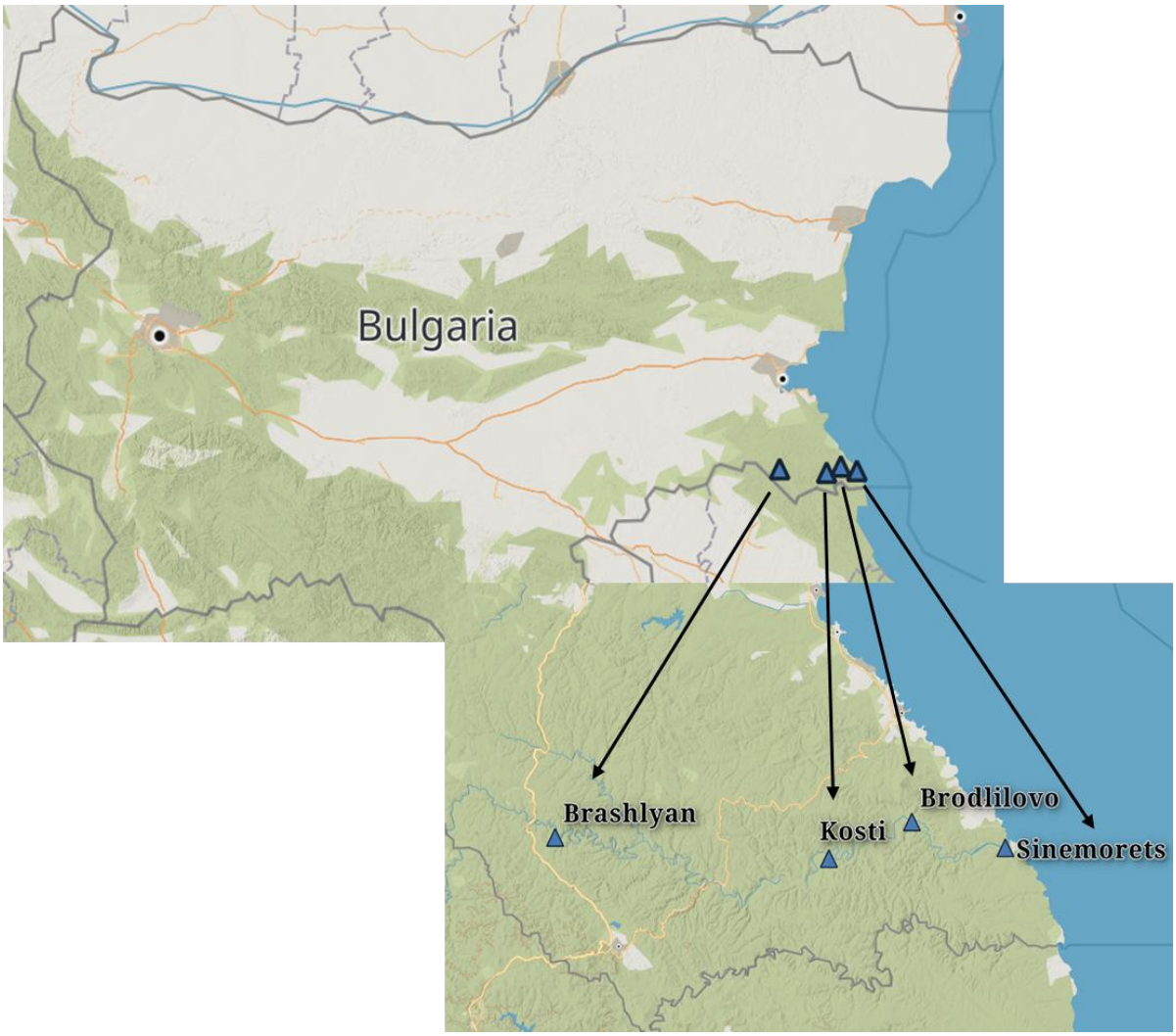

Fig. 1. Location of the studied sites.

Results and Discussion

Studied sites along the upper Veleka River were slightly alkaline and with moderate conductivity, while river water at the mouth was influenced by the Black Sea (Table 1).

