

Flora of the Mediterranean Rivers in Bulgaria

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Abstract. Species composition and distribution of aquatic bryophytes and vascular plants assemblages in Mediterranean Rivers in Bulgaria are presented in this work. Aquatic macrophytes were studied at thirteen rivers in South Bulgaria during 2014, together with abiotic factors (flow velocity, shading, and substrate type), mean depth and altitude. In total, 73 species were registered, of them 13 bryophytes and 60 vascular plants were identified. Aquatic bryophytes included 10 mosses and 3 liverworts. The recorded bryophytes species refer to 7 families and 12 genera. The most frequently distributed species was *Leptodictyum riparium* (Hedw.) Warnst., followed by *Cratoneuron filicinum* (Hedw.) Spruce and *Platyhypnidium riparioides* (Hedw.) Dixon, *Brachythecium rivulare* Schimp. and *Hygroamblystegium tenax* (Hedw.) Jenn. The recorded 60 species of vascular plants refer to 25 families and 43 genera. The most common hydrophyte species was *Lemna minor* L., followed by *Ranunculus trichophyllus* Chaix, *Myriophyllum spicatum* L. and *Potamogeton nodosus* Poir. The most abundant species from the group of helophytes and amphiphytes was *Mentha aquatica* L., followed by *Agrostis stolonifera* L. *Mentha spicata* L., *Berula erecta* (Huds.) Coville, *Juncus effusus* L., *Lycopus europaeus* L., *Lythrum salicaria* L., *Phalaris arundinacea* L., *Ranunculus repens* L., *Sparganium erectum* L., *Typha latifolia* L., and *Veronica anagalis-aquatica* L. The majority of studied rivers sites were sunny, with moderate velocity, stony bottom, average depth up to 0.3 m and altitude between 100 and 500 m a.s.l.

Keywords: Flora, Mediterranean rivers, Bulgaria.

Introduction

River flora and vegetation comprise species which are a group of macroscopic photosynthetic organisms that colonize a multiplicity of habitats from submersed and emerged rocks to soft substrates, bankside edges tree trunks and roots, and that can also occur unattached on the water surface. These plants are represented by 7 plant divisions: Cyanobacteria, Chlorophyta, Rhodophyta, Xanthophyta, Bryophyta, Pteridophyta, and Spermatophyta. Species composition and distribution of aquatic bryophytes (Bryophyta) assemblages are

less well-known than for the aquatic vascular plants (Pteridophyta and Spermatophyta), which are represented by 88 families with 2614 species belonging to 412 genera. These 2614 aquatic species of Pteridophyta and Spermatophyta evolved from land plants and represent only a small fraction (-1%) of the total number of vascular plants (CHAMBERS *et al.*, 2008). Local habitat characteristics determine species composition of aquatic bryophytes and vascular plants, particularly light availability, current velocity and sediment patterns (BIRK & WILLBY, 2010). Rocks and

hard, immobile substrates and variable flow regime are associated with bryophytes and the exclusion of vascular hydrophytes (SCARLETT & O'HARE, 2006).

Bryophytes are dominants in lotic ecosystems, especially in undisturbed conditions. River bryophyte flora and vegetation in Bulgaria comprise about 94 species growing in or beside the water. According to current data on the distribution of aquatic macrophytes in Bulgaria, vascular plants (Pteridophyta and Spermatophyta) count of 345 species, belonging to 158 genera of 66 families. They comprise only 9% of the total number of vascular plants, which are 4030 species for the country (PETROVA & VLADIMIROV, 2010). About 68 species of aquatic vascular plants are submerged (plants that grow completely submerged under the water, with roots or root-analogues in, attached to, or closely associated with the substrate), free-floating macrophytes (plants that typically float on or under the water surface) and 277 species are emergent organisms tolerant to seasonal drought (plants that are rooted in submerged soils or soils that are periodically inundated, with foliage extending into the air). Families of highest species richness are: *Cyperaceae* (66 species), *Poaceae* (22), *Ranunculaceae* (20), *Potamogetonaceae* (17). The most species are belonged to the genera: *Carex* (29), *Potamogeton* (15), *Ranunculus* (13), *Juncus* (13), *Cyperus* (11), *Equisetum* (8) and *Oenanthe* (7).

