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BIOLOGICAL MONITORING OF THE KAYALIIKA AND MECHKA RIVERS BASED ON THE BIOLOGICAL QUALITY ELEMENT MACROZOOBENTHOS

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Abstract

The study aims to conduct biological monitoring of the Kayaliika and Mechka Rivers (Maritsa River catchment) based on the biological quality element macrozoobenthos. For the study, the lower reaches of the Kayaliika River (Varbitsa biotope) and Mechka River (Debar and Lyubenovo biotopes) were visited. The studied rivers belong to Type R5 “Semi-mountainous rivers” in Ecoregion 7, the Eastern Balkans. Sampling was carried out during the spring and summer seasons of 2024. Forty-one taxa (744 specimens) of macroinvertebrate organisms were identified from the Kayaliika River, and 43 taxa (1722 specimens) from the Mechka River. The discovered macroinvertebrate taxa belong to 17 orders (Allogastropoda, Amphipoda, Arhynchobdellida, Coleoptera, Crassiclitellata, Diptera, Ephemeroptera, Hemiptera, Hygrophila, Isopoda, Littorinimorpha, Odonata, Rhynchobdellida, Sphaeriida, Trichoptera, Tricladida, Tubificida). In the Mechka River, Debar biotope was recorded as having the presence of Nematoda. The biomonitoring was conducted in accordance with a methodology approved by the country and the European Union. Basic metrics (the total number of taxa; number of taxa from the orders Ephemeroptera, Plecoptera and Trichoptera (EPT); % (Oligochaeta and Diptera); % Filtering feeders; % EPT taxa; Shannon-Weaver species diversity index; saprobic index; trophic index; adapted Biotic Index) were calculated and discussed. The study found a deterioration in the ecological state of both rivers in their lower reaches, compared to previous years.

Keywords: Bulgaria, ecological state, indicator taxa, Maritsa River basin, metrics

INTRODUCTION

The Kayaliika and Mechka Rivers originate from the Eastern Rhodopes and are part of the Maritsa River catchment (Kiradzhiev, 2013). According to the typology of surface waters and river category, both rivers belong to type R5 “Semi-

mountainous rivers" in Ecoregion 7 Eastern Balkans (Belkinova et al., 2013). Biological quality elements play a major role in determining the ecological state of surface waters. In contrast, physicochemical quality elements (abiotic environmental factors) play a complementary role and explain the reasons that led to the deterioration of the ecological status. Changes in the latter lead to changes in the state of biological quality elements. The composition and abundance of aquatic flora and benthic invertebrate fauna, as well as the composition, abundance and age structure of fish fauna, are of great importance for determining the state of surface waters (Directive 2000/60/EC, Regulation No. H-4 of 14.09.2012). In general, the state of aquatic ecosystems is determined by the element in the worst condition (the one out – all out rule) (Directive 2000/60/EC, Cheshmedjiev & Marinov, 2008, Belkinova et al., 2013). At present, no scientific studies have been established on the ecological state of the waters of the Kayaliika River and the Mechka River based on the biological quality element (BQE) macrozoobenthos. Georgiev (2012) studied the freshwater malacofauna of the Mechka River and other rivers of the Upper Thracian Lowland.

The present study aims to conduct biological monitoring of the Kayaliika and Mechka Rivers based on the biological quality element macrozoobenthos during two seasons (spring and summer) to assess the state of the two river ecosystems and the anthropogenic impact on them.

MATERIALS AND METHODS

The ecological monitoring covers the waters of the Kayaliika River in the area of the village of Varbitsa (42°03'08.3"N 25°20'40.3"E; 173 m above sea level) and the waters of the Mechka River - in the vicinity of the town of Parvomay, Debar district (42°04'27.7"N 25°11'49.1"E; 185 m above sea level) and Lyubenovo district (42°06'29.6"N 25°16'07.9"E; 161 m above sea level). The selected sites of both rivers are marked as biotopes (Map 1; Photos 1-2).

