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APPLICATION OF TROPHIC INDICES IN ECOLOGICAL STATE ASSESSMENT OF RIVERINE WATER BODIES

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Abstract

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Benhtosological data from 39 potentially referent sites situated on 33 Bulgarian rivers are used for this study. Functional feeding group distribution and the main indicator macroinvertebrate groups along the studied sites are analyzed. Current ecological state, based on German Feeding Type index and Index of Trophic Completeness, of the studied sites was determined. Assessment was compared with the one made in the adapted version of Irish Biotic Index, widely applied in Bulgarian benthosological practice. Percentage distribution of the species in the main indicative groups demonstrates that SC and SH are dominant in macrozoobenthic trophic structure of the studied sites. Benthic species, which belong to functional group SH, are sensitive, while SC, PR, CL and FL are more or less tolerant. DF is characterized as most tolerant. Applicability of two trophic indices showed that the highest coincidence in assessment between the BI and RETI/PETI is observed. RETI/PETI is closer in ecological assessment to the BI and more relevant for conditions of the Bulgarian riverine ecosystems.

Key words: macrozoobenthos, referent sites, functional feeding groups, ecological state
Abbreviations: SH – shredders; SC – scrapers; FL – collectors filterers; CL – collectors gatherers; DF – deposit feeders; RETI/PETI– German feeding type index, ITC – Index of trophic completeness, BI – Irish Biotic index, EQR – Ecological quality ratio

Introduction

During the last decades in hydrobiological practice, trophic structure parameters of macrozoobenthos are used as indicator of the degree of the biotic response toward environmental influences in water ecosystems (Grubaudh and Wallance, 1995; Rawer-Jost et al., 2000; Varadinova et al., 2008). Indices based on functional feeding groups are used in elaboration of classification systems for assessment of the ecological status of riverine water bodies based on analyses of benthic macroinvertebrate communities (Schweder, 1990; Pavluk at al., 2000; Varadinova et al., 2007).

The aim of this paper is to compare application of two trophic indices on potentially referent river sites, which are characterized with different catchments area, attitude and hydromorphology.

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Materials and Methods

Benhtosological data from 39 potentially referent sites, situated on 33 Bulgarian rivers (Figure 1) are used for this survey. Studied sites are the following:

1-Veleka_Aydere; 2-Batova_Batovo; 3-Dvoinitsha_Popovich; 4-Fakiyska_Varovnik; 5-Golyamata reka_Svetlina; 6-Kamchia_Beronovo; 7-Kamchia_Dabovitsha; 8-Kamchia_Ichera; 9-Medvenska_Medven; 10-Neykovska_Neykovo; 11-Ropotamo_Velyov vir; 12-Sadovska_ustie; 13Sredetshka_Valchanovo; 14-Kamchia_Ticha; 15-Veleka_Brodilovo; 16-Veleka_Kosti; 17-Velikovska_Dvoinitsha; 18-Banderitsha_Vihren; 19-Cherna Mesta_Cherna Mesta; 20-Dospatska_Selishte; 21-Iliyna_Rilska; 22-Matnitsha_Petrelik; 23-Mesta_Ablanitsha; 24-Petrovska; 25-Stara_Jeleznitsha; 26-Struma_Razhdavitsa; 27-Biserska_Dolno Botevo; 28-Biserska_Leshnikovo_Na-

