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TESTING THE ADEQUACY OF THE HUNGARIAN TYPOLOGICAL SYSTEM ON THE WATERCOURSES OF THE IPOLY BASIN, BASED ON THE MACROINVERTEBRATE COMMUNITIES

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A HAZAI FELSZÍNI VÍZI TIPOLÓGIA ALKALMAZHATÓSÁGÁNAK TESZTELÉSE AZ IPOLY VÍZGYŰJTŐ PATAKJAIBAN MAKROSZKOPIKUS GERINCTELEN KÖZÖSSÉGEK ALAPJÁN

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ABSTRACT: The Hungarian typology of watercourses is based on abiotic factors and little is known about how this classification is reflected in macroinvertebrate communities. The Hungarian Multimetric Macrozoobenthon Index (HMMI) is built by five indices, which suggests that a more robust typology could be sufficient based on them. We investigated the deviations between the typology and biota in samples taken from the catchment of the Ipoly River and revealed the causes in case of 5 types of running waters. Based on the macroinvertebrates, only the separation of the mountainous regions and the submontane zone was perceptible and Crustaceans were the main factors influencing the development of the groups. The quality of 61% of the water bodies in the catchment area of the Ipoly needs improvement to reach good ecological status. Community of the Nyerges-patak (mountainous region) shows more similarity to the communities of streams in the submontane zone. The assessment carried out based on the new categories had positive influence on the ecological status.

Key words: benthic invertebrates, biological quality assessment, WFD

KIVONAT: A hazai felszíni vizek tipológiai besorolása abiotikus tényezőkön alapult. Hiányos ismeretekkel rendelkezünk arról, hogy az makrogerinctelen közösségek mennyire tükrözik ezt az abiotikus tényezőkön alapuló felosztást. A Multimetrikus Makrozoobenton (HMMI) indexcsalád öt indexet tartalmaz, melyeket a víztér típusok összevont csoportjaira kell alkalmazni, ami azt sugallja, hogy makrogerinctelen közösségek alapján robosztusabb tipizálás lehetséges. Öt víztér típus esetében vizsgáltuk az eltérés mértékét az Ipoly vízgyűjtőjéről származó mintákban. A makrogerinctelenek alapján csak a hegyvidéki és a dombvidéki patakokat lehetett elkülöníteni, a szétválásban a Crustacea fajoknak volt szerepe. A minősítés alapján a vizsgált víztestek 2/3-ának javulnia kell, hogy elérjék az ökológiailag jó állapotot. A Nyerges-patak a hegyvidéki típusba tartozik, azonban a fajkészlete alapján inkább megfelelne valamelyik dombvidéki kategóriának. Az átsorolás eredményeképp az ökológiai állapota javulna a víztérnek.

Kulcsszavak: vízi gerinctelenek, biológiai vízminősítés, EU Víz Keretirányelv (VKI)

Introduction

The Hungarian typology of running water bodies is included in the GOVERNMENT REGULATION 221/2004. This typology was based on sub-ecoregions, hydrogeochemical aspects, substrate and catchment size and altogether 25 types were distinguished. Classification was based only on abiotic factors therefore we know little of how this classification is reflected in the inhabiting macroinvertebrate communities (VÁRBÍRÓ et al. 2010, VÁRBÍRÓ et al. 2011).

Aquatic macroinvertebrates are of high importance as they are good representatives of the quality of the habitats, show quick reactions to the changes in the environment, are easy to collect, move in small areas, and their life cycles are long enough to show the presence of the 'indicandum' (PLAFKIN et al. 1989, VOSHELL et al. 1997). With the exception of a few taxa, their identification present no difficulties, the environmental needs of most of the species are well known as is their ability to indicate environmental factors in an integrative way (METCALFE 1989, METCALFE-SMITH 1996, RESH 1995). Consequently, macroinvertebrates are good indicators and they are suited to the fauna based assessment of running waters (BÖHMER et al. 2004, HERING et al. 2004). Thus, they became one of the main factors considering the assessment of the ecological status of aquatic habitats in the EU Water Framework Directive (WFD, 22nd December, 2000). Applying the WFD compatible national methodology one can conclude the state of the watercourses assessing the macroinvertebrate communities. According to the normative definitions of the WFD, ecological assessment of running waters was based on multimetric indices (MMI) including number of species, diversity and abundance.