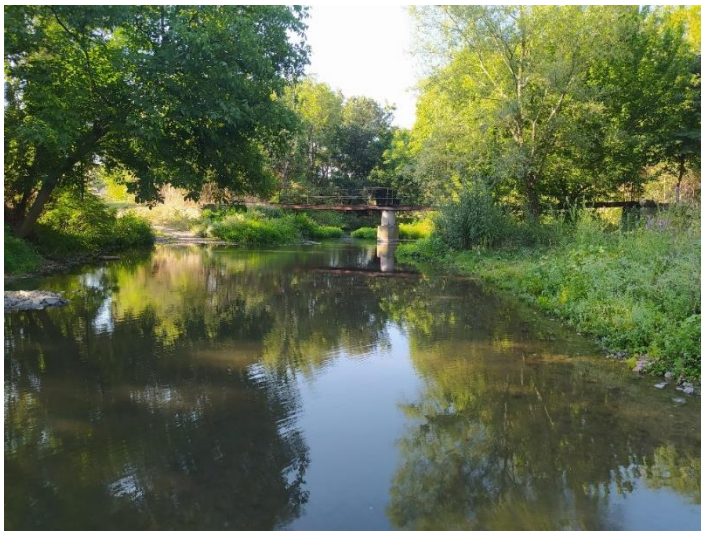
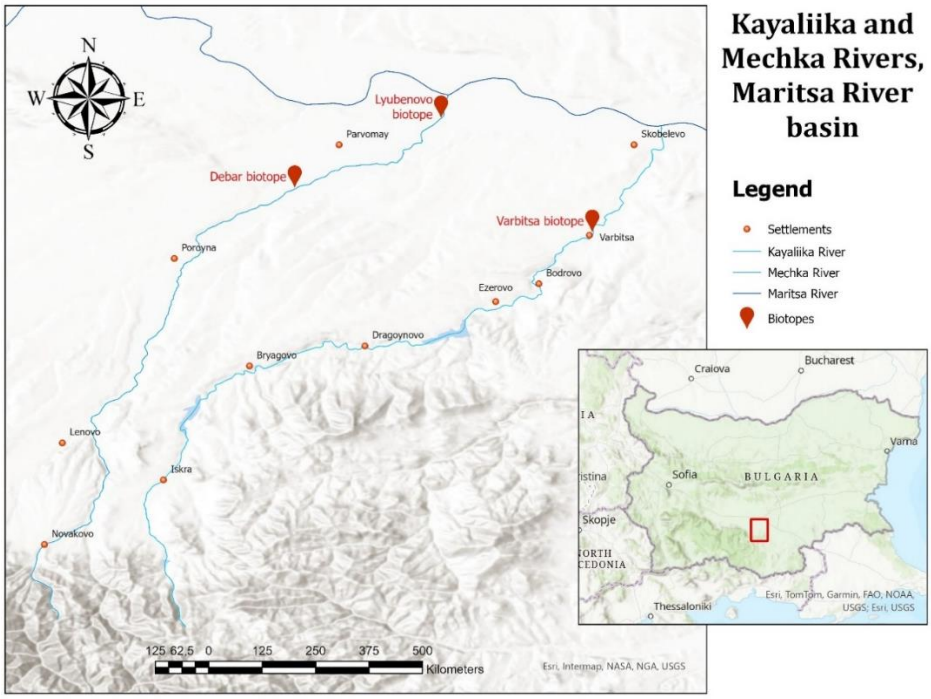


Photo 1. Kayaliika River, Biotope Varbitsa

Photo 2. Mechka River, Biotopes Debar and Lyubenovo (from left to right)



Map 1. Researched biotopes from the Kayaliika and Mechka Rivers

The collection of macrozoobenthos samples was carried out in the spring and summer of 2024, according to Cheshmedjiev et al. (2011), EN ISO 10870:2012, EN 16150:2012, Regulation No. H-4 of 14.09.2012, Belkinova et al. (2013). A monitoring methodology approved for the European Union and Bulgaria was applied. The taxonomic composition of the collected macrozoobenthos was determined in laboratory conditions under a Micros Austria MZ 1240 stereomicroscope. The following main metrics were calculated (Regulation No. H-4 of 14.09.2012, Belkinova et al., 2013):

- the total number of taxa;
- number of taxa from the orders Ephemeroptera, Plecoptera and Trichoptera (EPT);
- % (Oligochaeta and Diptera);
- % Filtering feeders;
- % EPT taxa;
- Shannon-Weaver species diversity index (H') – is calculated by the formula:

$\mathbf{H} = (\mathbf{P})(\mathbf{logP})$, where:

H – diversity index, P – taxon proportion (amount of taxon divided by the total number of organisms in the sample);

