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BIOCENOTIC COMPOSITION OF THE MACROZOOBENTHOS ON DIFFERENT HABITATS FROM THE LITTORAL REGION OF LAKE OHRID

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A b s t r a c t: Biocenotic research on the benthic fauna from the northwestern part of Lake Ohrid, has shown that different habitats characterize different qualitative compositions of the benthic fauna.

The affinity of the macrozoobenthic communities to populate different habitats was investigated in 5 different localities from the northwestern part of Lake Ohrid. Among the five different types of habitats such as stony bottom, sandy bottom, sandy-muddy bottom and muddy bottom mostly covered with mollusc shells, it was found that from the qualitative point of view, the sandy-muddy bottom covered with vascular macrophytes is characterized with highest biodiversity of benthic fauna.

In all localities, with the exclusion of the locality As (where the macrophytic vegetation is not well developed), the maximum number of species was recorded between depth points from 3 to 11m. In the Radožda locality, the maximum number of species (11 species) was recorded at a depth point of 6m., on a bottom covered with sandy mud. In the Livadishte locality, the highest biodiversity (13 species) was recorded at a depth points of 5 and 11m., on bottom covered with sandy mud with well developed macrophytic vegetation. The localities Kališta and Struga, the maximum number of species (14 in Kališta and 11 in Struga) was also recorded in the same type of habitat, a sandy-muddy bottom with well developed macrophytic vegetation.

Key words: macrozoobenthos, biocenotic composition, habitats, Lake Ohrid.

Introduction

It is a fact that the benthic fauna from Lake Ohrid is characterized with highest biodiversity, richness and endemorelict animal elements. Although this rich animal component has a long chronology of investigation, there are only a few references in literature to biocenotic composition (all groups) of the macrozoobenthos from Lake Ohrid. Except for works of Šapkarev & Točko (1972), and Točko & Šapkarev (1978), most of the recent researches were focused on some particular group of organisms (Šapkarev, 1964; Krstanovski, 1994; Smiljkov, 1999, 2001). In addition to this, it should be mentioned that even poorer is the list of published works about the integral biocenotic (all groups of macrozoobenthos) in different habitats and different localities. There are only two works: Stankovic (1960) and Šapkarev (1967) in which the main groups from the benthic fauna of the Lake are mentioned but, in general, the researches are focused on a few localities.

The main subject in our investigations was to carry out integral biocenotic research into the composition of all groups of macrozoobenthos in different habitats and in different localities of the littoral part of Lake Ohrid.

The investigations were focused on the north-western part of the littoral region of Lake Ohrid and comprised the following localities: Radožda, Livadišta, Kališta, Struga and As. Based on the structure of the sediments, it was established that the habitats could be divided to five groups: stone-sandy bottom, sandy-muddy bottom, muddy-sandy bottom, and muddy bottom covered with molluscs.

Material and methods

The samples were collected according to standard limnological methods for collecting benthal material: Lind (1985), Wetzel & Likens (1979), Wetzel (1972).

The material was collected during the summer of 2001, in five different littoral regions of Lake Ohrid. The depth points from which the samples were taken, were characterised by their different bottom texture. The samples were collected from 4 depth points (except the locality Radožda where the samples were collected from 5 depth points) starting from 1 m to 20 meters depth. Actually, the samples were collected from the beginning of the littoral to its end, or to the beginning of the shell zone.

The benthic fauna was examined by stereo mircroscope and determined using keys for determination of freshwater invertebrates: Šapkarev (1964); Barnes (1980); Lukin (1976); Brinkhurst & Jamieson (1978); Karaman (1976); Snegarova (1954); Hadzishce (1974); Kerovec (1986), Kellogg (1994), etc.

Results and discussion

The biocenotic composition of the bental fauna in different localities from the north-western littoral part of Lake Ohrid is shown in the tables 1–5.

According to the values in the tables, it is noticeable that different habitats are populated by different macrozoobenthic communities. By combining the results for biocenotic composition in integral form, it is possible to determine which habitat is characterized by the highest diversity or richest biocenotic composition. This is shown in tab. 6. The underlined numbers represent the maximum number of species at a certain depth. Comparing these values with the bottom facies of the relevant depth, it is obvious that the highest number of species or highest grade of biodiversity is noticed between 3 and 11 meters.