The Hungarian Multimetric Macrozoobenthon Index (HMMI) was developed within the framework of the international ecological intercalibration project according to the compatibility requirements of the WFD, based on the data provided by the WFD monitoring stations operated by the Regional Environmental Inspectorates. Classification of the ecological state was done by calculating the Ecological Quality Ratio (EQR) value which represents the relationship between the observed and the reference values and ranges from 0 to 1, 1 meaning high and 0 meaning bad ecological status (WFD, 2000). HMMI was built by five indices (VÁRBÍRÓ et al. 2010, VÁRBÍRÓ et al. 2011), all of which should be applied for pooled groups of types of running waters, which suggests boundaries easily blurred between the water types classified based on abiotic factors and that a more robust typology could be sufficient based on macroinvertebrate communities. Due to limitations both in time and means we could only afford to study 5 from all 25 categories.

Our questions were the following: i) Do water bodies separate the same way based on macroinvertebrate communities and on abiotic factors? ii) If they don't, what causes the difference? iii) Will the classification change if one of the water bodies is trans-categorized?

Materials and methods

Sampling sites

During the selection of our sampling sites we tried to find a small water catchment area which contains several types of watercourses (thus reducing the sampling costs as well as the time and effort needed). The study area was located in the Ipoly basin, which covers 1521 km^2 and is an independent planning subunit in the Water Basin Management Plan (WBMP). The location of the studied area is north from the capital and consists of the mountainous and submontane zones of the Northern Hills. 29 surface watercourses were included in WBMP and from these 23 streams were sampled. Sampled water bodies belong to 5 types and a minimum of three streams were sampled in each type. The sampling was carried out on the 10th and 11th in October 2013 at one time. Table 1 contains the names and the types of the sampling sites, the UTM codes and geographical co-ordinates.

Sampling methods

Sampling procedure, identification, sorting method and evaluation was based on the Hungarian Aquatic Macroinvertebrates Methodological Guidelines (CSÁNYI et al. 2012). Sampling sites were preselected using Google Earth. Representative sample units were appointed in all the sampled water bodies assuring there were no hydromorphological shifts (e.g. bridge, bank saving pitching) near them. During the field sampling the representative units were restricted and then a 20-50 m long section was selected as the sampling site. Sampling was carried out by disturbing the substrate upstream into a Standard Pond Net. The length and the width of the frame of the net were 25 cms and the mesh size of the net was 1 mm. A sample consists of 20 sampling units taken from all habitat types at the sampling site with a share of at least 5 % coverage. The proportions of the habitat types were mapped visually. The samples were collected in a bucket and their volume was reduced. The samples were conserved in 70 % ethanol and carried into a laboratory in order to be sorted.

After sorting the different taxa were identified by experts using stereo microscope. For the identification the following taxonomical keys were used: for Odonata: ASKEW (1988), GERKEN and STERNBERG (1999), CHAM (2009); for Mollusca: RICHNOVSZKY-PINTÉR (1979), GLÖER and MEIER-Brook (1998); for Crustacea: KONTSCHÁN, B. MUSKÓ and MURÁNYI (2002); for Heteroptera: SAVAGE (1989); for Coleoptera: CSABAI (2000), CSABAI et al. (2002); for Trichoptera: WARINGER and GRAF (1997); for Oligochaeta: TACHET et al. (2010); for Hirudinea: NIESEMANN (1997); for Ephemeroptera: Bauernfeind and HUMPESCH (2001), EISELER (2005), KŁONOWSKA-OLEJNIK (2004), HAYBACH (1999). After sorting the samples were labelled and kept in 70 % ethanol.

Table 1. List of the sampled watercourses in the Ipoly catchment area with the types of the waterbodies, and the exact EOV co-ordinates and 10×10 UTM grid codes. In cases of some geographical terms we left the original Hungarian form for the localities being more identifiable: patak = stream, mellékvizei, mellékágai = tributaries, alsó = lower section, felső = upper section.