- saprobic index (SPUB) – is calculated by the formula:

$\mathbf{SPUB} = \sum(\mathbf{s_i h_i I_i})/\sum(\mathbf{h_i I_i})$, where:

s_i – saprobic significance of the species/ taxon i, h_i – relative abundance of the species/ taxon, I_i – indicator weight of the species/ taxon;

- trophic index RETI – is calculated by the formula:

$\mathbf{RETI} = (\mathbf{SH} + \mathbf{SC})/(\mathbf{SH} + \mathbf{SC} + \mathbf{FL} + \mathbf{CL} + \mathbf{DF})$, where:

SH – shredders, SC – scrapers, FL – filtering feeders, CL – collectors, DF – deposit feeders;

- adapted Biotic Index (BI).

RESULTS AND DISCUSSION

In the spring and summer of 2024 forty-one taxa (with 744 specimens) of macroinvertebrate organisms were collected from the Kayaliika River and 43 taxa (with 1722 specimens) from the Mechka River. The discovered macroinvertebrate taxa from the Kayaliika River belong to 17 orders (Allogastropoda, Amphipoda, Arhynchobdellida, Coleoptera, Crassiclitellata, Diptera, Ephemeroptera, Hemiptera, Hygrophila, Isopoda, Littorinimorpha, Odonata, Rhynchobdellida, Sphaeriida, Trichoptera, Tricladida, Tubificida), and those from Mechka River – to 15 orders (Allogastropoda, Amphipoda, Arhynchobdellida, Coleoptera, Crassiclitellata, Diptera, Ephemeroptera, Hemiptera, Hygrophila, Isopoda, Odonata, Rhynchobdellida, Sphaeriida, Trichoptera, Tubificida). In the Mechka River, Debar biotope, recorded the presence of Nematoda. Dominant taxa in the Kayaliika River (Varbitsa) are *Hydropsyche ornatula* McLachlan 1878, larva and *Cloeon* sp., larva in spring and summer, respectively. *Gammarus pulex* (Linnaeus, 1758) is dominant in the Mechka River (Debar) in both seasons studied. Dominant taxa in the Mechka River (Lyubenovo) are *Cloeon* sp., larva and *Physella acuta* (Draparnaud, 1805) in spring and summer, respectively (Figures 1-3).

The largest number of taxa was found in Varbitsa biotope in the spring season (37 taxa), and the smallest – in Debar biotope in the summer season (17 taxa). In all studied biotopes and both seasons, according to the metric total number of taxa, the ecological state was assessed as very good. The largest number of taxa of Ephemeroptera,

