ECOLOGIA BALKANICA

2021, Vol. 13, Issue 2 December 2021 pp. 107-114

Trends in the Change of the Ecological Condition of the River Mesta After 10 Years Period of Research

Galia N. Georgieva[1], Emilia D. Varadinova[1, 2]*

1 - Bulgarian Academy of Sciences, Institute of Biodiversity and Ecosystem Research, Department of Aquatic Ecosystems, 2 Gagarin St. 1113 Sofia, BULGARIA
2 - South-West University "Neofit Rilski", Ecology and Environmental Protection Faculty of Mathematics and Natural Sciences, Department Geography, 66 Ivan Michailov St. 2700 Blagoevgrad, BULGARIA
*Corresponding author: emily.varadinova@gmail.com

Abstract. Long-term trends of the ecological status assessed by biological quality element macrozoobenthos, of the transboundary Mesta River (South Bulgaria) during the period 1978-2020 were analyzed. Macrozoobenthos samples were taken and physico-chemical parameters were measured twice at 7 sites situated on the main river and its tributaries during the low water period (August-September 2019 and 2020). Selected sites represented various ecological situations that are characterized by different types of human impact. Data on the current status of the river were compared with the last studied periods 2009-2010. The investigation was an extension of long-term research of the Mesta River that associated the river with the European Long Term Ecological Research Network (LTER). During the last decades, the self-purification processes and recovery of the bottom invertebrate communities and processes of stabilization of the aquatic ecosystem have been observed, after stopping the heavy organic pollution from industries in the Razlog town. This resulted in improvement of the water quality and the Mesta River ecological status. The current study demonstrated local sources of load on the aquatic ecosystem (agriculture, lack of urban wastewater treatment plants), which has a negative effect on the ecological situation in the river. Measures aimed at stimulating environmentally friendly agricultural practices and the construction of treatment plants are needed to preserve the integrity of the aquatic ecosystem and to maintain the regulated good ecological status.

Key words: Mesta River, macrozoobenthos, water quality, ecological status assessment.

Introduction

Mesta River was a subject of periodical hydrobiological (Kovachev, 1977; 1991; Psilovikos et al., 2005; Uzunov et al., 2011; Varadinova et al., 2013 a), ecological (Kovachev, Uzunov, 1986; Varadinova & Uzunov 2002; Varadinova et al., 2013c) and hydrological (Mimides et al., 2007; Diadovski et al., 2007, Hristova, 2012) studies during the last 40 years.

A special emphasis in the previous research was the selection of the Mesta River as a model object for the study of the functional trophic groups of the macrozoobenthos communities (Varadinova et al., 2008; 2013b; Kerakova et al., 2017; Varadinova & Kerakova, 2018).

Due to the long range of systematic biological, physico-chemical, and hydrological

data storage the river is a representative lotic site in the national network for long-term research, as well as in the European ecological network LTER (Varadinova et al., 2013a; Sani et al., 2012). Mesta River was an excellent model object for investigation processes of the heavy organic matter pollution before 1990, from industries in the Razlog Valley, discharging untreated waters in its right tributary - the Iztok River and domestic wastewater from the town of Gotse Delchev. The powerful self-purification potential, as well as the lack of other significant sources of organic load, led downstream to self-purification processes and after the site MKU (Table 1), improvement of the ecological situation (beta-mesosaproby) was registered (Kovachev, 1977; Kovachev & Uzunov, 1986). After stopping the operation of the industries in 1990, a transformation of the biotic communities and recovery of the lotic ecosystems have been found by Kovachev (1993). In the new saprobic conditions a gradual shortening of the recovering area of the river (Varadinova & Uzunov, 2002) and improvement of the ecological situation was registered (Varadinova et al., 2013c). The results of long-term researches were summarized in the monographic study for the Mesta River (Varadinova et al., 2013a).

The present paper was aimed at assessing the current ecological status of the Mesta River through macrozoobenthos, as well as analyzing the trends in the situation of the aquatic ecosystem 10 years after the last benthological study.

Material and Methods

Study area

The studies were carried out in a low water period (August-September) in 2019 and 2020. A total of seven 7 sampling sites (five situated on the main river and two on its' tributaries - the Cherna Mesta River and the Bunderitsa River (Fig. 1) were investigated.