Studies related to aquatic macrophytes are part of floristic investigation in Bulgaria. The extent and level of knowledge on river flora and vegetation in the country by the end of the 20th century were generalized and analysed by VODENITCHAROV *et al.* (1993) and APOSTOLOVA (2007). In recent years numerous floristic reports were published identifying new fields of aquatic macrophytes in the country (PETROVA, 2008; 2010; PETROVA *et al.*, 2009; 2010; SOPOTLIEVA, 2006). Also a new "key" for determining the species of narrow-leaved group of representatives of the genus *Potamogeton*, as well as information about their distribution was updated and two new species for

Bulgarian flora were reported - *P. obtusifolius* Mert. & W.D.J.Koch and *P. berchtoldii* Fieber (KIRYAKOV & CHESHMEDJIEV, 2007). The species composition and abundance of macrophytes in Natural Park "Vrachanski Balkan" were studied (VALCHEV & STOIEVA, 2010), the diversity of aquatic vascular plants and conservation significance species of the macrophytes along the Danube (YURUKOVA, 2002; VALCHEV *et al.*, 2006), as well as the hygrophytes and hydrophytes vegetation in some protected areas near the Danube (TZONEV, 2009).

Mediterranean River typology is characterised by a predictable annual cycle of flood and drought that varies in intensity according to the levels and duration of annual and interannual rainfall (HUGHES *et al.*, 2009). This is the first study describing the aquatic macrophytes composition and distribution, relation to abiotic habitat factors (flow velocity, shading, substrate type), and relative abundance of species of Mediterranean Rivers in Bulgaria. Altitude and riparian vegetation were also discussed.

Materials and Methods

Aquatic macrophytes were studied in the beginning of growing season (mid May 2014) at 15 sampling sites along thirteen rivers in South Bulgaria (Fig. 1). All bryophytes and vascular plants were included in 3 groups: hydrophytes, amphiphytes (species capable of growing on land or in water), and helophytes (emergent plants, rooted under water). Species were recorded together with site descriptions (speed of the water flow, shading, substrate type, mean depth and altitude, riparian vegetation). The length of a survey site was approximately 100 m. Bryophyte samples were stored in collecting packets, determined in the laboratory according to PETROV (1975) and SMITH (1980, 2004). Nomenclature accepted in GROLLE & LONG (2000) for liverworts and HILL *et al.* (2006) for mosses was followed. The taxonomy of vascular plants followed Flora Europaea (TUTIN *et al.*, 1964-1980, 1993). Macrophyte relative abundance was quantified based on

percentage frequency of occurrence at 15 sampling sites.

Speed of the water flow, shading and mean depth were determined according to [SCHAUMBURG et al. \(2004, 2006\)](#) in a semi-quantitative way using class scales, to enable a fast and easy field application. Velocity of flow was recorded via a 6-point scale: I = not visible, II = barely visible, III = slowly running, IV = rapidly running (current with moderate turbulences), V = rapidly running (turbulently running), VI = torrential. The substratum conditions at the

sampling site were classified in 5% steps according to an 8-point scale: % mud, % clay/loam (<0.063 mm), % sand (0.063–2.0 mm), % fine/medium gravel (2.0–6.3/6.3–20 mm), % coarse gravel (20–63 mm), % stones (63–200 mm), % boulders (>200 mm), and % organic/peat. Mean depth was noted on a 3-degree scale (I = 0–30 cm, II = 30–100 cm, III >100 cm). Shading was noted based on the 5-degree scale (1 = completely sunny, 2 = sunny, 3 = partly overcast, 4 = half-shaded, 5 = completely shaded) of [WÖRLEIN \(1992\)](#).

