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MACROPHYTE VEGETATION ASSESSMENT IN STREAMS OF THE VENTA RIVER BASIN DISTRICT

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The species composition and dominating species were determined in 30 sites located in the Venta River Basin district on 26 streams during the vegetation period in 2006, 2007, 2008 and 2013.

A total of 57 macrophyte taxa were found in the investigated streams. 49 taxa were indentified to species level, but 8 taxa – to genus level. The macrophyte communities in the streams were dominated by *Phalaris arundinacea* (80% of the sites), *Nuphar lutea* (70%), *Carex* sp. (63%), *Scirpus sylvaticus* (53%) and *Sium latifolium* (50%). The species richness ranged from 4 to 18 species per site. The lowest number of species was found in the river Pūre, but the largest number of species was in the river Rinda.

Key words: macrophytes, running waters, macrophyte diversity,Venta river basin district.

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INTRODUCTION

Aquatic macrophytes are aquatic photosynthetic organisms, large enough to see with the naked eye, that actively grow permanently or periodically submerged below, floating on, or growing up through the water surface (Chambers et al. 2008). The European Water Framework Directive (Directive 2000/60/EC – Establishing a Framework for Community Action in the Field of Water Policy, WFD) lists aquatic macrophytes as one of the biological quality elements needed for assessing the ecological status of surface water bodies (Anonymous 2000). There are several advantages in using macrophytes for biological monitoring. Macrophytes are non-mobile and therefore present responses to local environmental changes. They can also integrate environmental changes over periods of a few years, and the cumulative effects of successive disturbances (Brabec & Szoszkiewicz 2006). Macrophytes are an important influence on the ecology of rivers (Sand-Jensen 1998). As a major source of primary production they interact directly with higher trophic levels in a variety of ways, they directly or indirectly determine the level of physical habitat support for macroinvertebrates and fish, and exert a significant influence on the efficiency and spatial variation in transport of both water and sediment (Dawson 1978), as well as regulation fluxes of key nutrients (Kleeberg & Heidenreich 2004, Birk & Willby 2010).

In understanding the long-term changes in freshwater ecosystems, the composition and diversity of aquatic plants are considered as one of the most significant indicators of the ecological quality of waters. In comparison to other organisms, macrophytes are slower in reacting to environmental changes, however, they are suitable indicators in assessments of long-term changes. The role of macrophytes in aquatic environments and the possibility to use them as indicators in assessing the water quality attracts more and more attention worldwide (Onaindia et al. 2005).

The relationship between aquatic macrophytes and the trophic status of rivers is a complex one because of the synergistic effects of a range of environmental variables – stream velocity (Haslam 1978, Riis & Biggs 2003, Franklin et al. 2008, Janauer et al. 2010), light availability (Dawson & Kern – Hansen 1979, Sand – Jensen 1989), substrate type (Barko & Smart 1986, Clarke & Wharton 2001, Gurnell et al. 2006, Jones et al. 2012), depth and width of river (Riis & Biggs 2003, Paal & Trei 2004), nutrient concentration (Demars & Harper 1998, Thiebaut & Muller 1998, Schulz et al. 2003).

Because of different human activities, nowadays it is difficult to find pristine macrophyte communities in European lowland streams (Baatrup-Pedersen et al. 2006). In the temperate zone, the anthropogenic disturbance of macrophyte communities in running waters is expressed as eutrophication (Robach et al. 1996, Hilton et al. 2006), pollution of water (Daniel et al. 2005), change in the hydrological regime as a consequence of building dams and channels (Riis et al. 2008).

Water bodies have to be managed and protected according to the natural hydrological boundaries of river basins instead of the administrative ones. A river basin is understood as the area from which all surface water flows into one river. In order to facilitate management of water and water bodies, the Latvian river basins were divided into the following four river basin districts (RBD): Venta, Daugava, Lielupe and Gauja. The management plans shall present an overview of the current RBD status and the results of the analysis of impacts of human activity thereon, provide information on water protection objectives and their justification, identify water bodies at risk of failing to achieve good status.