Current results were compared with published data from the last studied period 2009-2010 (Varadinova et al., 2013a; Varadinova et al., 2013c). Selected seven sites (Table 1) were common for the two studied periods.

Sampling methods

The macrozoobenthos was taken following the multi-habitat sampling approach (Cheshmedjiev et al., 2011) following the standards BDS EN ISO 5667-1:2007 and BDS EN ISO 5667- 3:2018. *In situ*, the basic physico-chemical parameters (pH, electrical conductivity (µS/cm), dissolved oxygen concentration (mg/l), and saturation) were measured with a portable Windaus Labortechnik Package.

The collected material was fixed with 70% ethanol *in situ*. In the laboratory, the macroinvertebrates were sorted by taxonomic groups. The species composition and abundance were analyzed. After primary processing and identification of macrozoobenthos, feeding groups' affiliation was assigned according to Cheshmedjiev & Varadinova (2013).

The assessment of the ecological status through Total Number of Taxa (TNT) and Biotic Index (BI) based on the regulations in the Ordinance № H-4/2012 was made.

In addition, the trophic index RETI based on functional feeding groups according (Chesmedjiev & Varadinova, 2013) was calculated.

The map of the surveyed lotic water bodies was prepared with the help of the software product Quantum GIS Version 2.18 Las Palmas.

Results and Discussion

According to the Bulgarian typology, studied sites situated on the main stream (MYA, MGK, MIZ, MKU, MHD) were defined as water bodies R5 type "Semi mountain rivers" in ecoregion 7 – Eastern Balkans. The smaller tributaries belong respectively– Bunderitsa River to R1 "Alpine rivers" and Cherna Mesta River to R3 type "Mountain rivers".

The presence, abundance, and structure of the macrozoobenthos communities in lotic

ecosystems are strongly influenced by various abiotic factors such as temperature, dissolved oxygen, pH, substrate, and conductivity of the bottom water (Beuchel et al., 2006). The dynamics of the values of the aquatic parameters at the studied sites during 2019 and 2020 (Fig. 2, 3) characterized water ecosystems in good-high status (Table 2). Slight deterioration of oxygen parameters at the site BUN (Fig. 2, 3 - 2019-8.5mg/l; 2020-6.84 mg/l) in 2020 was due to the registered local extensive stream of tourists and higher water temperature at the moment of sampling (2019-10.5ºC; 2020-14.7ºC). Comparative analysis between the years 2009-2010 and 2019-2020 showed that the studied sites retain the standards for high and good status (Varadinova et al., 2013c).

The dynamics of the benthological indices during the 2019 and 2020 (Fig. 4, 5) demonstrated that the values of TNT, BI, and RETI were characterized with a trend of decreasing downstream. This corresponded to the deterioration of the ecological situation in the lower river sections.

Table 1. Main features and coding of the studied sampling sites. *Legend:* R. – river, u/s – upstream the site, d/s – downstream the site, R – referent conditions; SA – slightly affected; A – affected.

Code	Sampling point	Degree of human impact	N	E	Altitude (m a.s.l.)
BUN	Bunderitsa R. u/s Vihren hut	R	41.756062	23.416446	1983
CHM	Cherna Mesta R., u/s Cherna Mesta Village	R	42.058139	23.727472	1011
MYA	Mesta R. u/s Yakoruda	SA	42.03115	23.6914	935
MGK	Mesta R., General Kovatchev (u/s Iztok River)	A	41.88705	23.57172	750
MIZ	Mesta R. d/s Iztok R.	A	41.8825	23.57335	756
MKU	Mesta R., at Kupena	A	41.70987	23.70255	599
MHD	Mesta R., at Hadzhidimovo	A	41.525033	23.87175	460