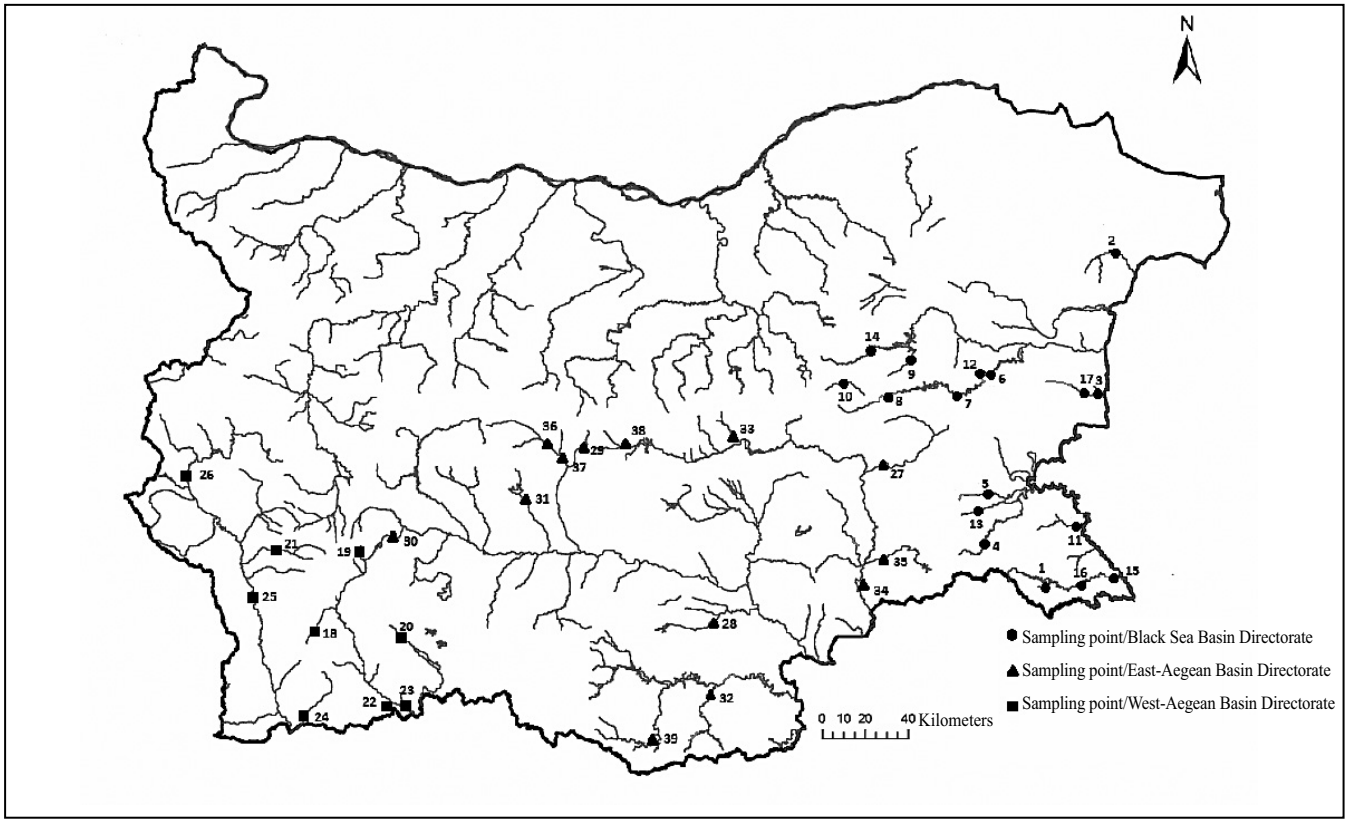

Fig. 1. Location of the sampling point on the Bulgarian territory

dezhden; 29-Damladere_Rozino; 30-Ibar_Raduil; 31-Kalavashtica_Malo Krushevo; 32-Krumovitsha_Melnitsha; 33-Manastirska_Mina Mramor; 34-Melnishka_Melnitsha; 35-Popovska_Ustie; 36-Striama_Klisura; 37-Stryama_Slatina; 38-Tundzha_Panitshite; 39-Varbitsha_Krilatitsha.

From them, 17 sites are located on the territory of Black Sea Basin Directorate, 13 – East Aegean Basin Directorate, and 9 – West Aegean Basin Directorate.

Benthosological study was conducted during the summer 2011. Adapted version of multi-habitat method (Cheshmedjiev et. al. 2011) with different sampling technics (ISO 7828:1985/EN 27828:1994 ISO 8265:1988/EN 28265:1994) was used for the data collecting. After relevant processing of the materials obtained species determination of the macrozoobenthos and there affiliation towards different functional groups (SH, SC, CL, FL, DF and PR,) was made.

Two trophic indices – adapted version (Varadinova, 2006) of the RETI/PETI (Schweder, 1990) and ITC (Pavluk et al., 2000) were tested on the benthosological data. Calculation of ITC index was done by the means of MaTros program product (http://macro.nemi-ekb.ru/site/login). BI (Clabby and Bowman, 1979), which is broadly used from 1998 in series of benthosological scientific and applied elaboration in Bulgaria, was leading in assessment of ecological state of the studied site. EQRs were recalculated according scales developed in pursuance of national project "Developing of the classification system for assessment of the ecological state and potential of certain types surface waters (rivers & lakes) at territory of the Republic Bulgaria (based on the typology of system B".

