MACROZOOBENTHOS COMMUNITY AND ECOLOGICAL STATUS IN PRESPA LAKE (OTESHEVO, STENJE AND EZERANI) IN SPRING 2022

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Abstract

This study represents the results for the invertebrate fauna carried out in the spring of 2022 at Prespa Lake (Republic of North Macedonia). The survey has covered three distinctive localities: Oteshevo, Stenje and Ezerani. Twelve species from six systematic groups have been registered from the above mentioned localities in Lake: Oligochaeta, Hirudinea, Gastropoda, Bivalvia, Amphipoda and Insecta. The results of the survey clearly showed that the structure of the invertebrate community along the littoral zone of the Lake varies from one locality to another. Thus, more than half of the total diversity was registered in the locality of Ezerani, while the community of invertebrates is almost half poorer in Stenje and Oteshevo, with 5 species on each locality. As for the density, similarly to biodiversity, the highest number of individuals per square meter was registered in the Ezerani locality - a total of 10,750 ind/m². The second-highest density was recorded in the locality of Stenje with 4,225, while the lowest density was recorded in the locality of Oteshevo with 1,200 ind/m². The highest population density of Dreissena carinata was recorded - 3,250 ind/m² in the Stenje locality at a depth of 5 m in the shell zone. The results of the research indicate that the biodiversity of the invertebrate fauna decreases with increasing depth, which is closely related to the increase in the uniformity of the sediments and the stability of the environmental factors along its depth. In contrast, there is no density dependence with depth.

Keywords: macroinvertebrates, biodiversity, ecological status, Lake Prespa.

INTRODUCTION

Benthic macroinvertebrates are common inhabitants of lakes and streams where they are important in moving energy through food webs. The term "benthic" means "bottom-living", so these organisms usually inhabit bottom substrates for at least part of their life cycle; the prefix "macro" indicates that these organisms are retained by mesh sizes of ~200–500 mm [1]. In order to achieve and maintain the highest water quality in lakes, rivers, and streams, environmental researchers are using the resident organisms living in these waters as sensitive indicators of change. Biomonitoring is based on the straightforward premise that living organisms are the ultimate indicators of environmental quality. According to Annex V of the Water Framework Directive [2], the macrozoobenthos or organisms from the benthic fauna are one of the four most relevant indicators of the quality of aquatic ecosystems. The Prespa Lake's Basin is an area of rich biodiversity that has been subject to intense pressures from human activities over the past decades [3]. The main goals of the study were to ascertain the invertebrate community structure, the species abundances, as well as the general condition of

the benthic fauna from the Oteshevo, Stenjeand Ezerani localities in Prespa Lake (Republic of North Macedonia) in the spring 2022.

MATERIALS AND METHODS

The field research took place on three localities (Oteshevo, Stenje and Ezerani) which, according to previous research, are distinguished by the intensity of the anthropogenic pressure and changes in the ecological status.The research was done using standard limnological methods [4–6] and in accordance with the EU Directive. Samples were taken with a van Veen grab (225 cm^2) from different depths (2, 5, 10 m) and habitats using the method of vertical transects to the extent of macrophytic vegetation in Lake Prespa. The density values refer to the average density of individuals from two samples on a unit surface - m^2. Determination was done to the species level. The processed material was preserved in 96% ethyl alcohol, labeled and stored in plastic vials.The macrozobenthos species were determined using keys by the following authors: [4,7–15].

To determine the ecological status of the structure of the macrozoobenthos community the following structural indices have been calculated: index of species richness - S, Shannon-Wiener Diversity Index - H' (diversity), Pielou'sindex of evenness J(e) and Simpson's index (c) in different habitats and localities. The Average Score Per Taxon (ASPT) represents the average tolerance score of all taxa within the community and is calculated by dividing the BMWP (Table-6 scores for pollution sensitivity grades for macroinvertebrates families) by the number of families represented in the sample [16].

RESULTS AND DISCUSSION

During the field activities in June 2022, the qualitative and quantitative composition of the fauna at the bottom of the Oteshevo locality was analyzed. Consequently, five species from five classes of bottom fauna (Oligochaeta, Hirudinea, Gastropoda, Amphipoda, and Insecta) were recorded in the samples (Table 1). These species, representing the aforementioned five classes, serve as indicators of increased trophic levels in the water, signifying the presence of organic pollution. The highest biodiversity was observed at a depth of 2 meters, where all five species were registered. Regarding the density, the population of *Dreissena carinata* exhibited the highest density, with 400 ind/m^2.