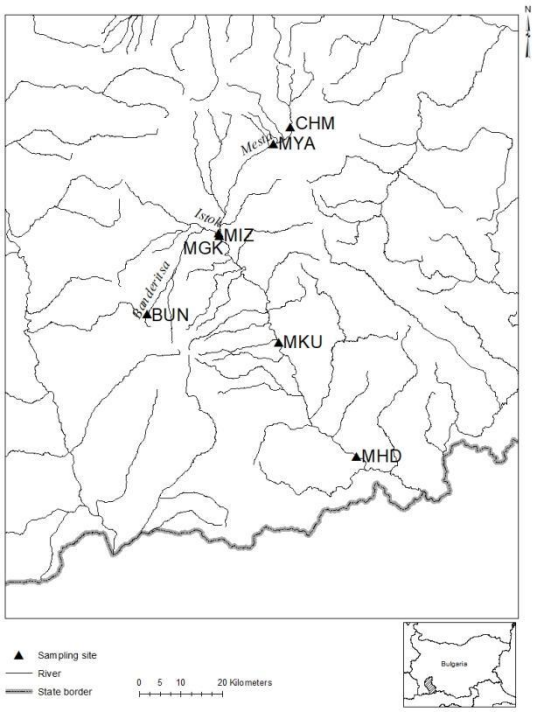

Fig. 1. Scheme of Mesta River valley with the sampling sites.

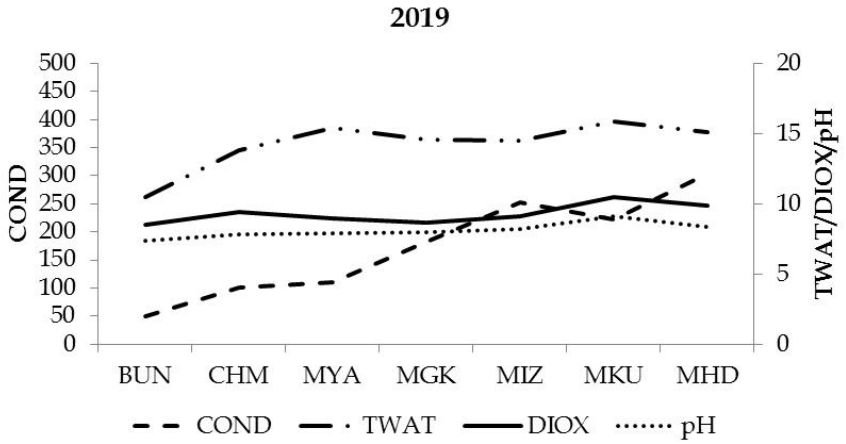

Fig. 2. Longitudinal dynamics of the values of physico-chemical parameters (dissolved oxygen (DIOX), pH, conductivity (COND) and water temperature (TWAT) in the studied sites during 2019.

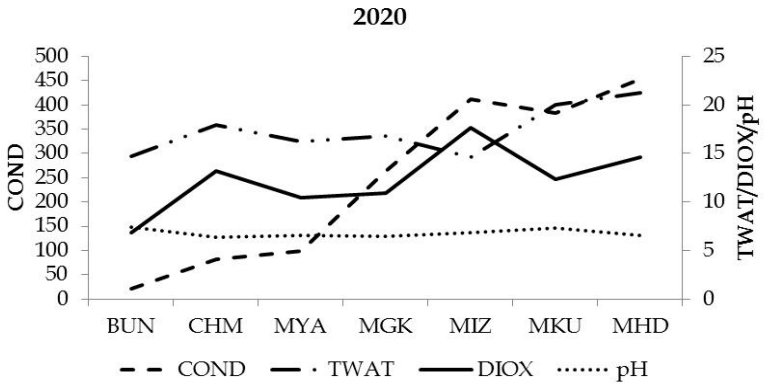

Fig. 3. Longitudinal dynamics of the values of physico-chemical parameters (dissolved oxygen (DIOX), pH, conductivity (COND) and water temperature (TWAT) in the studied sites during 2020.