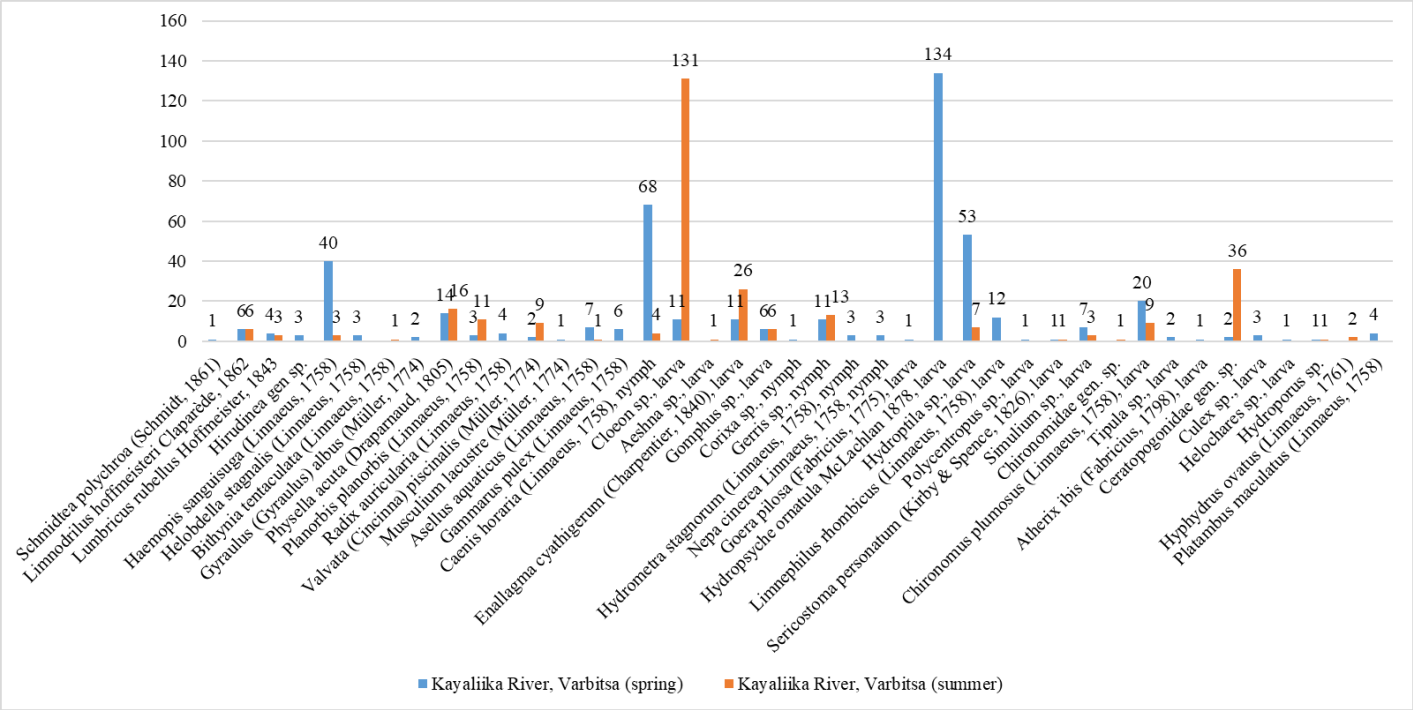


Figure 1. Number of the identified macrozoobenthos taxa from Kayaliika River (Varbitsa) by seasons

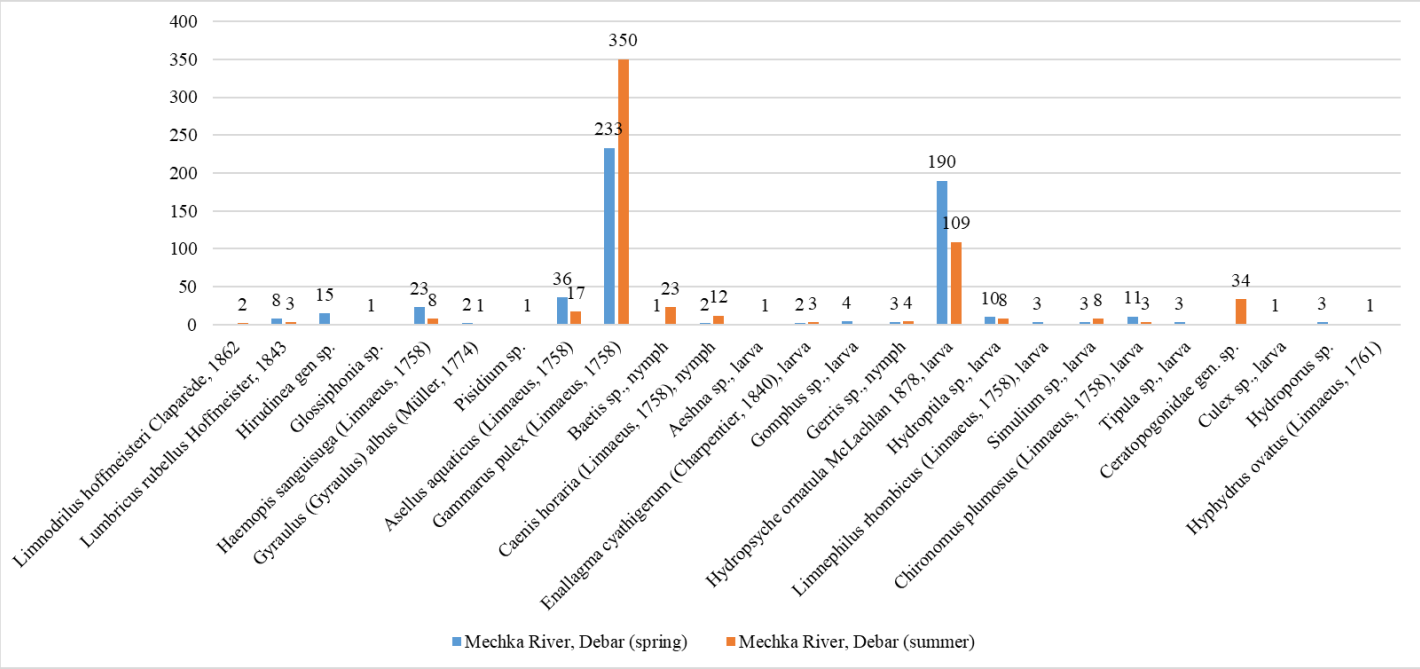


Figure 2. Number of the identified macrozoobenthos taxa from Mechka River (Debar) by seasons