Results and Discussion

According River basin management plans, studied sites belong to two catchments area (Aegean and Black Sea) and are characterized with different attitude and hydromorphology. In this sense, applicability of two trophic indices in the referent conditions gives more relevant and real assessment without taking into account anthropogenic impacts. In compliance with principals of River Continuum concept (Vannot et al., 1985), in undisturbed

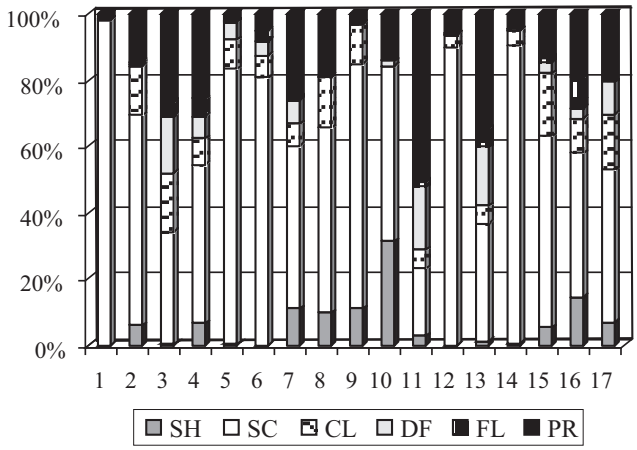

Fig. 2. Percentage distribution of functional feeding groups of the studied sites, situated on the Black Sea Basin Directorate

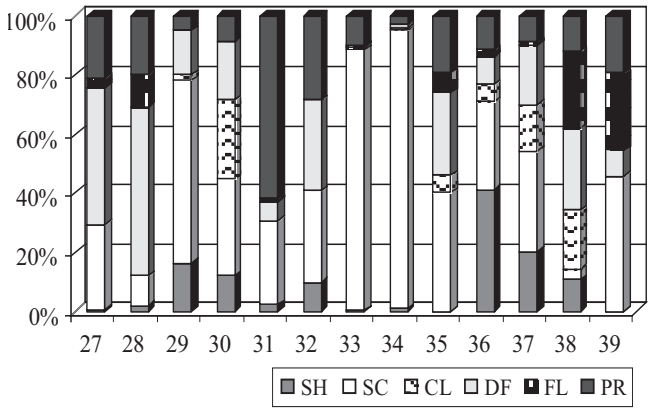

Fig. 4. Percentage distribution of functional feeding groups of the studied sites, situated on the East Aegean Basin Directorate

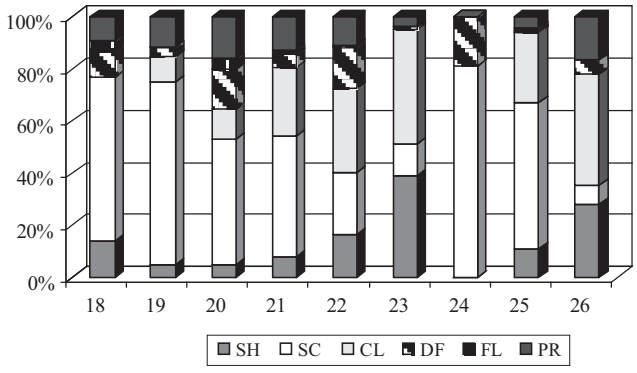

Fig. 3. Percentage distribution of functional feeding groups of the studied sites, situated on the West Aegean Basin Directorate

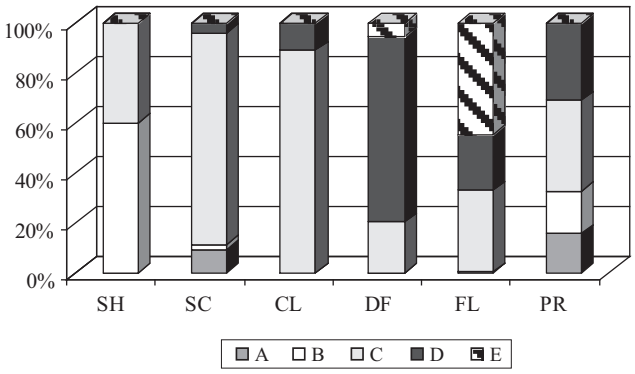

Fig. 5. Percentage distribution of the indicator groups macroinvertebrates entering into the composition in the trophic groups

environmental condition, physical factors are leading in trophic structure formation. As far as studied site are characterized as referent (free of human activities) our results demonstrate that "specialized feeders" (Barbour et al., 1996) SC and SH, as a more sensitive towards disturbances (McCormick et al., 2004; Varadinova, 2007) are dominating in composition of trophic structure of the macrozoobenthos (Figures 2, 3 and 4).