Actually, the maximum number of species (10 species) of the macrozoobenthos recorded in the locality Radožda corresponds to a depth point of 10m., where there is a bottom covered with sandy-muddy facies. On this bottom there are well developed mixed communities of macrophytic vegetation with the following dominant species: *Ceratophyllum demersum, Potamogeton perfoliatus, Myriophyllum spicatum, Potamogeton lucens, Characea* and *Cladophora sp.*

In the locality Livadište, at two depth points there were noticed 13 macrozoobenthic species. In both cases (Tab. 2.), at the depth points of 5 and 11m, the bottom was sandy and muddy covered with mixed associations of *Characeae*. At the first depth mixed associations of *Characeae* predominate, while at the second depth point pure and dense associations of *Chara ceratophylla* predominate.

In the locality Kališta, as in the other two mentioned localities, the biocenotic analyses showed that a depth point of 3 m., is characterized by the richest (14 species) qualitative composition of macrozoobenthos. The bottom at this depth is covered with sandy-muddy facies (a sandy-muddy habitat) with mixed associations of macrophytic species such as: *Zanichellia palustris, Potamogeton perfoliatus* and species of *Characea*.

In the Struga locality, the depth point of 5m., is qualitatively richest. At this depth the bottom is sandy-muddy covered (Tab. 4.) with macrophytic species of the POTAMETO-NAJADETUM (Micevski, 1969) association.

The biocenotic analyses of the macrozoobenthos in the As locality showed that at all depths, the qualitative composition was poorer compared with other localities. From Table 5, it is obvious that this locality is characterized by poor and rare developed macrophytic vegetation. In this locality there are the representatives from the POTAMETO-NAJADETUM (Micevski, 1969) association, together with some rare specimens of *Characeae*.

If we make an analysis of the determined species from all benthic groups, then from the given tables we can notice that the richest group in a

Table 1–5 *Qualitative composition of the macrozoobethos at different localities and depths in the littoral region of Lake Ohrid*

Table 1

RADOZDA

Depth (m)	Facies	List of species	$A \cdot m^{-2}$	Tot. num.
4	**Sand, middle-sized stones and sandy-muddy bottom**	*Tubifex tubifex*	89	1598
		Dreissena polymorpha	666	
		Chylopyrgula sturanyi	222	
		Radix relicta	44	
		Gammarus roeselii	133	
		Asellus aquaticus	178	
		Chironomus plumosus	266	
4	***Potamogeton perfoliatus, Potamogeton lucens, Myriophyllum spicatum, Vallisneria spirallis* and *Cladophora sp.***	*Tubifex tubifex*	44	1998
		Eiseniella ochridana	89	
		Glossiphonia pulchella	133	
		Dreissena polymorpha	1154	
		Valvata stenotrema	178	
		Gammarus roeselii	178	
		Asellus aquaticus	89	
		Chironomus plumosus	44	
		Cricotopus algarum	89	
6	**Sandy-muddy bottom with: *Ceratophyllum demersum, Potamogeton perfoliatus, Myriophyllum spicatum, Potamogeton lucens, Characeae* and *Cladophora sp.***	*Phagocata ochridana*	44	3253
		Criodrilus lacuum	89	
		Glossiphonia pulchella	178	
		Dreissena polymorpha	1998	
		Chylopyrgula sturanyi	44	
		Theodoxus fluviatilis dalmaticus	44	
		Gamarus ochridensis ochridensis	178	
		Gammarus roeselii	311	
		Asellus aquaticus	89	
		Caenis macrura	89	
		Chironomus plumosus	189	
9	***Chara ceratophylla***	*Limnodrilus hoffmaesteri*	44	7724
		Rhynchelmis komareki typica	89	
		Cystobranchus pawlowskii	44	
		Glossiphonia maculosa	178	
		Glossiphonia pulchella	266	
		Dreissena polymorpha	6615	
		Gammarus roeselii	355	
		Asellus aquaticus	44	
		Chironomus plumosus	89	
19	**Muddy bottom with small-grained sand and shells of Gastropoda and Bivalvia**	*Dendrocoelum magnum*	89	4173
		Dendrocoelum sanctnaumi	44	
		Glossiphonia pulchella	44	
		Dina lepinja	44	
		Dreissena polymorpha	3774	
		Valvata stenotrema	89	
		Asellus arnautovici litoralis	89	