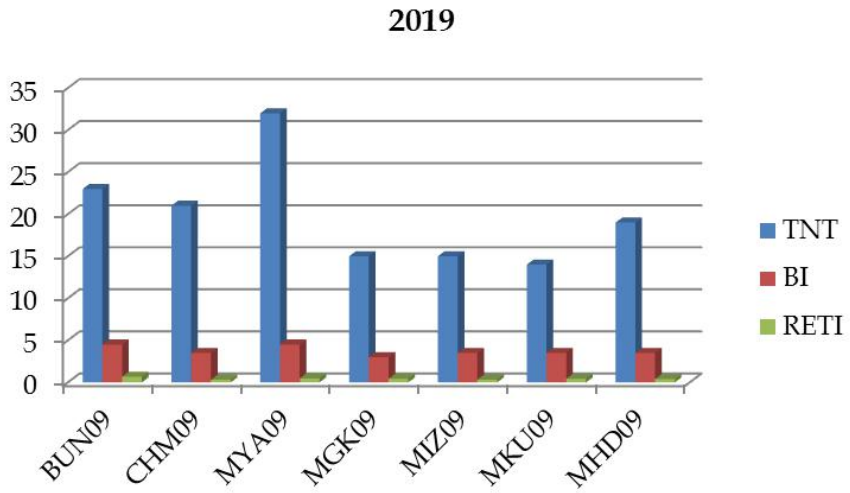

Fig. 4. Ecological state assessment, based on TNT, BI and RETI at studied sites during 2019.

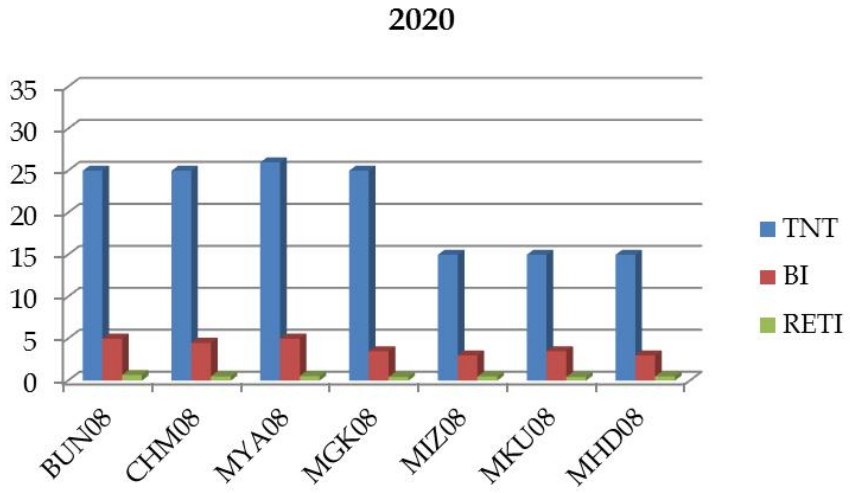

Fig. 5. Ecological state assessment, based on TNT, BI and RETI at studied sites during 2020.

The ecological status evaluation determined by BI values showed high-moderate status of the studied sites (tributaries and main river) (Table 2). Officially, BUN and CHM were defined in the active River Basin Management Plan (West Aegean RBMP, 2016-2021) as sites with referent conditions. During the current study and in the previous studied period (Varadinova et al., 2013c), biological indices (TNT and BI) calculated for BUN and CHM retained the requirements for high and good ecological status.

In the section of the Mesta River, after the town of Yakoruda (MGK), to the last studied site MHD, the aquatic ecosystem was influenced in varying degrees from negative anthropogenic influences (West Aegean RBMP, 2016-2021), which redounded in a decrease of BI values (Fig. 2) and a variation in the assessment between good and moderate status (Table 2). Fluctuations in the indices values represent the changes in the benthic communities, caused by the anthropogenic impact and different kinds of land use that affect the macroinvertebrates in the streams (Cooper et al., 2013).

A similar situation was observed at site MHD, situated nearby settlements Hadzhidimovo and Blatska. MHD showed deterioration of the ecological assessment – moderate-good (2019-2020, compared to good-high status, defined 10 years ago (2009-2010)). The sampling site was affected by the hydromorphological changes in the river bank by the local sandpit. In addition, the self-purification capacity of the lotic ecosystem was not able to cope with the organic pollution from the fertilizers and detergents used in agriculture and wastewaters inflows from the settlements. The planned wastewater treatment plant in the Hadzhidimovo municipality will significantly alleviate the load on the river, which will contribute to improving the ecological condition in the transboundary part of the Mesta River (River Basin Management plans, 2016-2021).

The values of the RETI trophic index showed a significantly lower assessment, compared to the TNT and BI regulated in the legislation (Table 2). The reason for this could be found in the higher sensitiveness of the trophic structure towards different hydromorphological changes, registered downstream as well unfavourable local impact caused by agricultural activities close to the riverbed, which reflected on the sensitive functional feeding groups' (shredders and scrapers) and caused trophic structure transformation (Fu et al., 2016; Moreyra et al., 2015).