As far as indicator groups macroinvertebrates serve as a bases for calculation of the leading in assessment BI (Clabby and Bowman, 1979) we presented percentage distribution of the indicator groups macroinvertebrates entering into the composition of the different trophic groups (Figure 5). Species, which belong to SH, are defined as less sensitive taxa (indicative group B), while SC, PR, CL and FL belong to the group of relatively tolerant taxa (group C). DF is characterized as more tolerant (group D). According principles of calculation of the BI, presence of species from indicative group A (sensitive) is an indication for high ecological status of the water bodies. Species belonging to this group are least represented in the trophic structure of the studied sites. A possible reason for this result could be the fact that sensitive indicator species occupy and are adapted mainly for living in high mountain river habitats, but not all studied sites are situated at these areas. Studying of climate changes effects on the rivers demonstrate that more susceptible biological indicators are specifically sensitive and respond to the effects of climate change in local scale. For example, changes in thermal regimes are expected to shift species ranges to the north (and/or to higher elevations);

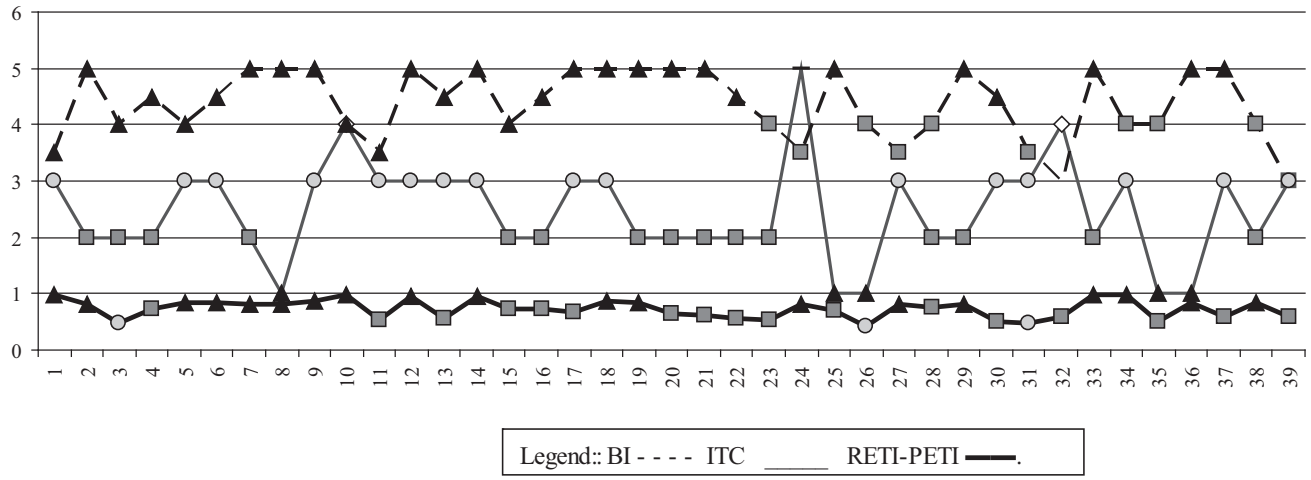

Fig. 6. Dynamics of values of the indices RETI/PETI, ITC and BI along the studied sites

species at the southern limits of their ranges will migrate or suffer local extinctions.

Dynamics of values of the two trophic indices RETI/PETI, ITC and BI are presented at Figure 6. Ecological states of the potentially referent sites were marked on the figure with triangles (high state), square (good), circles (moderate) and rhombs (poor/bad).

According the values of RETI/PETI 19 sites are determined in high ecological state, 17 – in good and 3 – in moderate. In comparison, ITC values show worse evaluations. The highest coincidence in assessment is observed between the values of BI and RETI/PETI – at 19 sites. From them, at 14.common site ecological state was determined as high.