The Venta River is a river in north-western Lithuania and western Latvia. The total length of the Venta River is 343.3 km and the catchment size constitutes 11.8 thousand km^2 (7, 9 thousand km^2 in Latvia). 178 km of Venta flow in Latvia. Total area of Venta RBD in Latvia is 15 625 km^2 and it takes 24, 5% of Latvia's territory (Ventas upju.., 2009).

MATERIAL AND METHODS

Study area

The study used the Latvian Environment, Geology and Meteorology centre data of Surface Water monitoring program. A total of 30 sites in 26 rivers in the Venta River Basin District (RBD) were investigated (Fig. 1). Data were collected during the vegetation season from June to August in 2006, 2007, 2008 and 2013. According to the Water Framework Directive 2000/60/EC System B typology, Latvian rivers can be divided into six types: small rhitral rivers,

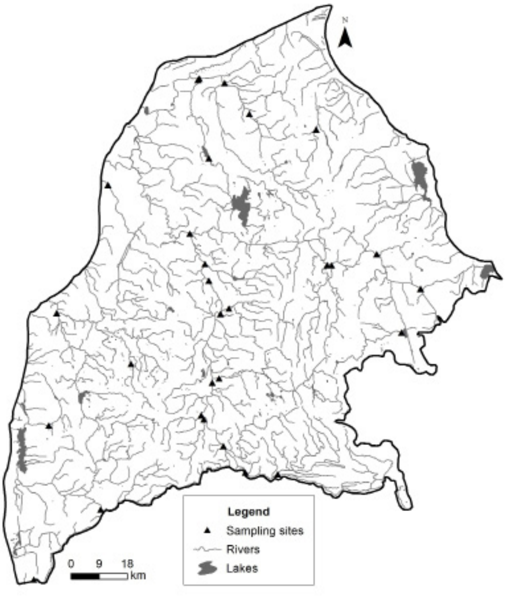

Fig. 1. Location of sampling sites in the Venta River Basin district, Latvia.

small potamal rivers, medium-sized rhitral rivers (11 sites investigated), medium-sized potamal rivers (10 sites), large rhitral rivers (1 site) and large potamal rivers (8 sites).

Macrophyte sampling

Macrophyte surveys were undertaken using the protocols associated with the Standard LVS EN 14184:2003. The sampling reach was 100 m in length. Macrophyte sampling was undertaken in vegetation period from June to August. All macrophytes present were recorded, together with the estimated percentage cover of each species. Macrophytes were identified to species or to the lowest practical taxonomic level. Macrophyte abundance was expressed in terms of the percentage of the survey length covered. A cover score was allocated to each macrophyte species present using the following scale 1: <0.1%, 2: 0.1 – 1%, 3: 1 – 2.5%, 4: 2.5 – 5%, 5: 5 – 10%, 6: 10 – 25%, 7: 25 – 50%, 8: 50 – 75%, 9: >75%.

Data analysis

Pearson's correlation coefficient was used to test the significance of the association between species richness and chemical variables calculated by SPSS Statistics 22.

RESULTS AND DISCUSSION

A total of 57 macrophyte taxa were found in the investigated streams. 49 taxa were indentified to species level, but 8 taxa – to genus level. Among the most frequent macrophyte species, emergent macrophytes prevail. The macrophyte communities in the streams were dominated by *Phalaris arundinacea* (80% of the sites), *Nuphar lutea* (70%), *Carex sp.* (63%), *Scirpus sylvaticus* (53%), *Sium latifolium* (50%), *Alisma plantago-aquatica* (40%), *Potamogeton perfoliatus* (40%), *Sagittaria sagittifolia* (40%) and *Schoenoplectus lacustris* (40%) (Table 1), which indicates their flow-resistance and indifferent character to many environmental factors. All these species are deeply rooted and tolerant of disturbance (Preston & Croft 2001). A lot of species were found only in one or few investigated stream stretches, e.g. *Berula erecta*, *Cardamine amara*, *Carex acutiformis*, *Charophyta*, *Cladophora*