Table 1 *Composition and density of bottom fauna in Oteshevo (June 2022)*

Locality Otesevo				
Depth (m)	**Bottom facies (ratio)**	**Class**	**Species**	**Density (ind/m^2)**
2	Muddy bottom with shells (50:50)	Oligochaeta	*Tubifex tubifex*	100
		Hirudinea	*Glossiphonia maculosa*	25
		Gastropoda	*Valvata piscinalis*	25
		Bivalvia	*Dreissena carinata*	125
		Insecta	*Chironomus plumosus*	50
5	Muddy with Dreissena shells	Oligochaeta	*Tubifex tubifex*	175
		Gastropoda	*Valvata piscinalis*	25
		Insecta	*Chironomus plumosus*	100
10	Muddy with Dreissena shells	Bivalvia	*Dreissena carinata*	400
		Insecta	*Chironomus plumosus*	175

The bottom fauna in the Stenje locality, as observed in the samples from the spring campaign, was represented by 5 taxa from 5 groups of organisms: Oligochaeta, Hirudinea, Amphipoda, Bivalvia and Insecta (Table 2). Despite the fair uniformity of the bottom profile along the transect (mud and shell facies), the distribution of species was not uniform. In this context, the highest density was observed at a depth of 5 meters, on a muddy facies with shells, where 5 species were registered, and the highest population of the species *Dreissena carinata* was recorded at 3250 ind/m².

Table 2 *Composition and density of bottom fauna in Stenje (June 2022)*

Locality Stenje				
Depth (m)	**Bottom facies (ratio)**	**Class**	**Species**	**Density (ind/m²)**
2	Muddy bottom with shells	Oligochaeta	*Tubifex tubifex*	50
		Hirudinea	*Erpobdella octoculata*	25
		Amphipoda	*Gammarus triacanthus prespensis*	25
		Insecta	*Chironomus plumosus*	250
5	Muddy bottom with shells	Oligochaeta	*Tubifex tubifex*	50
		Hirudinea	*Erpobdella octoculata*	25
		Bivalvia	*Dreissena carinata*	3250
		Amphipoda	*Gammarus triacanthus prespensis*	50
		Insecta	*Chironomus plumosus*	50
10	Muddy	Oligochaeta	*Tubifex tubifex*	375
		Insecta	*Chironomus plumosus*	75

During the spring period, the locality of Ezerani was characterized by greater biodiversity and density of organisms from the bottom fauna compared to other localities (Tables 3and 4). In June, 9 taxa from 6 systematic groups (Oligochaeta, Hirudinea, Gastropoda, Amphipoda, Bivalvia and Insecta) were recorded in this locality. At a depth of 5 meters, distinguished by facies on the bottom with shells of snails and shells, the greatest biodiversity was observed, with 7 species from 6 systematic groups. The highest density was observed in the species *Limnodrilus hoffmeisteri* - 2000 ind/m².

The results of the survey clearly showed that the structure of the invertebrate community along the littoral zone of the Lake varies from one locality to another (Figure 1). Thus, more than half of the total diversity is registered in the locality of Ezerani, while the community of invertebrates is almost half poorer in Stenje and Oteshevo by five species. Such status is strongly correlated with the intensity of anthropogenic pressure and changes in the quality of sediments resulting from fluctuations in the water level of the Lake.

According to the results of the research during April 2021 [17] greater biodiversity and density were found in the locality of Ezerani, while the lowest density and diversity were observed in Oteshevo. The most abundant species of the bottom fauna was Dreissena carinata. All physical-chemical parameters investigated indicate that Lake Prespa is undergoing eutrophication, and besides the increased phosphorus level, the water level has lowered as well [18,19]. The diversity and abundance of the benthic fauna, as one of the key components most affected by the constant fluctuation and withdrawal of the Lake's water, has already been drastically reduced based on the latest research (2020–2023) [20]. According to the authors, thus, global warming and changes in water trophy are considered the main triggers and

vectors that would facilitate the transmission and rapid acclimatization and adaptation of new species.

Table 3 *Composition and density of bottom fauna in Ezerani (June 2022)*

Locality Ezerani				
Depth (m)	**Bottom facies (ratio)**	**Class**	**Species**	**Density (ind/m^2)**
2	Muddy bottom with shells	Oligochaeta	*Eiseniella tetraedra*	100
		Gastropoda	*Pyrgohydrobia prespaensis*	25
		Insecta	*Baetis vernus*	25
			Chironomus plumosus	25
5	Shell zone	Oligochaeta	*Eiseniella tetraedra*	1500
			Limnodrilus hoffmeisteri	2000
		Hirudinea	*Glossiphonia complanata*	25
		Gastropoda	*Valvata piscinalis*	25
		Bivalvia	*Dreissena carinata*	1300
		Amphipoda	*Gammarus triacanthus prespensis*	150
		Insecta	*Chironomus plumosus*	1350
10	Muddy with shells (without vegetation)	Oligochaeta	*Eiseniella tetraedra*	1775
			Limnodrilus hoffmeisteri	1000
		Insecta	*Baetis vernus*	25
			Chironomus plumosus	1425

