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Ecological conditions in the Turiec River (Slovakia) and their influences on the distribution of aquatic macrophytes

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Abstract: Distribution, mass of aquatic macrophytes and selected ecological condition was studied in the two different parts of the Turiec River in summer of 2000. The species diversity and mass of macrophytes changed due to different ecological condition and intensity of human impact. The upper part (A) is characterised as sub-mountain brook with well-developed tree and shrub formations on the banks, lower human impact and small diversity of aquatic macrophytes, dominated by filamentous algae. On the other hand, the lower part (B) is a typical colline river in open landscape with apparent impact of man. Numerous eutrophic vascular plants increase species diversity and the mass of aquatic macrophytes is higher.

Key words: aquatic plants, Kohler's method, mean mass index, relative plant mass, running water

Introduction

Bioindication properties of plants are generally used for monitoring of environment. Quality of the water can be assessed by distribution and mass of macrophytes (e.g. KOHLER 1982, TREMP & KOHLER 1995, KELLY & WHITTON 1998, SZOSZKIEWICZ et al. 2002). Kohler's method was specially developed for this purpose (cf. KOHLER 1978, KOHLER & JANAUER 1995), and recently used in several Danube countries (e.g. PÁLL et al. 1996, VEIT et al. 1997, JANAUER 1999, GERM et al. 2003, JANAUER et al. 2003, OTAHELOVÁ & VALACHOVIČ 2003, SARBU 2003).

The aim of this study is to ascertain the relation between the distribution of aquatic macrophytes and the ecological conditions of environment, with respect to two different parts in the Turiec River.

Study area

The Turiec River is situated in North-Western Slovakia. Its source is located in the Kremnické vrchy Mts (altitude 1060 m), and after 66 km, near the town of Vrútky (377 m above s. l.) it merges with the Váh River, which is the main tributary to the Danube River in Slovakia.

Study areas were chosen in the north and central part of the catchment area, between Požehy settlement and Dubové village [upper part (A)] and Moškovec village and Socovce village [lower part (B)], respectively. The upper reach is 3921 m long and the second one 4467 m.

Materials and Methods

During August 2000 the distribution of all macrophytes and selected ecological conditions were investigated in numerous survey units. The units were defined according uniform hydrological and ecological conditions, as well as human impact. Their location was recorded using geographical position system (GPS).

For field mapping of macrophytes in running water and evaluation of data Kohler's method was applied (KOHLER & JANAUER 1995). Later, the data were transformed for mapping using ArcView GIS software. Vegetation and ecological data were added into MS EXCEL table and than were evaluated at the University of Vienna (Austria) using standard software developed for the MIDCC project (www.midcc.at).

For aquatic plants the relative plant mass (RPM) and mean mass indices (MMT, MMO) were calculated (cf. KOHLER & JANAUER l.c., JANAUER 2003). The selected environmental parameters, such as sediment class, bank structure, flow velocity class, and CORINE land use type were assessed, according to categories presented by JANAUER (l.c.). The riparian trees and shrub formations were recorded in all survey units, too.

Names of plants follow the checklist by MARHOLD & HINDÁK (1998).

Results and Discussion

Ecological condition

The basic ecological conditions monitored in both reaches of the Turiec River are presented in Table 1. Whereas the upper part A is a typical sub-mountain brook, the lower part B is a typical colline river with about three times greater average width of the watercourse. Bank structure is similar in reaches. Fine inorganic substrate is the dominating type. Other ecological parameters are very different, e.g. shade. In the part A almost 85% of banks are covered by tree and shrub formations, in contrast to more than 74% of the banks in the part B, which are without woody vegetation. Between sediment class and flow class exists noticeable conformity. Part A is segmented mainly into stretches with slow flow of water (bottom: gravel or sand) or fast flow (solid rock). In part B medium flow of water prevails (bottom: gravel, sand and fine inorganic substrate). In case of part A, the surrounding land is formed of pastures and mown wet meadows and for part B heterogeneous agricultural areas (pastures, mown wet meadows) and riverine forests dominate. Really artificial areas were recognised only in the lower part of the river.

Table 1. Selected ecological characteristics of parts A and B of the Turiec river

Ecological conditions	Part of river A				Part of river B			
Average width of river (m)	4.75				12.90			
Average depth of river (m)	0.41				0.66			
Trees and shrub formations (% of length)	yes		no		yes		no	
	84.1		15.9		25.8		74.2	
Bank structure (% of length)	1	2	3	4	1	2	3	4
	0.0	0.0	0.0	100.0	0.0	0.0	0.0	97.9*
Prevailing sediment class (% of length)	1	2	3	4	1	2	3	4
	28.0	35.4	36.6	0.0	0.0	46.9	44.0	8.8**
Flow velocity class (% of length)	1	2	3	4	1	2	3	4
	0.0	60.4	8.5	31.1	0.0	22.7	64.1	13.2
CORINE land use types	1	2	3	4	1	2	3	4
Left side (% of length)	0.0	85.2	3.2	11.6	0.3	64.1	35.6	0.0
Right side (% of length)	0.0	93.0	7.0	0.0	4.5	52.2	43.3	0.0

* 2.1 % – artificial embankment material; ** 0.3 % – artificial bottom

Legend:

Bank structure: 1 – large blocks and stones, 2 – gravel, 3 – sand, 4 – fine substrate

Sediment class: 1 – solid rock, 2 – gravel, 3 – sand, 4 – fine inorganic sediment

Flow velocity class: 1 – no flow, 2 – slow flow, 3 – medium flow, 4 – fast flow

CORINE land use types: 1 – artificial surfaces, 2 – agricultural areas, 3 – forest and semi-natural areas, 4 – wetlands

Distribution and mass of aquatic macrophytes

Nine taxa of vascular aquatic plants, one moss and filamentous algae were found in both parts of river, whereas only three taxa were common to both. Species diversity was considerably higher in part B (Tab. 2).