Table 2. Evaluation of the ecological status of the studied sampling sites in 2019/2020.

	Site Code/ Year	BUN	CHM	MYA	MGK	MIZ	MKU	MHD
O_2 mg/l	2019	high	high	high	high	high	high	high
	2020	good	high	high	high	high	high	high
pH	2019	good	good	good	good	good	good	good
	2020	good	good	good	good	good	good	good
COND µS/cm	2019	high	high	high	high	high	high	high
	2020	high	high	high	high	high	high	high
EQR/ BI	2019	high	good	high	moderate	good	good	good
	2020	high	high	high	good	moderate	good	moderate
EQR/ RETI	2019	good	poor	moderate	moderate	poor	moderate	moderate
	2020	good	good	good	moderate	moderate	moderate	moderate
TNT	2019	high	high	high	good	good	good	high
	2020	high	high	high	high	good	good	good

Conclusion

The upper river sections and mountain tributaries of the Mesta River fully met the requirements for referent conditions. Aquatic invertebrate communities were characterized by high taxonomic richness and aquatic ecosystems were defined as unaffected and balanced. However, downstream the aquatic ecosystem integrity was highly vulnerable, because of the accumulated local effects of the human impact. These processes had a negative effect on the assessment, which in certain periods deteriorated and fell below the recommended in Europe and national water legislation good ecological status.

This requires measures aimed at implementing environmentally-friendly agricultural practices near the riverbed and the construction of treatment plants in the adjacent settlements.

Acknowledgements

This study is funded by the project "Upgrading distributed scientific infrastructure "Bulgarian Network for Long-Term Ecosystem Research (LTER-BG)" implemented within the National Roadmap for Research Infrastructure (2020-2027) (DO1-405/18.12.2020)

References

Beuchel, F., Gulliksen, B. & Carroll, M. (2006). Long-term pattern of rocky bottom macrobenthic community structure in an Arctic fjord (Kongsfjorden, Svalbard) in relation to climate variability (1980-2003). *Journal of Marine Systems, 63*, 35-48. doi: 10.1016/j.jmarsys.2006.05.002.

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

Chesmedjiev, S. & Varadinova, E. (2013). Bottom Invertebrates, In: Belkinova, D., G. Gecheva, S. Cheshmedjiev, I. Dimitrova-Dyulgerova, R. Mladenov, M. Marinov, I. Teneva, P. Stoyanov, S. Mihov, L. Pehlivanov, E. Varadinova,

Ts. Karagyozova, M. Vasilev, A. Apostolu, B. Velkov, M. Pavlova. Biological Analysis and Ecological Status Assessment of Bulgarian Surface Water Ecosystems. *University of Plovdiv Publishing House*, Plovdiv, (pp. 147-164). ISBN 978-954-423-824-7. (In Bulgarian).

Cooper, S.D., Lake, P.S., Sabater, S., Melack, J.M. & Sabo, J.L. (2013). The effects of land use changes on streams and rivers in mediterranean climates. *Hydrobiologia 719*, 383–425. doi: 10.1007/s10750-012-1333-4.

Diadovski, K., Atanassova, M. & Ivanov, I. (2007). Integral assessment of climate impact on the transboundary Mesta River flow formation in Bulgaria. *Environmental Monitoring and Assessment*, *127*, 383-388. doi: 10.1007/s10661-006-9287-5.

Hristova, N. (2012). Hydrology of Bulgaria. Sofia, Tip-top press publishing house, 830 p.

Kerakova, M., Uzunov, Y. & Varadinova, E. (2017). Comparison of Trophic Structure of the Benthic Macroinvertebrates in Three Bulgarian Riverine Water Bodies. *Turkish Journal of Zoology*, *41*(2), 267-277

Kovachev, S. (1977). Saprobiological processes in Mesta River. *Hydrobiologia*, (5):70-79. (In Bulgarian)

Kovachev, S. & Uzunov, Y. (1986). Formation of macroinvertebrate communities in the course of the biological selfpurification of the Mesta River. *Archiv fur Hydrobiologie*, *4*, 427-526.

Kovachev, S. (1991). Forming the ecological state of Mesta River system after elimination of pollution from both hydrolysis and yeast production plant and cellulose and cardboard plant in Razlog. *Final report, Project № 33/1990, MOEW*, 48 p. (In Bulgarian).