The incomplete overlapping of assessments estimated by BI and RETI/PETI could be because BI is determined based on the presence of indicators in the species/taxa composition of the benthic community. In contrast, the trophic index is calculated though the proportion between macroinvertebrates functional feeding groups. EQR values based on RETI/PETI and BI demonstrate higher EQR scores, which are corresponded to high and good ecological state. Data received are explicably in view of the fact that studied sites are determined as referent. At 10 sites, the assessment based on the two trophic indices coincides. Considerable discrepancy is observed between the results of BI and ITC, where at only 6 sites the categories (EQR scores) are the same. At only 3 common sites assessment based on three indices together coincides.

Conclusion

Functional feeding groups' distribution of the studied potentially referent sites, demonstrates that SC and SH are dominant in macrozoobenthic trophic structure. Benthic species, which belong to functional group SH, are sensitive, while SC, PR, CL and FL are more or less tolerant. DF is characterized as most tolerant. Applicability of two trophic indices showed that RETI/PETI is closer in ecological assessment to the BI and more relevant in the conditions of Bulgarian river ecosystem. This index could be recommended and included in classification system for riverine water body's assessment.

Acknowledgements

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References

Barbour, M. T., J. Gerritsen, G. E. Griffith, R. Frydenborg, E. McCarron, J. S. White and M. L. Bastian, 1996.A framework for biological criteria for Florida streams using benthic macroinvertebrates. *Jour.North Amer.Benth.Soc*., **15**: 185–211.

Cheshmedjiev, S., R. Soufi, , Y. Vidinova, V. Tyufekchieva, I. Yaneva, Y. Uzunov and E. Varadinova, 2011. Multi-habitat sampling method for benthic macroinvertebrate communities in different river types in Bulgaria. *Water Research and Management*, **1 (**3): 55–58.

Clabby, K. and J. Bowman, 1979. Report of Irish participants. In: Ghetti, P.F. (Editor), 3rd Technical Seminar on Biological Water Assessment Methods, Parma, Vol. **1** Commission of the European Communities.

Grubaugh, J. W. and J. B. Wallance, 1995. Functional structure and production of the benthic community in a Piedmont

river: 1956–1957 and 1991–1992. *Limnol. Oceanogr*., **40** (3): 490–501.

Mccormick, P. V., R. B. E. Shuford and P. S. Pawlik, 2004. Changes in macroinvertebrate community structure and function along a river length. *Hydrobiologia*, **529 (**1): 113–132.

Pavluk, T. I., B. de Vaate and A. Leslie, 2000. Biological assessment method based on trophic structure of benthic macroinvertebrate communities. *Hydrobiologia*, **427:** 135–141.

Rawer-Jost, C., J. Bohmer, J. Blank and H. Rahmann, 2000. Macroinvertebrate functional feeding group methods in ecological assessment. *Hydrobiologia*, **422/423:** 225–232.

Schweder, H., 1990, Neue Indizes fur die Bewertung des ocologischen Zastandes von Fliebgewassern, abgeleiten aus der Macroinvertebraten-Ernahrungstypologie.. In: Friedrich, G. & J. Lacombe (Editors). Okologische Bewertung von Fliebgewassern. Limnologie aktuell 3. G. *Fischer Verlag.* Stuttgart, pp. 353–377.

Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell and C. E. Cushing. 1980. The river continuum concept. *Can. J. Fish. Aquat. Sci*., **37 (**1): 130–137.

Varadinova , E., 2006. Study of fuctional feeding groups' of the macrozoobenthos in the Mesta River. PhD theses, 180 pp. (Bg).

Varadinova, E., Y. Uzunov and R. Soufi, 2007. A New Integrated Index for Assessment of the Ecological Status of Rivers as Based on Functional Feeding Groups of the Macrozoobenthos. *J. Envir. Prot. Ecol*., **4** (8): 754–762.

Varadinova, E., Y. Vidinova, V. Tyufekchieva and I. Yaneva, 2008. Trophic structure of macrozoobenthos as measure of water bodies ecological state assessment. *Journal of Balkan Ecology*, **11** (3): 297–308.

* Climate Change Effects on Stream and River Biological Indicators: A Preliminary Analysis., EPA/600/R-07/085 March 2008, *www.epa.gov/ncea*