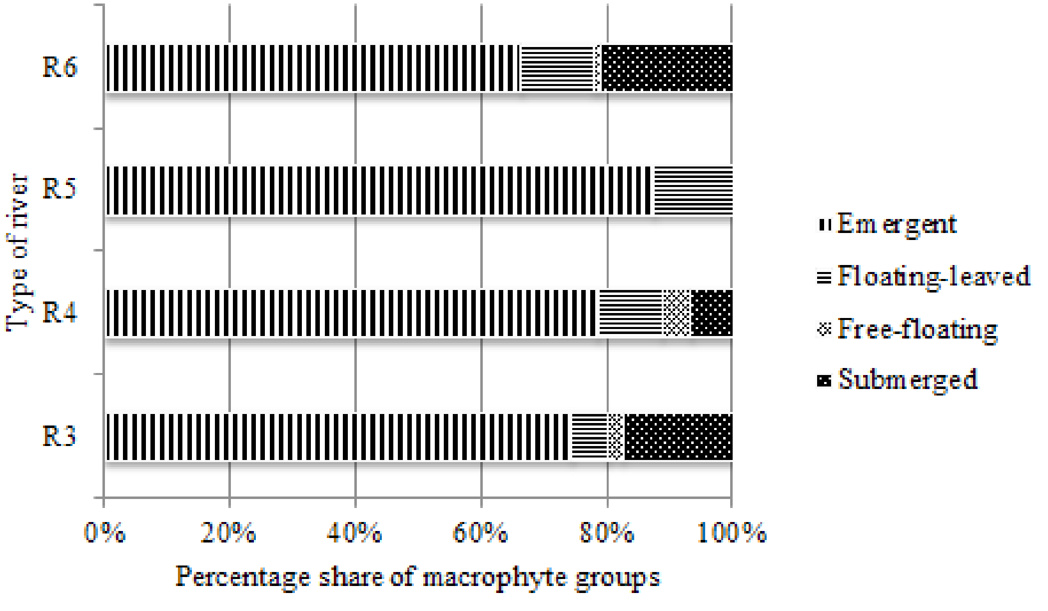

Fig. 2. Percentage share of growth forms of aquatic plants in different types of rivers (R3- medium-sized rhitral rivers, R4- medium-sized potamal rivers, R5- large rhitral rivers, R6- large potamal rivers).

Table 1. Floristic composition of sampling sites

Species	River site																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Acorus calamus																2				1				4	5	4	3	5	6	
Alisma plantago-aquatica		2						2			1		1	1		1		1	1			1		2	1	1				
Berula erecta																				2										
Butomus umbellatus	1															1								2	2	1	1			
Caltha palustris								1		1		1						1			2				1					1
Cardamine amara																									1					
Carex acutiformis												2																		
Carex sp.				1							1	1	2	2	2	4	2	6	4		1	2	1	4	6	5		2	2	4
Charophyta		1																												
Cladophora sp.		8	4																											
Elodea canadensis			1					1														1								
Equisetum fluviatile				1					1	1	1				1			1				1						1		
Eupatorium cannabium							1					1																		
Fontinalis antipyretica													1				2						4			4	2			4
Fontinalis sp.						2		2																						
Galium palustre											1																			
Glyceria fluitans								3	1						1					1										
Glyceria maxima					1		1																							
Hippuris vulgaris				1												1														
Hydrocharis morsus-ranae																						1								
Iris pseudocarus															1			1		1		1								
Juncus articulatus																										1				
Juncus sp.															1															