Table 2

LIVADISTE

Depth (m)	Facies	List of species	$A \cdot m^{-2}$	Tot num.
2	**Sandy bottom with small-sized rocks and macrophytic species:** *Potamogeton perfoliatus, Potamogeton lucens, Characeae* and *Cladophora sp.*	*Limnodrilus hoffmeisteri*	89	663
		Dreissena polymorpha	132	
		Valvata stenotrema	89	
		Radix relicta	44	
		Gammarus roeselii triacanthus	89	
		Caenis macrura	44	
		Chironomus plumosus	176	
5	**Sandy mud with species of *Characeae***	*Criodrilus lacuum*	178	1106
		Eiseniella tetraedra. typica	89	
		Glossiphonia pulchella	44	
		Dina krilata	44	
		Dreissena polymorpha	176	
		Sphaerium corneum	44	
		Chylopyrgula sturanyi	132	
		Ginaia munda	44	
		Pyrgohydrobia grochmalickii	44	
		Valvata stenotrema	44	
		Gammarus roeselii	89	
		Asellus remyi typicus	89	
		Chironomus plumosus	89	
11	**Muddy bottom with *Chara ceratophylla***	*Phagocata ochridana*	89	1996
		Pothamotrix hammoniensis	133	
		Criodrilus lacuum	89	
		Glossiphonia complanata complanata	89	
		Dina krilata	178	
		Dreissena polymorpha	444	
		Chylopyrgula sturanyi	176	
		Viviparus vivparus	89	
		Valvata stenotrema	132	
		Radix relicta	89	
		Gamarus ochridensis ochridensis	178	
		Gammarus roeselii	266	
		Polypedulum bicreantum	44	
19	**Shell zone**	*Pothamotrix hammoniensis*	178	711
		Dina krilata	44	
		Dreissena polymorpha	222	
		Gamarus ochridensis ochridensis	89	
		Asellus aquaticus	178	

Table 3

KALISTA

Depth (m)	Facies	**List of species**	***A·m***$^{-2}$	**Tot. num.**
1	**Mediu-sized rocks without detritus**	*Dendrocoelum maculatum*	44	355
		Limnodrilus udekamianus	89	
		Dreissena polymorpha	44	
		Valvata stenotrema	178	
3	**Sandy-muddy bottom with: *Zanichellia palustris, Potamogeton perfoliatus* and species of *Characea***	*Limnodrilus hoffmeisteri*	89	1864
		Limnodrilus udekamianus	44	
		Allolobophora lacusrtis	222	
		Glossiphonia maculosa	89	
		Glossiphonia pulchella	44	
		Dreissena polymorpha	266	
		Chylopyrgula sturanyi	178	
		Valvata rhabdota	44	
		Gammarus roeselii	178	
		Gammarus roeselii triacanthus	89	
		Asellus djordjevici litoralis	133	
		Polypedulum bicrenatum	400	
		Polypedulum pedestre	44	
		Odontocerum sp.	44	
8	**Muddy bottom with dense associations of *Chara ceratophylla***	*Limnodrilus hoffmeisteri*	133	2275
		Criodrilus lacuum	89	
		Eiseniella tetraedra. typica	310	
		Dina krilata	133	
		Dreissena polymorpha	900	
		Chylopyrgula sturanyi	133	
		Gammarus roeselii	488	
		Polypedulum bicrenatum	89	
15	**Muddy bottom**	*Dendrocoelum sanctinaumi*	44	975
		Criodrilus lacuum	44	
		Eiseniella tetraedra. typica	133	
		Dina krilata	44	
		Dreissena polymorpha	444	
		Gammarus roeselii	44	
		Asellus aquaticus	178	
		Polypedulum bicrenatum	44	