The highest value of Relative Plant Mass (RPM) was detected for filamentous algae in part A, and for the species of genus *Batrachium* in part B, respectively. In both parts of the river, only the moss *Fontinalis antipyretica* had a similar value of RPM. The rate of aquatic macrophytes among of all macrophytes in part A and B was more 15% and 81%, respectively (except filamentous algae; Fig. 1).

Mean mass indices (MMT, MMO) of aquatic plants are illustrated in Fig. 2. In part B, the most abundant and ubiquitous species were *Batrachium aquatile, B. trichophyllum* and *Myriophyllum spicatum*, whereas *Zannichellia palustris* and *Potamogeton perfoliatus* had clumped distribution. *Cladophora glomerata* and other algae species in the complex of filamentous algae were ubiquitous only in the upper part of the river.

Table 2. Total list of aquatic macrophytes, their growth forms, distribution in both parts of river and proper index of saprobity (S_t)

Name of species	1	2	A	B	S_t
*Algae filamentosae**	Alg fil	Sa			–
Fontinalis antipyretica	Fon ant	Sa			–
Potamogeton crispus	Pot cri	Sa			2.5
*Batrachium sp.***	Bat spe	Sa			2.2
Lemna minor	Lem min	Ap			2.2
Myriophyllum spicatum	Myr spi	Sa			2.3
Potamogeton pectinatus	Pot pec	Sa			2.8
Potamogeton perfoliatus	Pot per	Sa			2.2
Potamogeton pusillus	Pot pus	Sa			1.9
Zannichellia palustris	Zan pal	Sa			2.7
Number of taxa	10		3	10	

Legend:
[1] Abbreviation of name
[2] Growth forms: Ap – acro-pleustophyte, Sa – submersed anchored macrophyte
A Plants presented in upper part of the river
B Plants presented in lower part of the river
S_t – according to HUSÁK et al. (1989)
* mainly *Cladophora glomerata* (L.) Kütz., *Melosira varians* C. Agardh.
** incl. *Batrachium aquatile* (L.) Dumort (frequently; St = 2.2), *B. trichophyllum* (Chaich. In Vill., em. Freyn.) Bosch (rarely; S_t = 2.2)

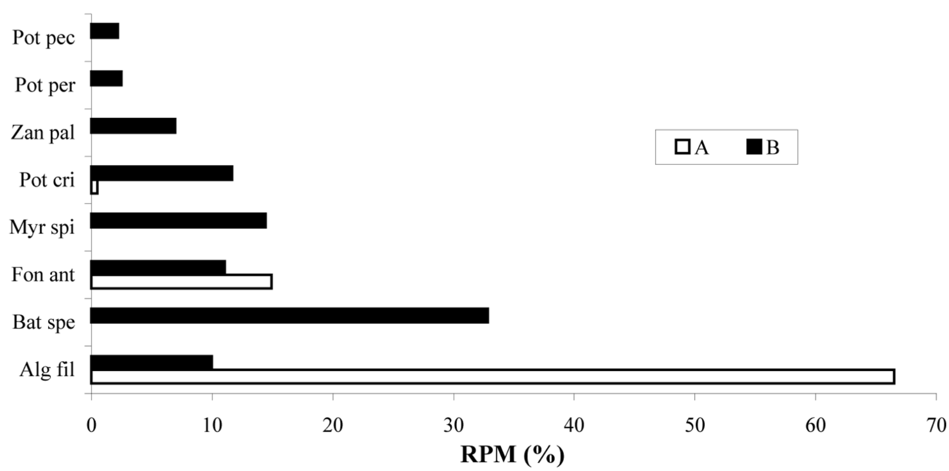

Figure 1. Relative Plant Mass (RPM in %) of aquatic plants as a ratio of all macrophytes. Only plants with RPM >1% are included.

The impact of ecological conditions to macrophytes

The higher species diversity of aquatic macrophytes in part A is due to favourable ecological conditions (mainly light and trophy). Most of the aquatic plants detected in the river are eutrophic species. Their occurrence and mass is highest in the surroundings of villages and in agricultural areas with intensive exploitation. Aquatic macrophytes such as *Potamogeton crispus, P. pectinatus, Zannichellia palustris* belong to a set of species with a reliable saprobic index (HUSÁK et al. 1989; Tab. 2), which indicate highly eutrophic waters (SCHULTZ 1995, SCHMIEDER 1997, KOHLER & SCHNEIDER 2003).

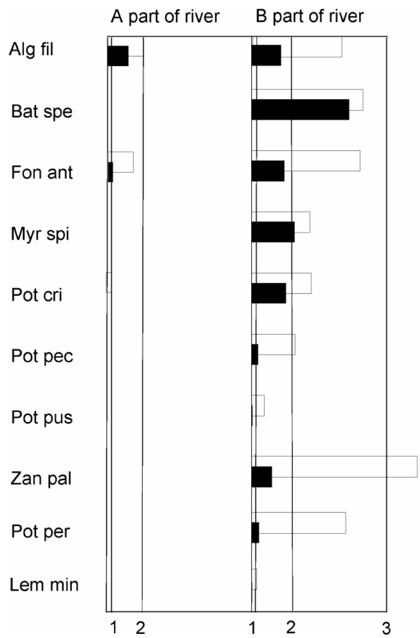

Figure 2. Mean Mass Indices calculated for all aquatic plants in total stretches (MMT, dark column), and stretches with their occurrence (MMO, empty column) in both parts of the river

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