Species	**River site**																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Lemna minor			1		5			1				1																		
Lysimachia vulgaris								2				1																		
Mentha aquatica								4									2				4	2								
Myosotis palustris					1					1		1																		
Myriophyllum spicatum																										4				
Nuphar lutea			1	5	4	4	1			2	3	2		2	2	2		1		1	5	1		2	4		5	4	4	5
Nymphaea candida																									1			2	1	
Nymphaea sp.											1																			
Oenanthe aquatica																						1								
Phalaris arundinacea					5	4	1	5	4	3		4	5	3	1	5	5	5	2	1	4		2	4	4	6	3	6	5	5
Phragmites australis															5	1				6	7					2		4	2	
Polygonum amphibium																									1					
Potamogeton crispus													4																	
Potamogeton lucens						2			1					4						2										
Potamogeton natans											1									3		2								
Potamogeton pectinatus	2										1		2	1						4			2		5	6			5	
Potamogeton perfoliatus	3										1		4	4			1	1		2					5	5	2	3	3	
Potamogeton praelongus																									5	2				
Ranunculus lingua																				1										
Ranunculus sp.								2																						
Rorripa amphibia					1			1			2							1		1										
Rumex hydrolapathum																							1							
Sagittaria sagittifolia	1			2		1	1				2	1								1		1			4	1	3		4	
Schoenoplectus lacustris						2					1			1			1	4		1	5			6	6	6	3		6	
Scirpus sylvaticus			1	1	1		2	5	4	1			5	2					1	2	5	1						6	2	4

Species	River site																													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Scutellaria galericulata								1		1																				
Sium latifolium					1		1		1		2	2			5	1					4	2		2	2		1	1	1	1
Solanum dulcamara												1					1			1										
Sparganium emersum			5						4	2	3						5													
Sparganium erectum			4									2	3		1						5				2		2		4	4
Sparganium sp.	2	1		1		5								2		1			1											
Spirodela polyrhiza							1															1					2			
Typha latifolia				1																	1									
Veronica anagallis-aquatica														1	1				1	1										

The species abundance is expressed according to nine point scale: 1: <0.1%, 2: 0.1 – 1%, 3: 1 – 2.5%, 4: 2.5 – 5%, 5: 5 – 10%, 6: 10 – 25%, 7: 25 – 50%, 8: 50 – 75%, 9: >75%.

number (6 species) was found for the pondweed family Potamogetonaceae. The most frequent pondweed species are *Potamogeton perfoliatus* (occurred in 40% of sites), *Potamogeton pectinatus* (30% of sites) and *Potamogeton lucens* (13% of sites). In the European assessment systems considerable proportion in species composition is filled by species of the families Callitrichaceae and Ranunculaceae, while in the Latvian streams species of these families is low represented (Grīnberga 2011).

The species richness ranged from 4 to 18 species per site; on average 10 macrophyte taxa per stretch were found. The lowest number of species was found in the river Pūre (type R4), but the largest number of species was in the river Rinda (type R4).

Analyses revealed that the presence of various growth forms of plants is not significantly differentiated between the four identified types of rivers (Fig. 2). It was found that all types of rivers are overgrown mainly by emergent plants (helophytes). They represented 74% of all vegetation in medium-sized rhitral rivers, 79% in medium-sized potamal rivers, 88% in large rhitral rivers (there was only one site) and 66% in large potamal rivers.

Large potamal rivers and medium-sized rhitral rivers also had a high share of submerged macrophytes, which covered 21% and 17% of the vegetated area. Large rhitral river site (river Vadakste) had only two macrophyte growth forms – emergent and floating-leaved. The free-floating macrophyte species such as *Lemna minor*, *Spirodela polyrhiza* and *Hydrocharis morsus-ranae* were detected only in some stream sites. These species are known to be limited by stream velocity and they reached their highest abundances in slow flowing streams with sandy and soft, silty substrates (Grīnberga 2010).

Table 2. Pearson linear correlation coefficients among species richness and chemical variables

	Species richness	P_{tot}	N_{tot}	$N\text{-}NH_4^+$	$N\text{-}NO_2^-$	$N\text{-}NO_3^-$	$P\text{-}PO_4^{3-}$
Species richness	1						
P_{tot}	,269	1					
N_{tot}	-,138	,032	1				
$N\text{-}NH_4^+$	**-,336***	**,367***	**,321***	1			
$N\text{-}NO_2^-$	-,244	,261	**,490****	**,452****	1		
$N\text{-}NO_3^-$	-,173	-,007	**,930****	,198	**,478****	1	
$P\text{-}PO_4^{3-}$	-,173	,163	,133	,235	,244	-,074	1