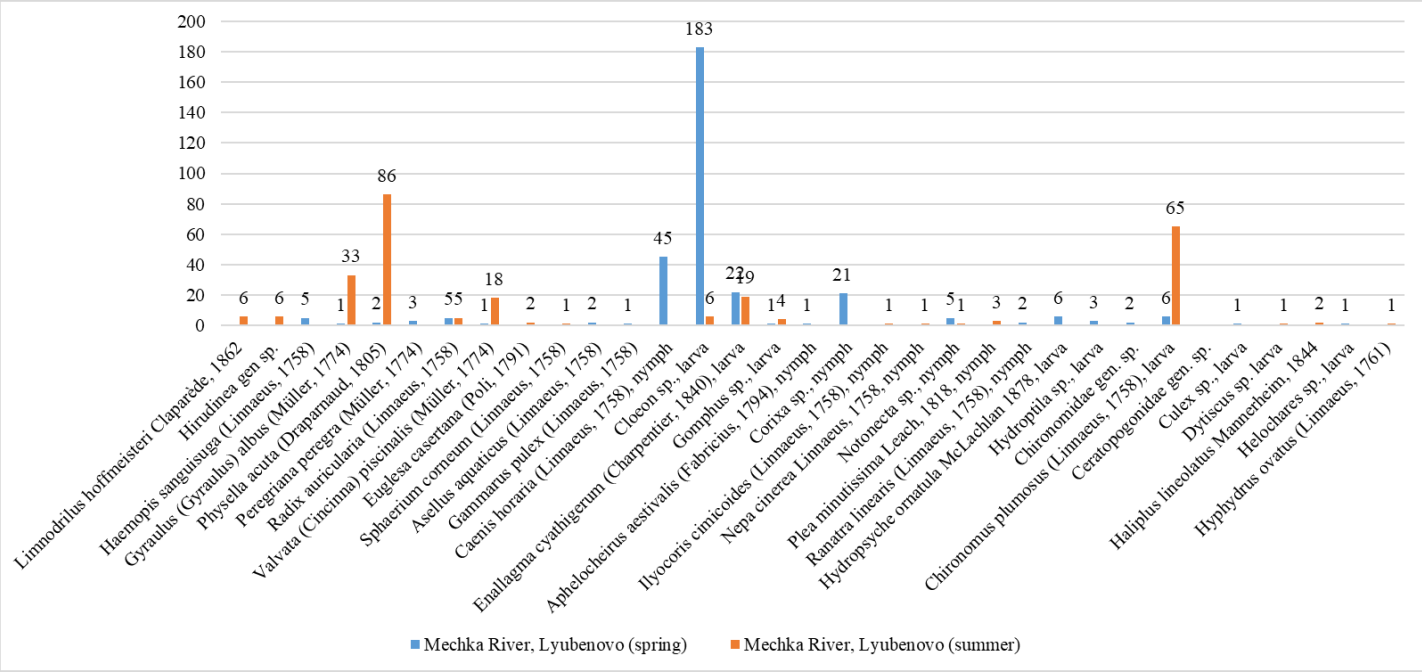


Figure 3. Number of the identified macrozoobenthos taxa from Mechka River (Lyubenovo) by seasons

Plecoptera and Trichoptera (species sensitive to pollution) were found in Varbitsa biotope in the spring and the smallest – in Lyubenovo biotope in the summer, which determines the ecological state as good and bad, respectively (Table 1). Georgiev (2012) reported for the Mechka River (at the bridge of Parvomay town) the species *Planorbis planorbis* (Linnaeus 1758) and *Anodonta cygnaea* (Linnaeus 1758). The present study, *Pl. planorbis*, was found in Varbitsa biotope during both study seasons.

