

TYOLOGY AND ECOLOGICAL STATUS ASSESSMENT OF HILLY-MOUNTAINOUS WATERCOURSES BASED ON AQUATIC MACROINVERTEBRATES - THE BALKAN PENINSULA CASE STUDY

Biljana Rimcheska

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Summary

In the past decades, the majority of the European countries have developed evaluation systems for freshwater ecosystems, including quality estimation through the living organisms as biological quality elements (BQE). The aim of this study was to provide indicative ecological status assessment of mountain and semi-mountain small streams and river sections belonging to Mesta, Struma and Vardar watersheds in a poorly studied area of the North Macedonia/Bulgaria cross-border territory (7th Ecoregion “Eastern Balkans”) based on the benthic macroinvertebrate (macrozoobenthos) as BQE. Thus, the present study provides also data on the taxonomic diversity and trophic structure of the benthic macroinvertebrate communities and analyse the similarity in communities between/within studied basins.

The basic dataset used for the performed analyses included 69 samples from 38 sites from both countries (sampled in autumn 2017 and spring 2018), all belonging to the R3- (mountainous) and R5- (semi-mountainous) river types, while for further comparison of the basic dataset an additional 74 samples from 56 sites (or in total 143 samples from 94 sites) were included, where, the similarity between macroinvertebrate communities from the three ecoregions (Dinaric/Hellenic Western Balkans and Eastern Balkans) was interpreted. The variation of the number of taxa, total abundance, relative abundance, species diversity and richness, evenness, index of dominance and the following indices - GDS, BMWP, ASPT, BI, EPT-taxa richness, RETI and ITC, were analysed. For the best representation of the studied data set, the corresponding statistical analyses were applied using the statistical packages Statistica 7/13.0, PRIMER-E v.6 and CANOCO 5.0.

In this study were found rich and diverse communities, totaling 280 macroinvertebrate taxa assigned to seven Functional Feeding Groups belonging to 15 systematic groups, where the insects dominated the macroinvertebrate communities (> 70%). The list of benthic macroinvertebrate fauna for the watershed of the Vardar, Struma and Mesta rivers has been supplemented. Thus, three new mayfly species (*Procladius pulchrum*, *Ecdyonurus macani* and *Habroplebia eldae*) were recorded for the first time for the fauna of N. Macedonia and

the presence of some Balkan endemic species was confirmed, five - for the Vardar watershed, ten - for the Struma watershed and eight for the Mesta watershed.

The highest α - and β -diversity were recorded within the Struma River watershed, which contributed to the higher γ -diversity and reflected the typical macroinvertebrate assemblages from the studied rivers. Overall, site similarities reflected the key macroinvertebrate metacommunities in R3- and R5-river type sections that provided higher β -diversity and lower similarities compared to the remainder of the watersheds. MDS- and dbRDA analyses separated the river basins by stream size and substratum heterogeneity. It became apparent that the highest α -dissimilarity was evident within Vardar and Mesta watersheds, even distinguishing the Vardar watershed sites independently from closest Struma River watershed sites. Also, the PCA analyses including the additional data set showed similar results. Regarding this, was proposed that the border between ecoregions 6 and 7 should be moved east of the originally proposed outline, joining the whole of the Vardar River watershed to the 6th Ecoregion (Hellenic Western Balkans).

The benthic macroinvertebrate's trophic structure and its dynamics were analyzed in different seasons. The level of similarity between the sampling localities was analyzed in the context of both the river typology and the water catchment. Based on the values of the indices BMWP, ASPT, BI and EPT-taxa richness, the water quality was assessed from excellent to poor (I – IV class). Some of the studied rivers do not achieve a good ecological status, mainly due to hydromorphological stress and habitat degradation (damming/mining/hydropower stations) and/or organic/anthropogenic pollution. Statistical treatment of the dataset indicated the strongest and most significant positive correlation between BMWP and EPT-taxa and negative correlation between BMWP and BI. The correlation between the GDS and the applied ecological quality indices clearly outlined a negative trend.

A comparison between the two trophic indices (RETI and ITC) was conducted in order to analyze the advantages of the application of these indices for assessment of the ecological status at the studied sites. It was found. that the trophic structure of the benthic macroinvertebrate communities in ostensibly typologically similar river sections differs at the undisturbed vs the impacted sampled sites. To a large extent, these differences were also determined by the presence of anthropogenic influence that resulted in the predominance of deposit feeders amplifying on higher disturbance on some of the studied rivers.

Nevertheless, this study contributes to the knowledge on the specific metacommunity representatives of these small, permanent lotic ecosystems and further to the distinctive macroinvertebrates assemblages in this part of the Eastern Balkans Ecoregion. The results

confirmed the sensitivity of the indices BMWP and EPT to seasonal changes of the macroinvertebrate communities. Long-term negative pressure has led to changes in microhabitats that affect the structure and functioning of the aquatic ecosystem by transformation of the trophic structure of the macrozoobenthos. These results would be applicable in the management protocols especially when alike activities involve such river ecosystems.