Table 4

STRUGA

Depth (m)	Facies	List of species	$A \cdot m^{-2}$	Tot. num.
1	**Sandy bottom with rare species of *Characea***	*Tubifex tubifex*	44	310
		Psammoryctes ochridanus variabilis	9	
		Dreissena polymorpha	133	
		Valvata stenotrema	44	
5	ass. POTAMETO-NAJADETUM **Sandy-muddy bottom with macrophytic species: *Potamogeton perfoliatus, Potamogeton pectinatus, Myriophyllum spicatum, Najas minor, Cladophora sp.*, also species of *Characea*, with dominant species *Chara ceratophylla***	*Criodrilus lacuum*	44	1729
		Glossiphonia maculosa	44	
		Dina krilata	89	
		Dina sp.	44	
		Dreissena polymorpha	1021	
		Ginaia munda	44	
		Gammarus roeselii triacanthus	44	
		Gammarus roeselii ochridensis	133	
		Asellus djordjevici litoralis	44	
		Haliplus triopsis	89	
		Sialis luttaria	133	
8	**Mud with pure associations of *Chara ceratophylla***	*Criodrilus lacuum*	133	897
		Cystobranchus pavlowskii	44	
		Glossiphonia complanata complanata	44	
		Dina sp.	44	
		Dreissena polymorpha	266	
		Chironomus plumosus	44	
		Polypedulum bicrenatum	189	
		Cricotopus algarum	133	
15	**Muddy bottom**	*Dendrocoelum magnum*	44	399
		Dina krilata	4	
		Dreissena polymorpha	133	
		Asellus djordjevici litoralis	89	
		Chironomus plumosus	89	

Table 5

AS

Depth (m)	Facies	**List of species**	***A·m*$^{-2}$**	**Tot. num**
2	ass. POTAMETO-NAJADETUM **Sandy bottom with *Potamogeton perfoliatus* and *Najas major***	*Tubifex tubifex* *Polypedulum bicrenatim*	44 89	133
3	**Small-grained sand**	*Psammoryctes ochridanus. variabilis* *Dina krilata* *Chylopyrgula sturanyi* *Polypedulum bicrenatum* *Procladius choreus*	178 178 44 266 189	855
6	**Muddy bottom covered with turf *chara* (*Chara spp.)***	*Psammoryctes ochridanus. variabilis* *Dreissena polymorpha* *Sphaerium corneum* *Chironomus plumosus*	222 222 355 266	1065
19	**Shell zone**	*Dina krilata* *Gammarus roeselii* *Asellus remyi acatangulus* *Aellus arnautovici litoralis*	89 44 133 89	355

Table 6

Total number of macrozoobenthos species at different depths in all investigated localities from the north-western littoral region of Lake Ohrid

Depth. (m)	Radožda	Livadište	Kališta	Struga	As
1	-	-	2	4	-
2	-	6	-	-	2
3	-	-	11	-	3
4 (without veg.)	9	-	-	-	-
4 (with veg.)	7	-	-	-	-
5	-	13	-	10	-
6	11	-	-	-	4
8	-	-	8	6	-
9	6	-	-	-	-
11	-	13	-	-	-
15	-	-	8	5	-
19	5	5	-	-	1

qualitative sense is the group of Insecta, with 9 species. The second place is taken by *Gastropoda* (8 species), third are *Hirudinea* and *Oligochaeta* (7 species). 4 species were determined in classes of *Turbellaria, Amphipoda* and *Isopoda*, while a poorer qualitative composition was noticed in the class of *Bivalvia* – 2 species.

Obviously, a sandy-muddy habitat with vascular macrophytic species and *Characea* communities is the most attractive habitat with the richest biocenotic composition and diversity of the benthic fauna. This is reasonable because this microhabitat and its complexity offer good living conditions to the benthic animals. According to Allan (1995), the diversity and density of benthic invertebrates increases in a mixed habitat with middle-sized particles, while they decrease on a substrate covered with stones, especially rocky stones. The same author stresses that benthic animals show a higher affinity in the colonization of mixed substrates with medium-sized particles. In such cases, these particles may interact with organic particles and to build a stable substrate. The sandy-muddy bottom of Lake Ohrid is such a kind of habitat in which macrophytic vegetation develops. The development of macrophytic vegetation enables conditions for the creation of microhabitats (Trajanovski, 2004), which also gives a wide range of opportunities for colonization of macrozoobenthos. The macrophytic vegetation is a very important habitat for the macrozoobenthos. This fact is pointed out in the investigations of many authors such as: Stanković (1960); Allen (1977); Mastrantuono (1993); Wetzel (1975) *et al*. All these authors agree that the richness and complexity of the living conditions in the zone of macrophytic vegetations attract the benthic communities.