Kovachev, S. (1993). Formation of the ecological situation in the Mesta River valey in connection with pollution elimination from the Yeast and Cardborad Manifacturing. *Final report, Project 33/1993/MOEW*. (In Bulgarian).

Fu, L., Jiang, Y., Ding, J., Liu, Q., Peng, Q. & Kang, M. (2016). Impacts of land use and environmental factors on macroinvertebrate functional feeding groups in the Dongjiang River basin, southeast China. *Journal of Freshwater Ecology*, *31*(1), 21-35. doi: 10.1080/02705060.2015.1017847.

Mimides, T., Kotsovinos, N., Rizos, S., Soulis, C., Karakatsoulis, P. & D. Stavropoulos. (2007). Integrated runoff and balance analysis concerning Greek-Bulgarian transboundary hydrological basin of River Nestos/Mesta – Desalination. *International Conference on New Water Culture of South East European Countries-AQUA, 213*, 174-181.

Moreyra, A. & Padovesi-Fonseca, C. (2015). Environmental effects and urban impacts on aquatic macroinvertebrates in a stream of central Brazilian Cerrado. *Sustainable Water Resources Management*, 1, 125–136. doi: 10.1007/s40899-015-0013-8.

Ordinance H-4/2012 for characterization of the superficial waters. (2013). *State Gazette*, № 22, 2013. Retrieved from www.bsbd.org. (In Bulgarian).

Psilovikos, A., Margoni, S. & Psilovikos, A. (2005). Monitoring Water Quality of the Transboundary River Nestos. *American Journal of Applied Science*, 2(4):759-762. doi: 10.3844/ajassp.2005.759.762.

River Basin Management Plans of East/West Aegean Region. (2016-2021). Retrieved from moew.government.bg. (In Bulgarian).

Sani, D., Focaccia, P., Ravaioti, M., Badea, O., Krauze, K., Kuitunen, P., Neagu, S. & Varadinova, E. (2012). *EnvEurope, Buletin*. Retrieved from enveurope.eu.

Uzunov, Y., Varadinova, E., Yaneva, I., Stoichev, S., Vidinova, Y. & Kumanski, K. (2011). Long-term changes of the bottom invertebrate fauna of the Mesta River in southwestern

Bulgarian. *Annual de l'universite de Sofia "St. Kliment Ohridski" Faculte de Biologie Livre 1. Zoologie*, *99*, 33-52.

Varadinova, E. & Uzunov, Y. (2002). Recent Assessment and Long-Term Changes in the Saprobiological State of the Mesta River (South-Western Bulgaria). *Journal of Environmental Protection & Ecology*, *3*(1), 68-75.

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

Varadinova, E., Kerakova, M., Soufi, R., Aleksandrova, M., Stoichev, S., Vidinova, Y., Tyufekchieva, V. & Uzunov, Y. (2013a). Bottom invertebrate communities (the macrozoobenthos): Key biological quality element for ecological classification of the Mesta River basin. In Uzunov, Y., Pehlivanov V., Georgiev, B., Varadinova, E. (Eds.). *Mesta River: Biological quality elements & Ecological status.* Professor Marin Drinov Academic Publishing house, (pp. 61-97). ISBN 978-954-322-689-4.

Varadinova, E., Kerakova, M. & Uzunov, Y., (2013b). Mesta River: The trophic structure of the macrozoobenthos. In Uzunov, Y., Pehlivanov V., Georgiev, B., Varadinova, E. (Eds.). *Mesta River: Biological quality elements & Ecological status.* Professor Marin Drinov Academic Publishing house, (pp. 97-123). ISBN 978-954-322-689-4.

Varadinova, E., Kerakova, M., Soufi, R., Ihtimanska, M. & Uzunov, Y. (2013c). Current Ecological State Assessment of Bulgarian part of the Trans-boundary Mesta River (South-West Bulgaria). *Acta zoologica bulgarica*, *65* (2), 327-335.

Varadinova, E. & Kerakova, M. (2018). Trophic Structure of the Riverine Macroinvertebrates in Type-specific Reference Conditions. *Acta zoologica bulgarica*, *Sppl. 12*, 101-108

Received: 02.07.2021
Accepted: 01.09.2021