Name of the watercourses	river type	UTM	EOV co-ordinate		EQR	Ecological quality class
			X	Y		
Börzsöny- és Hosszúvölgyi-patak	1	CU31	287271	634720	0,81	High
Csitári-patak felső	8	CU82	299769	676277	0,57	Moderate
Damásdi-patak	1	CU30	278267	635176	0,67	Good
Darázsdói- és Lóci-patak	5	CU82	297708	684244	0,24	Poor
Derék-patak és mellékvizei	8	CU61	296816	658090	0,36	Poor
Dobroda-patak és mellékvizei	5	DU03	312277	699272	0,16	Bad
Dobroda-patak-alsó	5	CU94	318711	690236	0,87	High
Fekete-víz alsó	9	CU72	299301	671608	0,45	Moderate
Fekete-víz felső és mellékágai	9	CU81	292228	677368	0,47	Moderate
Ganádi-patak	1	CU31	287710	631585	0,66	Good
Hévíz-patak	4	CU52	299789	650122	0,66	Good
Kemence-patak	1	CU41	295604	638647	0,83	High
Kétbodonyi-patak	8	CU71	288746	668548	0,59	Moderate
Komra-patak	4	CU93	317236	692334	0,46	Moderate
Letkés-patak	1	CU30	282565	630785	0,67	Good
Lókos-patak	9	CU61	289593	664806	0,77	Good
Lókos-patak-felső és Jenői-patak	9	CU60	281716	659022	0,5	Moderate
Ménes-patak	5	CU92	307613	684834	0,53	Moderate
Ménes-patak felső és Nógrádmegyeri-patak	5	CU93	308038	695318	0,31	Poor
Nyerges-patak	1	CU30	285498	630134	0,26	Poor
Szakáli-patak	4	CU93	315908	686273	0,78	Good
Szentlélek-patak	5	CU82	304721	683240	0,27	Poor

Statistical analyses

The differences between the species composition of the watercourses were revealed using hierarchical cluster analyses using the Ward method. Based on the relative abundance Non-Metric Multidimensional Scaling (NMDS) was used with Bray-Curtis distance function for the analysis of the similarities of streams. Principal Component Analysis (PCA) was used for determining which species characterized our groups. All statistical analyses were done using the PAST software (HAMMER et al. 2001).

Results

During the sampling procedure 14 higher taxonomical groups and 146 taxa were found from which 129 were identified to the species-level (Bivalvia: 9, Coleoptera: 13, Crustacea: 5, Ephemeroptera: 26, Gastropoda: 14, Heteroptera: 15, Hirudinea: 5, Malacostraca: 4, Odonata: 13, Megaloptera: 2, Plecoptera: 1, Trichoptera: 22). The Diptera larvae and the Oligochaeta were identified to the family-level (10+1 family) and young specimens (7) were identified to the family-level as well. During the survey five protected species were found (100/2012. (IX. 28.) VM). These are the followings: *Calopteryx virgo* (Linnaeus, 1758), *Gomphus vulgatissimus* (Linnaeus, 1758), *Libellula fulva* Müller, 1764, *Onychogomphus forcipatus* (Linnaeus, 1758), and *Orthetrum brunneum* (Fonscolombe, 1837).

The five typological groups of running waters could not be separated based on the macroinvertberate assemblages (Fig 1). For this reason, three more robust types were created based on the dendrogram on which the differentiation was evident: i) streams of mountainous regions (1); ii) coarse substrate streams of submontane zones (4-5); iii) middle fine substrate streams of submontane zones (8-9). (The markings on the three figures (NMDS, PCA) were used consequently: (● - streams of mountainous regions;▲ - coarse substrate streams of submontane zones; ■ - middle fine substrate streams of submontane zones). The first group contains the watercourses of the mountainous region including the Kétbodonyi-patak of the submontane zone since the species pool of this stream is more similar to that of the streams of the mountainous regions. The other two groups consist of the streams of submontane zones including the Nyerges–patak of the mountainous region for the species pool of this stream shows more similarity to that of the submontane zones. Based on the substrates only, streams of the submontane zones show no aggregation (Fig 2).

In the PCA figure (Fig 3), we did not distinguish the two substrate based types of submontane zones for in the NMDS figure (Fig 2) it was clearly visible that there can be no differentiation. Nevertheless, types of the mountainous and submontane zones do separate and the influence of the studied variables (namely the species) is shown in the PCA diagram (Fig 3). The species *Gammarus balcanicus* Schaferna, 1922 was the main factor influencing the development of the group of the mountainous regions while there were two variables influencing the group of the submontane zones: seemingly the group was divided in two because of the effect of a pair of species, *Gammarus roeseli* Gervais, 1835 and *Asellus aquaticus* (Linnaeus, 1758) and a single species, *Gammarus fossarum* Koch, in Panzer, 1835.