It is well known that in the zone of macrophytic vegetation the processes of photosynthesis are intensified which contributes to good oxygen saturation of the water. At the same time, the macrophytic vegetation (the habitus, the branches, steams, and leaves often form dense nets) giving protection from predators (mostly fish and birds) and serving as shelter to the benthic animals. The dense macrophytic vegetation at the same time is a place where the majority of the macrozoobenthic species lay their eggs protected in cocoons (*Hirudinea, Oligochaeta*), or spend a part of their life living on the macrophytic vegetation, whether on the surface – species of *Dreissenia polymorpha* and *Gastropoda* or in the stems or roots of reeds, as is case with the species from the group of Insecta.

On the other hand, the macrophytic vegetation is a food resource itself for many species of the macrozoobenthos. Many benthic animals, especially Insecta larvae, feed on the young parts of the macrophytic species. After the period of vegetation, during the autumn and winter period, the greater part of macrophytic vegetation dies and drops to the Lake bottom enriching the sedimentary layer with food materials and mineral material that are food for many species of *Oligochaeta* and *Insecta*. But, the role and the importance of the macrophytic vegetation do not stop during the winter period. In Lake Ohrid, according to Trajanovska (2002), some of the macrophytic vegetation, or more specifically the algae from *Characeae* exists during the winter (with minimal development and biomass production) and plays the role of a habitat, giving protection from predators and serving as a food resource.

Conclusions

According to our results and discussion we can conclude that the maximum number of species, and highest biodiversity of macrozoobenthos in Lake Ohrid was found at depth points between 3 and 10 meters. In almost all investigated localities, those depth points correspond to well-developed vascular macrophytic species.

The highest biodiversity was noticed in the Kališta locality at a depth point of 3 m. (14 species) and Livadište at a depth point of 11 m. (14 species). In both cases the bottom facies presented the same type of habitat: a sandy-muddy bottom covered with macrophytic vegetation.

In qualitative sense, the qualitatively richest group is *Insecta*, with 9 species. They follow: *Gastropoda* (8 species), *Hirudinea* and *Oligochaeta* (7 species). *Turbellaria, Amphipoda* and *Isopoda* were represented with 4 species and *Bivalvia* with 2 species.

Considering the fact that the macrophytic vegetation and the bottom facies on which it develops, a sandy-muddy bottom, is located in the upper littoral zone of the Lake, the zone where the anthropogenic influence is strongest, it is necessary in the future to pay more attention to the protection of this zone. Knowing the importance of this zone for the rich and endemic benthic fauna, it is necessary to start an active protection of the macrophytic vegetation which will lead to the protection of the benthic fauna as a constitutive part of the macrophytic vegetation.

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Резиме

БИОЦЕНОЛОШКИ СОСТАВ НА МАКРОЗООБЕНТОСОТ НА РАЗЛИЧНИ ХАБИТАТИ ОД ЛИТОРАЛНИОТ РЕГИОН НА ОХРИДСКОТО ЕЗЕРО

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Биоценолошките истражувања на бенталната фауна од северозападниот регион на Охридското Езеро покажаа дека различни типови хабитати се одликуваат со различен квалитативен состав на видови од бенталната фауна.

Афинитетот на заедниците од макрозообентосот на Езерото кон различни типови на хабитати беше испитуван во пет локалитети од северозападниот регион на Охридското Езеро. Помеѓу петте типови на хабитати: каменесто дно, песокливо-тињесто дно, тињесто-песокливо, тињесто и дно прекриено со черупки од Mollusca, утврдено беше дека во квалитативна смисла, односно со најголемо видово богатство се одликува хабитатот песокливо-тињесто дно на кое се развиваат васкуларни макрофитски видови и видови од Characeae.

Во сите истражувани локалитети, со исклучок на локалитеот Ас, каде што макрофитската вегетација е слабо развиена или отсуствува, максимален број видови од макрозообентосот е забележан во длабочинските граници од 3 до 11 м. Во локалитетот Радожда, 11 видови (максимален број) се забележани на длабочина од 6 м, на facies прекриен со песоклива тиња. Во Ливадиште максималниот број на видови е забележан на длабочините од 5 и 11 м (13 видови), исто така на подлога од песоклива тиња на која се развиваат макирофитски видови. И во локалитетот Калишта максималниот број видови (14) е регистиран на песокливо-тињесто дно со макрофитски видови, како и во локалитетот Струга каде што на иститот тип хабитат се регистрирани 11 видови од макрозообентосот на длабочина од 5 метри.