Thirty-seven species from 3 taxonomic groups (bryophytes, pteridophytes, spermatophytes) were recorded (Table 2). Almost 40% of taxa were hydrophytes. Helophytes (n=15) were the second largest group. Only 3 aquatic moss species were registered but they were common for all river sites of the upper and middle Veleka River. *Platyhypnidium riparioides*, indicator of undisturbed habitats, dominated communities at sites close to Brashlyan and Kosti villages. *Myriophyllum spicatum* was the most common species along the river.

Species richness varied between 5 and 14 taxa. Sites with highest richness were those close to Brodilovo and Sinemorets villages. The macrophyte assemblage at the last site in 2020, was dominated by hornwort, naiads and waterweeds, and includes also endangered yellow waterlily and pondweeds. Two invasive aquatic macrophyte species *Elodea nuttallii* and *Elodea canadensis* were recorded during the last sampling campaign at the site. Both species tolerate disturbances, brackish water and salinity (Josefsson, 2011). Among the *Elodea* species negative effects are rapid development of dense monospecific stands, decreased light penetration and water movement. Thus, in the next years it should be monitored whether they will occur upstream and if they replace natural aquatic macrophytes.

The macrophyte-based ecological status was in the range from good to high for the studied 4 sites during the years 2009 to 2020 (Table 1). The assessed good status at the semi-mountain river site in 2009 can be linked to the slight deterioration of the water, particularly of nitrate nitrogen (Environmental Assessment Report of the draft Cross-Border Cooperation Programme 2021-2027, 2021). As pointed out above, the lower Veleka River has to be regularly studied in order to maintain its good ecological status and to monitor the highly invasive taxa development.

Table 1. List of the studied sites, coordinates, altitude, abiotic and physio-chemical parameters. Legend: R4 – semi-mountain rivers in Ecoregion 12 Pontic province; R10 – large Black Sea rivers; R16 – Balck Sea river firths in Ecoregion 12 Pontic province.

Site	**Brashlyan village**	**before Kosti village**	**Brodlilovo village**	**Sinemorets village**
National type	R4	R10	R10	R16
Latitude	42.068957	42.051667	42.0815	42.0605
Longitude	27.452058	27.765	27.85983333	27.96669
Altitude (m a.s.l.)	240	27	14	4
Mean width (m)	6	6	6	50
Velocity	rapidly running	slowly running	slowly running	barely visible
Shading	sunny	completely shaded	sunny	sunny
Water level	medium	low	low	low
pH	8.7	7.9	8.2	9.1
T (°C)	16.4	16.3	19.6	25.1
C (µS cm^{-1})	298	468	401	838
Macrophyte-based status	good	high	high	good

Table 2. List of the registered aquatic macrophte species and groups with regard the link to the water after Birk et al. (2007). Legend: BRm - mosses; PHe - helophytes ; PHg - hygrophytes; PHy - hydrophytes; PTE - pteridophytes.

Species	Group
Bidens tripartita L.	PHe
Bryum pallens Sw. ex anon.	BRm
Carex acuta L.	PHe
Ceratophyllum demersum L.	PHy
Cyperus fuscus L.	PHe
Cyperus longus L.	PHg
Elodea canadensis Michx.	PHy
Elodea nuttallii (Planch.) H.St.John	PHy
Equisetum arvense L.	PTE
Equisetum telmateia Ehrh.	PTE
Groenlandia densa (L.) Fourr.	PHy
Juncus effusus L.	PHe
Lemna minor L.	PHy
Leptodictyum riparium (Hedw.) Warnst.	BRm
Lycopus europaeus L.	PHe
Lythrum salicaria L.	PHe
Mentha aquatica L.	PHe
Myriophyllum spicatum L.	PHy
Najas marina L.	PHy
Najas minor All.	PHy
Nuphar lutea Sm.	PHy
Iris pseudacorus L.	PHe
Paspalum paspalodes (Michx.) Scribn.	PHg
Phragmites australis (Cav.) Trin. ex Steud.	PHe
Platyhypnidium riparioides (Hedw.) Dixon	BRm
Polygonum hydropiper L.	PHe
Polygonum lapathifolium L.	PHe
Polygonum mite Schrank	PHe
Potamogeton crispus L.	PHy
Potamogeton natans L.	PHy
Potamogeton nodosus Poir.	PHy
Potamogeton perfoliatus L.	PHy
Potamogeton polygonifolius Pourr.	PHy
Ranunculus repens L.	PHg
Sparganium erectum L.	PHe
Typha angustifolia L.	PHe
Typha latifolia L.	PHe

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