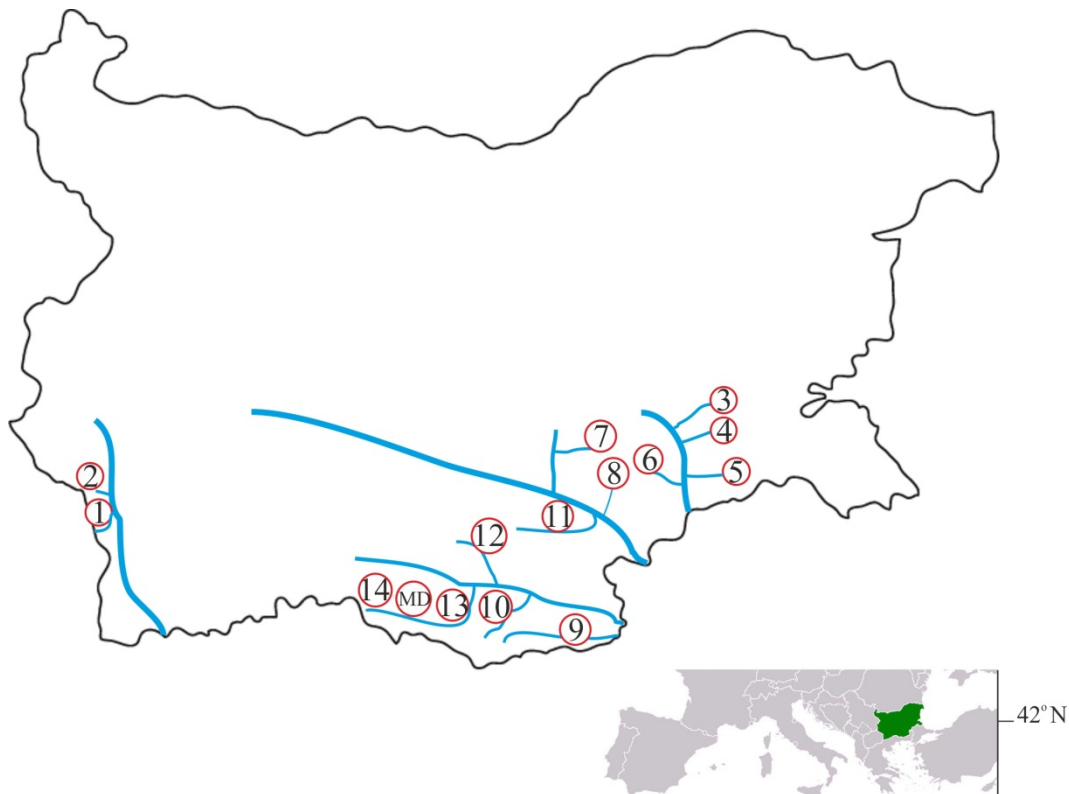


Fig 1. Location of the studied Mediterranean rivers in Bulgaria. Sites: 1-Brezhanska, 2-Stara, 3-Dereorman, 4-Popovska, 5-Melnishka, 6-Manastirska, 7-Sokolitsa, 8-Yerusalimovska, 9-Byala, 10-Krumovitsa, 11-Biserska, 12-Perpererek, 13-Varbitsa before Studen Kladenets Dam, 14-Varbitsa before Zlatograd town; MD-Macrophyte depopulation: Varbitsa–Krilatitsa bridge.

Results and Discussion

Taxonomic composition

The list of aquatic bryophytes (Bryophyta) and vascular plants (Pteridophyta and Spermatophyta) were presented (Table 1). In total, 73 species were observed, of which 13 were bryophytes, registered at 9 sites. Aquatic vascular plant determined patterns of distribution at 14

sites, where 60 species were registered including 8 hydrophytes and 52 helophytes and amphiphytes. Macrophyte depopulation was assessed at 1 site. Aquatic bryophytes include 10 mosses and 3 liverworts. The recorded bryophytes species referred to 7 families and 12 genera. The most frequently distributed bryophyte was *Leptodictyum riparium* (at 7 sites, relative