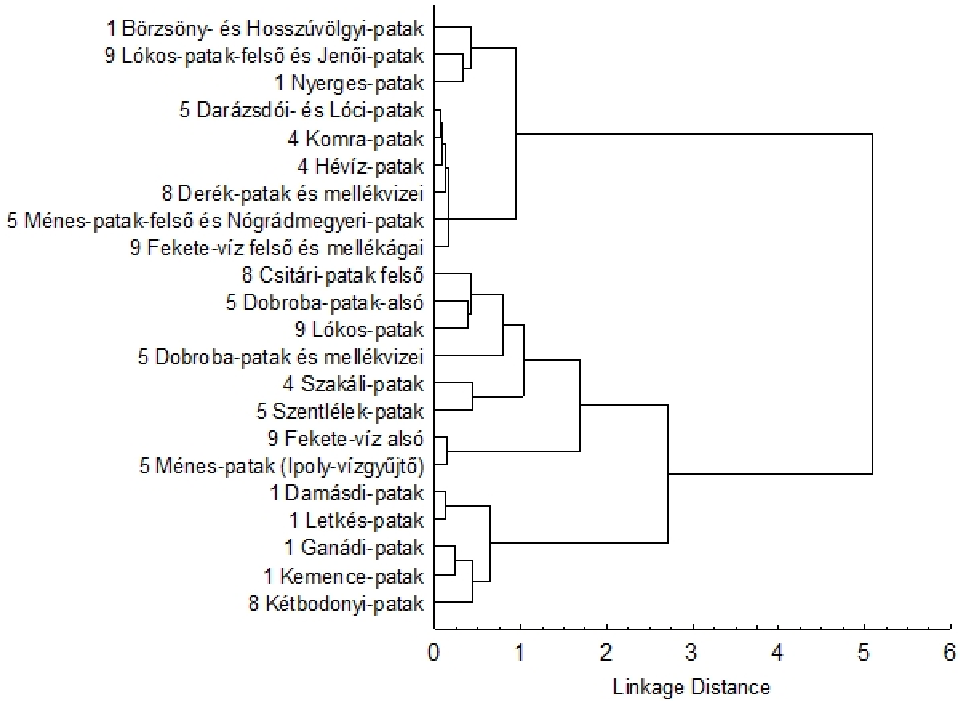

Figure 1. Statistical dissimilarity in aquatic macroinvertebrate communities within the water bodies based on cluster analyses with Ward method (The numbers before the name of the sampling sites refers to the Hungarian running water types).

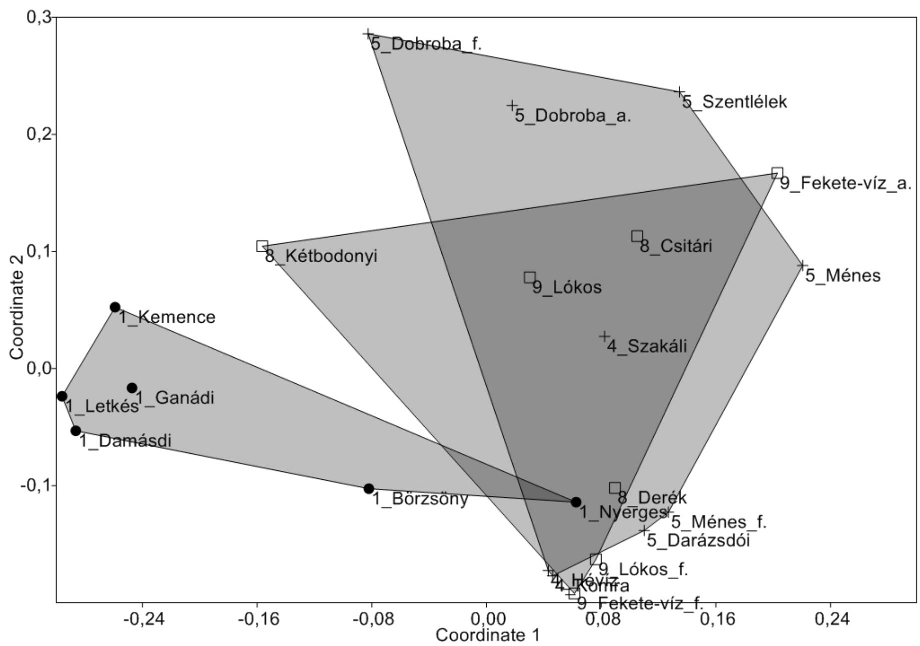

Figure 2. NMDS ordination of aquatic macroinvertebrate communities sampled from the water bodies. (● - streams of mountainous regions; ▲ - coarse substrate streams of submontane zones; ■ middle fine substrate streams of submontane zones).