(*) $p<0.05$; (**) $p<0.01$ N=30

sp., *Eupatorium cannabinum*, *Galium palustre*, *Glyceria maxima*, *Hippuris vulgaris*, *Hydrocharis morsus-ranae*, *Juncus articulatus*, *Lysimachia vulgaris*, *Myriophyllum spicatum*, *Oenanthe aquatica*, *Polygonum amphibium*, *Potamogeton crispus*, *Potamogeton praelongus*, *Ranunculus lingua*, *Rumex hydrolapathum* etc. Among the submerged macrophytes the highest species

Relationships between species richness and six chemical parameters (N_{tot}, P_{tot}, $N\text{-}NH_4^+$, $N\text{-}NO_2^-$, $N\text{-}NO_3^-$ and $P\text{-}PO_4^{3-}$) were calculated (Table 2). There was only one significant correlation among species richness and ammonium nitrogen. No significant correlations were established between other chemical variables and species richness. Macrophye diversity may be related to

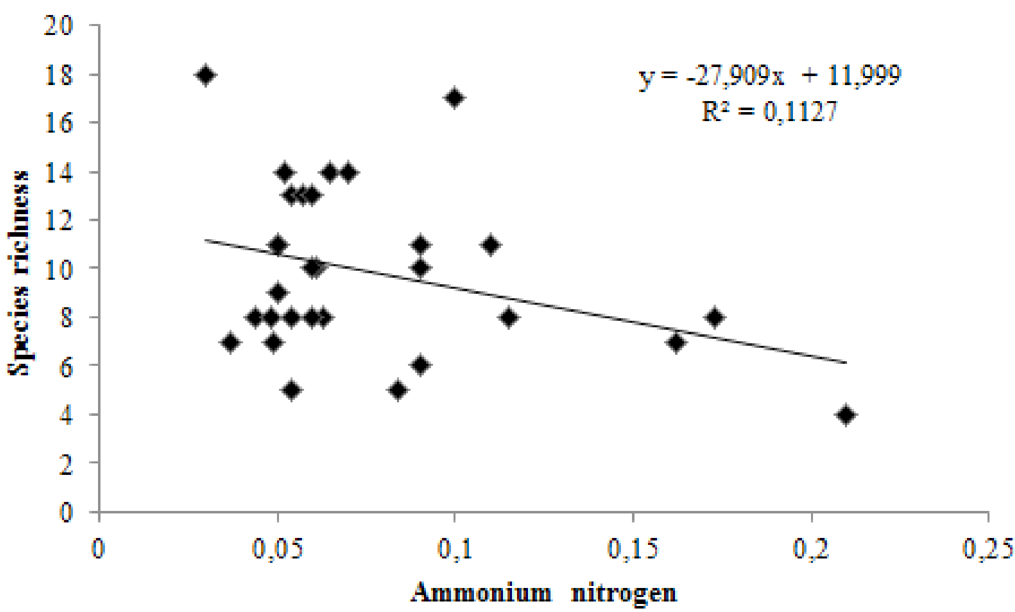

Fig. 3. Correlation between species richness and ammonium nitrogen (N-NH4+).

other factors besides the nutrients. Factors such as stream velocity, depth, substrate, habitats, shading, width, bed stability, singly or in some combinations, may have a stronger influence on the macrophyte floristic community than nutrients (Thiebaut et al. 2002).

CONCLUSIONS

Results revealed that the presence of various growth forms of plants is not significantly differentiated between the types of rivers. All types of rivers are overgrown mainly by emergent plants. The most frequent species were *Phalaris arundinacea*, *Nuphar lutea*, *Carex sp.*, *Scirpus sylvaticus* and *Sium latifolium*. In the Venta River Basin distric streams the number of macrophyte species range from 4 to 18. The lowest number of species was found in the river Pūre, but the largest number of species was in the river Rinda. There were not significant correlation between species richness and chemical parameters except ammonium nitrogen.

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