abundance 47%), followed by *Cratoneuron filicinum*, *Platyhypnidium riparioides* (at 4 sites, relative abundance 27%), *Brachythecium rivulare* and *Hygroamblystegium tenax* (at 3 sites, relative abundance 20%). Vascular plants referred to 25 families and 43 genera. The most common hydrophyte was *Lemna minor* L. (at 5 site, relative abundance 33%), followed by *Ranunculus trichophyllus* (at 4 site, relative abundance near 27%), *Myriophyllum spicatum* and *Potamogeton nodosus* (at 3 site, relative abundance 20%). The most abundant species from the group of helophytes and amphiphytes was *Mentha aquatica* (at 8 site, relative abundance 53%),

followed by *Agrostis stolonifera* and *Mentha spicata* (at 7 site, relative abundance near 47%), *Berula erecta*, *Juncus effusus*, *Lycopus europaeus*, *Lythrum salicaria*, *Phalaris arundinacea*, *Ranunculus repens*, *Sparganium erectum*, *Typha latifolia*, *Veronica anagalis-aquatica* (at 6 site, relative abundance 40%).

Two species were critically endangered: hydrophyte *Groenlandia densa* and helophyte *Myricaria germanica* (DIMITROVA, 2012; GUSSEV, 2012; PETROVA & VLADIMIROV, 2009).

Almost 65% of the 19 most frequent species for the common Mediterranean rivers type (AGUIAR *et al.*, 2014) were registered at studied Bulgarian rivers.

Table 1. List of registered bryophytes and vascular plants.

Species	Number of registered sites	Relative abundance, %
Bryophytes		
<i>Amblystegium humile</i> (P. Beauv.) Crundw.	1	6.7
<i>Aneura pinguis</i> (L.) Dumort.	1	6.7
<i>Brachythecium rivulare</i> Schimp.	3	20
<i>Brachythecium rutabulum</i> (Hedw.) Schimp.	1	6.7
<i>Bryum pallens</i> Sw. ex anon.	1	6.7
<i>Cratoneuron filicinum</i> (Hedw.) Spruce	4	26.7
<i>Eurhynchium swartzii</i> (Turner) Curn.	1	6.7
<i>Fontinalis hypnoides</i> C.Hartm.	1	6.7
<i>Hygroamblystegium tenax</i> (Hedw.) Jenn.	3	20
<i>Leptodictyum riparium</i> (Hedw.) Warnst.	7	46.7
<i>Marchantia polymorpha</i> L.	1	6.7
<i>Pellia endiviifolia</i> (Dicks.) Dumort.	2	13.3
<i>Platyhypnidium riparioides</i> (Hedw.) Dixon	4	26.7
Vascular plants		
Hydrophytes		
<i>Callitriche platycarpa</i> Kütz.	1	6.7
<i>Groenlandia densa</i> (L.) Fourr.	1	6.7
<i>Lemna minor</i> L.	5	33.3
<i>Myriophyllum spicatum</i> L.	3	20
<i>Potamogeton pusillus</i> L.	1	6.7
<i>Potamogeton crispus</i> L.	2	13.3
<i>Potamogeton nodosus</i> Poir.	3	20
<i>Ranunculus trichophyllus</i> Chaix	4	26.7
Helophytes & Amphiphytes		
<i>Agrostis stolonifera</i> L.	7	46.7
<i>Alisma lanceolatum</i> With.	3	20
<i>Berula erecta</i> (Huds.) Coville	6	40
<i>Cardamine amara</i> L.	1	6.7