Table 1. Taxonomic composition and abundance of macroinvertebrates from the Kayaliika and Mechka Rivers by biotope and season, 2024

Metrics	**Varbitsa (Kayaliika River)**		**Debar (Mechka River)**		**Lyubenovo (Mechka River)**	
Season	**spring**	**summer**	**spring**	**summer**	**spring**	**summer**
total number of taxa	37 (453 specimens) very good	22 (291 specimens) very good	21 (555 specimens) very good	17 (587 specimens) very good	22 (319 specimens) very good	19 (261 specimens) very good
number of EPT taxa	8 (281 specimens) good	4 (143 specimens) moderate	5 (206 specimens) moderate	4 (152 specimens) moderate	4 (237 specimens) moderate	1 (6 specimens) bad
% (Oligochaeta and Diptera)	9.93%	19.93%	4.69%	8.52%	2.82%	27.20%
% Filtering feeders	2.87%	13.40%	0.72%	7.33%	0.31%	1.15%
% EPT taxa	62.03%	49.14%	37.12%	25.89%	74.30%	2.30%
H'	2.07 β	2.5 β	1.56 α	1.44 α	2 β	1.63 α
RETI	0.32 bad	0.74 good	0.57 good	0.698 good	0.77 good	0.67 good
SPUB	1.99 good	2.06 good	1.82 very good	1.36 very good	1.82 very good	2.49 moderate
BI (nEQR)	3.5 (0.7) good	3.5 (0.7) good	3.0 (0.6) moderate	2.5 (0.5) moderate	2.5 (0.5) moderate	2.0 (0.4) bad

For both rivers, an increase in % (Oligochaeta and Diptera) and % Filter feeders, and a decrease in % EPT taxa from spring to summer, i.e. deterioration of the environmental conditions, is observed. The most drastic is the decrease in % EPT taxa in the Lyubenovo biotope – from 74.30% to 2.30%, as well as the increase in % (Oligochaeta and Diptera) – from 2.82% to 27.20% (Table 1).

The highest values of the Shannon-Weaver species diversity index were found in spring and summer in the Varbitsa biotope (Kayaliika River), as well as in spring in the Lyubenovo biotope (Mechka River), which indicates β-mesosaprobic conditions. Lower index values were found in the remaining cases, indicating α-mesosaprobic conditions (Table 1).

Regarding the calculated German trophic index RETI, the lowest index value was recorded for the Kayaliika River in spring, indicating an imbalance in the Varbitsa biotope. In contrast, the obtained index values indicate stable conditions

in the Varbitsa biotope in summer and in the Lyubenovo biotope in spring (Table 1).

In the Varbitsa biotopes (Kayaliika River) and Debar (Mechka River) in spring, the bioindicator macrozoobenthos for 0-β-mesosaprobic conditions prevails (9 and 5 taxa, respectively), and in summer – for β-mesosaprobic conditions (7 and 4 taxa, respectively). In the Lyubenovo biotope (Mechka River) in spring, the macrozoobenthos for β-mesosaprobic (8 taxa), and in summer for 0-β and β-mesosaprobic conditions (4 taxa each). According to the calculated saprobic index (SPUB), the state of the waters of the Kayaliika (Varbitsa) and Mechka (Debar) Rivers remained relatively constant during both seasons, while in Lyubenovo a deterioration of the water state was observed from spring to summer. According to this index, the water state in Debar was the best, and in Lyubenovo, the worst in summer (Table 1).

In the present study, indicator macroinvertebrate organisms from four sensitivity groups were found: group B (less sensitive forms), group C (relatively tolerant forms), group D (tolerant forms) and group E (the most tolerant forms). There were no representatives of group A (sensitive forms). In all studied biotopes and seasons, the number of macroinvertebrate taxa decreased in group C > group D > group B ≥ group E (Figure 4).

The calculated biotic index (BI) shows a good ecological state for the Kayaliika River (Varbitsa biotope), moderate ecological state for the Mechka River (Debar biotope) during both seasons and deterioration of the ecological state in the Lyubenovo biotope from moderate in spring to bad in summer (Table 1).