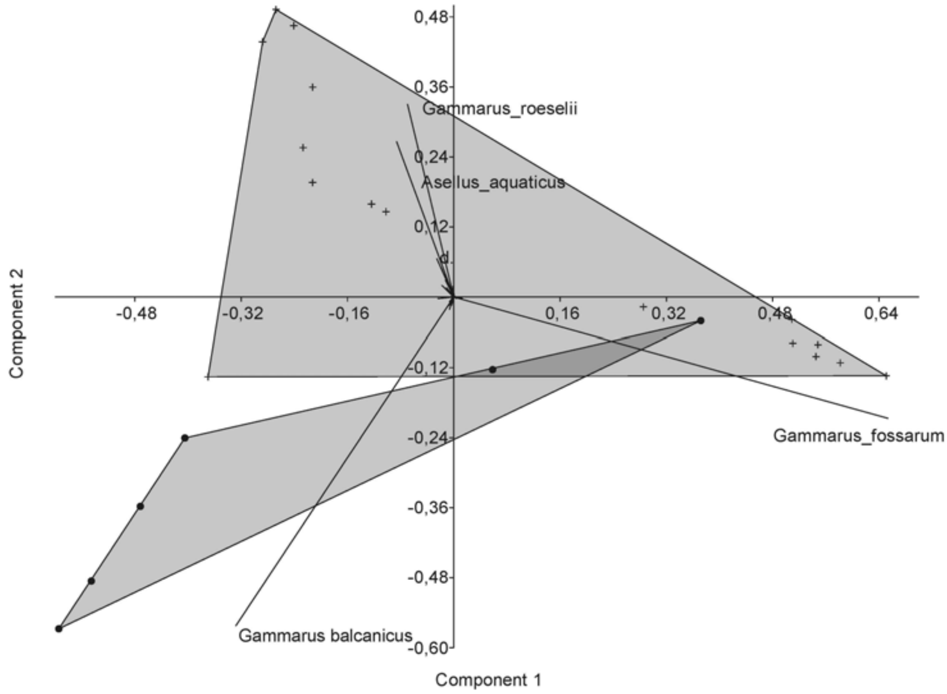

Figure 3. Biplot of the PCA (Principal Component Analysis) of sampling sites and species

Although this separation was not supported by the statistical analyses, because looking at either the classification or the type of the watercourse the group could not be divided (PCA). The qualifications of the streams were performed by the HMMI (Table 1). Only one stream (Dobroda-patak és mellékvizei) got bad quality, five streams were poor, eight were moderate, six streams were good, and only three streams had high ecological conditions (Table 1).

Discussion

Macroinvertebrate communities were studied at 23 sites in the catchment area of the Ipoly River in Hungary and biological quality of the sampling sites was assessed based on the macroinvertebrate communities. Results showed that 13% of the streams were of high (H), 26% good (G), 35% moderate (M) and 26% of them were of poor (P) and bad (B) quality, which means that the quality of 61% of the water bodies in the catchment area of the Ipoly River needs improvement to reach good ecological status, in accordance with objective of WFD.

Considering our results it is clear that the categorization that divided types of running waters into five categories is too subtle as aquatic macroinvertebrate communities do not show such fine detachment. We studied the case on a larger scale of rating, thus establishing a more robust system. The macroinvertebrate communities based separation of the streams of the mountainous regions and the streams of submontane zones was perceptible. The two types based on the substrate of the bed in submontane zones were not separated. Classification of the

Nyerges–patak proved to be difficult. Considering the classification based on the Hungarian typology of running waters it belonged to the first water type, however, our results suggested that one of the stream types of submontane zones would be more suitable. We wanted to know if the assessment carried out based on the new categories means an influence on the resulting ecological status. Using the original classification method the Nyerges-patak fell into the poor (P) ecological status class, although there were many typical mountainous region species. On the other hand, 65% of the individuals belonged to the species *Gammarus fossarum*, which is a characteristic species of the communities of submontane streams. The trans-categorization of the Nyerges-patak seemed well founded since using the index applied for water types of submontane zones, the EQR value of the stream increase to 0,57 and showing a moderate (M) ecological status. Furthermore, EP fauna indicating mountainous characteristic was completely absent.

In the PCA figure (Fig 3), we did not make a distinction between the two types of submontane zones based on substrates, because it is clearly seen previously that there is no difference between them (Fig 2). The two groups are completely separated except for a little overlap on the account of the Nyerges-patak. Differentiation of the watercourses of mountainous regions is caused by the *G. balcanicus,* as is the differentiation of the streams with rough substrate of the submontane zones caused by the *G. fossarum.* This is also the reason why the Nyerges-patak got classified together with the streams of the submontane zones. The main element dividing the streams with middle fine substrate of the lower regions from those mentioned above is the *A. aquaticus*. Proximity of the Kétbodonyi-patak to the streams of the mountainous regions is caused also by the *G. balcanicus*.

On the whole we can assume that further validation is necessary to find the optimal typological status of the Nyerges-patak and that a more robust typological system should be applied to Hungarian streams based on the macroinvertebrate communities.

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