<i>Carex pseudocyperus</i> L.	2	13.3
<i>Carex remota</i> L.	1	6.7
<i>Carex riparia</i> Curtis	4	26.7
<i>Carex vulpina</i> L.	1	6.7
<i>Cyperus longus</i> L.	2	13.3
<i>Echinochloa crus-galli</i> (L.) P.Beauv.	2	13.3
<i>Eleocharis palustris</i> (L.) Roem. & Schult.	1	6.7
<i>Equisetum arvense</i> L.	4	26.7
<i>Equisetum palustre</i> L.	3	20
<i>Galium uliginosum</i> L.	2	13.3
<i>Glyceria fluitans</i> (L.) R. Br.	1	6.7
<i>Glyceria maxima</i> (Hartm.) Holmb.	1	6.7
<i>Juncus articulatus</i> L.	1	6.7
<i>Juncus effusus</i> L.	6	40
<i>Lycopus europaeus</i> L.	6	40
<i>Lycopus exaltatus</i> L.f.	2	13.3
<i>Lysimachia nummularia</i> L.	4	26.7
<i>Lythrum salicaria</i> L.	6	40
<i>Mentha aquatica</i> L.	8	53.3
<i>Mentha spicata</i> L.	7	46.7
<i>Myosotis palustris</i> (L.) Nath.	1	6.7
<i>Myosoton aquaticum</i> (L.) Moench	1	6.7
<i>Myricaria germanica</i> (L.) Desv.	1	6.7
<i>Nasturtium officinale</i> R.Br.	3	20
<i>Oenanthe aquatica</i> (L.) Poir.	1	6.7
<i>Paspalum paspalodes</i> (Michx.) Scribn.	3	20
<i>Persicaria lapathifolia</i> (L.) Delarbre	1	6.7
<i>Persicaria maculosa</i> Gray	1	6.7
<i>Petasites hybridus</i> (L.) P.Gaertn. B.Mey. & Scherb.	2	13.3
<i>Phalaris arundinacea</i> L.	6	40
<i>Phragmites australis</i> (Cav.) Trin. ex Steud.	1	6.7
<i>Plantago lanceolata</i> L.	1	6.7
<i>Polygonum hydropiper</i> L.	1	6.7
<i>Polygonum mite</i> Schrank	1	6.7
<i>Ranunculus muricatus</i> L.	1	6.7
<i>Ranunculus repens</i> L.	6	40
<i>Rorippa sylvestris</i> (L.) Besser	3	20
<i>Rumex aquaticus</i> L.	1	6.7
<i>Rumex crispus</i> L.	1	6.7
<i>Scirpus lacustris</i> L.	3	20
<i>Solanum dulcamara</i> L.	1	6.7
<i>Sparganium erectum</i> L.	6	40
<i>Stellaria nemorum</i> L.	1	6.7
<i>Typha angustifolia</i> L.	2	13.3
<i>Typha latifolia</i> L.	6	40
<i>Veronica anagalis-aquatica</i> L.	6	40
<i>Veronica catenata</i> Pennell	2	13.3
<i>Veronica beccabunga</i> L.	3	20

Site characteristics

The majority of the studied Mediterranean Rivers were sunny, with moderate flow velocity and coarse bottom and average depth up to 0.3 m. The altitude of the rivers was between 100 and 500 m and the vegetation along the riverside was dominated by forests and agricultural areas. The site along Varbitsa River, near Krilatitsa village, assessed in macrophyte depopulation was characterized with rapidly running water and substrate was presented by sand and gravel. Thus, it was assumed that natural site characteristics accounted for the depopulation.

Conclusions

Seventy-three species were registered in studied 13 highly seasonal rivers in Bulgaria during 2014; among them were recorded 65% of the most frequent species for the common Mediterranean rivers type. Macrophyte flora at these small and medium streams was represented by both bryophytes and vascular plants. The most distributed bryophyte was *Leptodictyum riparium*, while *Lemna minor* was the most common hydrophyte. The most frequent bank species was *Mentha aquatica*. Based on this first preliminary study of Mediterranean rivers in Bulgaria, it could be summarized that species-rich macrophyte communities were recorded.

Acknowledgements

The research is a part of the project: "Intercalibration of the methods for analysis of biological quality elements (BQE) for the types of surface waters on the territory of Bulgaria, corresponding to common European types in the Geographical intercalibration groups" led by DICON-UBA (Dicon Group Ltd and the Austrian Environmental Agency - Umweltbundesamt Austria); Team leader: Dr. Robert Konecny; funded by Ministry of Environment and Waters, Bulgaria.

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Received: 11.05.2015

Accepted: 12.06.2015