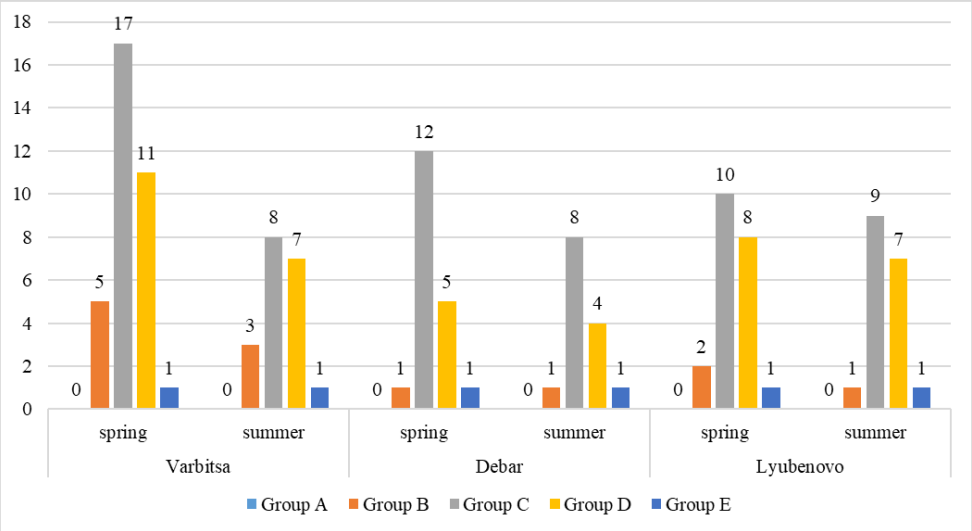


Figure 4. Distribution of macrozoobenthos taxa from Kayaliika and Mechka Rivers by sensitivity groups

In conclusion, the ecological state of the waters of the Kayaliika River (Varbitsa biotope) varies from bad in spring to moderate in summer. The bad ecological state of the waters in this biotope is probably due to the discharge of

domestic wastewater. The ecological state of the waters of the Mechka River (Debar biotope) remains moderate in both seasons. In contrast, the ecological state in the Lyubenovo biotope changes from moderate in spring to bad in summer. It is assumed that the deterioration of the ecological state in the Lyubenovo biotope from spring to summer is due to the anthropogenic pressure on the studied section of the river, the activities of the nearby cow farm and landfill, and the lowering of the water level during the summer season.

Table 2. The ecological state and chemical status of the Kayaliika River and the Mechka River according to data from the East Aegean River Basin Directorate (EARBD) for 2020-2023 (BQEs – biological quality elements; PhQEs – physicochemical quality elements)

	Ecological state on the BQEs	**Ecological state on the PhQEs**	**Ecological state**	**Chemical status**
Kayaliika River, upper reaches to Bryagovo Dam – R5				
2020	bad	moderate	bad	good
2021	bad	moderate	bad	good
2022			bad	unknown
2023	moderate	moderate	moderate	good
Kayaliika River, middle course from Bryagovo Dam to Ezerovo Dam – R5				
2020	moderate	moderate	moderate	good
2021	moderate	moderate	moderate	good
2022			moderate	good
2023	moderate	moderate	moderate	good
Kayaliika River from Ezerovo Dam to the confluence with the Maritsa River – R5				
2020	moderate	moderate	moderate	good
2021	bad	moderate	bad	good
2022			moderate	good
2023	bad	moderate	bad	good
Mechka River, upper reaches to the confluence with Chinardere River – R5				
2020	good	moderate	moderate	good
2021	good	moderate	moderate	good
2022			moderate	good
2023	unknown	moderate	moderate	good
Mechka River, lower reaches and tributary – R5				
2020	moderate	moderate	moderate	good
2021	moderate	moderate	moderate	good
2022			moderate	unknown
2023	moderate	moderate	moderate	good

According to the Reports on the state of water bodies in the territory of the East Aegean region (East Aegean River Basin Directorate, 2018) and the results obtained from this study, the ecological state of the Kayaliika River in the section of the Ezerovo Dam to the confluence with the Maritsa River, where the studied biotope Varbitsa is located, and the ecological state of the Mechka River in the lower reaches and tributary section, where the two studied biotopes (Debar and Lyubenovo) fall, deteriorates from moderate in the period 2020-2023 to bad in 2024 (Tables 1-2).

CONCLUSIONS

According to the calculated indices and metrics, a bad ecological state was found for the Kayaliika River (Varbitsa biotope) and the Mechka River (Lyubenovo biotope), as well as moderate for the Mechka River (Debar biotope) in 2024. The study found a deterioration in the ecological state of both rivers in their lower reaches, from moderate to bad, compared to previous years.

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