Table 4 *List of macrozoobenthos species composition in Prespa Lake in spring 2022*

Class	***Species***	**Otesevo**	**Stenje**	**Ezerani**
Oligochaeta	*Tubifex tubifex*	+	+	
	Eiseniella tetraedra			+
	Limnodrilus hoffmeisteri			+
Hirudinea	*Glossiphonia maculosa*	+		
	Glossiphonia complanata			+
	Erpobdella octoculata		+	
Gastropoda	*Valvata piscinalis*	+		+
	Pyrgohydrobia prespaensis			+
Bivalvia	*Dreissena carinata*	+	+	+
Amphipoda	*Gammarus triacanthus prespensis*		+	+
Insecta	*Baetis vernus*			+
	Chironomus plumosus	+	+	+

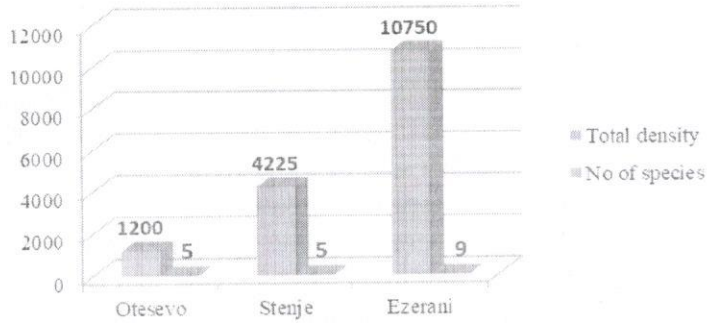

Figure 1 *Density and diversity in Otesevo, Stenje and Ezerani from Prespa Lake*

Table 5 depicts the environmental status of the sampling sites according to traditional indices. The environmental status varied from poor to very good, based on the Pielou and Simpson indices. The values of H (Shannon & Wiener diversity index) and d (Margalef index) were closer reflections of the real picture of the ecological status of the sampling sites.

Table 5 *The ecological status of the localities according to the indexes in spring 2022*

Indexes	Otesevo	Stenje	Ezerani
N (ind/m^2)	1200	4225	10750
Number of species S	5	5	9
Shannon&Wiener H	2.82	1.38	3
Margalef d	2.82	2.76	3.47
Pielou e	0.85	0.8	0.77
Simpson c	0.18	0.6	0.14

* red color-very heavily polluted waters; orange - heavily polluted waters; yellow -medium polluted waters; green-slightly polluted waters; blue -clean unpolluted waters.

None of the mentioned indices reflected the real condition of the Lake seen through the prism of the condition of the bottom fauna, which was generally either very poor in most of the localities in the Lake, or included representatives that were not indicative enough, or indicated an environmental status that did not meet the requirements for good environmental status according to the European Water Directive. Therefore, in this research, the ASPT index was also used, which proved to be sufficiently indicative and had been checked in past research. According to this index, no locality met the criteria for a good environmental condition. Specifically, the localities of Oteshevo and Stenje were categorized as having poor ecological status, while Ezerani had a moderate ecological status (Table 6).

Table 6 *The ecological status of localities according to the ASPT index in spring 2022*

Indexes	Otesevo	Stenje	Ezerani
ASPT			

*ASPT red color-bad ecological status; yellow color -moderate ecological status.

CONCLUSION

In Prespa Lake, 12 species from 6 systematic groups of bottom fauna were registered: Oligochaeta, Hirudinea, Gastropoda, Bivalvia, Amphipoda, and Insecta. The richest diversity is observed in the groups Oligochaeta and Hirudinea, with 3 species each. Other groups are represented by two species each, with Bivalvia and Amphipoda being the least represented with one representative each. The results of the survey clearly showed that the structure of the invertebrate community varies from one site to another along the littoral Lake zone. More than half of the total diversity is registered in the Ezerani locality, while the invertebrate community is almost half poorer in Stenje and Oteshevo, with 5 species each. We found greater biodiversity and density in the locality of Ezerani, while the lowest density and diversity were observed in Oteshevo. The most abundant species of the bottom fauna was *Dreissena carinata*. According to the ASPT index, the localities of Oteshevo and Stenje were distinguished by a poor ecological status, while Ezerani by a moderate ecological status.

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