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QUALITATIVE COMPOSITION OF MACROPHYTE VEGETATION AND CYPRINID FAUNA FROM LAKE OHRID

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Abstract

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In this paper are presented the researches of the macrophyte vegetation and the cyprinid fish from Lake Ohrid. The researches were performed on 9 localities which cover the whole Lake's coastline in the territory of R. Macedonia (Radozda, Kalishta, Sateska, Andon Dukov, Mazija, St. Stephan, Metropol, Velidab and Ljubanishta). The macrophyte vegetation from Lake Ohrid provides habitat, shelter and food for many organisms (algae, invertebrates, fish, aquatic birds, etc.). Also, it represents the spawning ground for cyprinid fishes, and has a large role in protecting from theirs predators. In Lake Ohrid, where the bottom of the littoral region gradually decreases in depth, the macrophyte vegetation is distributed in belts: belt of Cladophora, belt of Phragmites, belt of Potamogeton, and belt of Chara. In researched localities were evidenced total of 32 macrophyte species which belong to 14 families: Cladophoraceae, Poaceae, Typhaceae, Cyperaceae, Polygonaceae, Nympheaceae, Potamogetonaceae, Haloragaceae, Ceratophyllaceae, Hydrocharitaceae, Ranunculaceae, Najadaceae, Characeae and Nitellaceae. Also in particular localities was present water moss *Fontinalis antipyretica.* From cyprinid fish in researched localities were evidenced *Alburnoides ohridanus*, *Alburnus scoranza*, *Chondrostoma ohridanus*, *Cyprinis carpio*, *Gobio ohridanus*, *Pachychilon pictum*, *Rutilus ohridanus* and *Scardinius knezevici*. Based on the obtained results it can be concluded that qualitative composition of macrophyte vegetation and cyprinid fish is different and depend from slope of littoral region, type of substrate, quantity of nutrients and other ecological conditions present in researched localities. These researches represent a significant contribution to the knowledge of the role of the macrophyte vegetation in the maintenance of the population of cyprinid fish from Lake Ohrid.

Key words: Lake Ohrid, macrophyte vegetation, cyprinid fish

Introduction

Lake Ohrid is the largest and deepest lake in the Dassaret lake group. It fulfills the deepest part of Ohrid valley. At a sea level of 693.17 m Lake Ohrid has a surface area of 358.18 km^2, maximal length of 30.5 km, maximal width of 15 km, and a shore line of 87.53 km. Lake has maximal depth of 288.7 m, and a great transparency of water – 21 m.

Macrophyte vegetation is of great importance in the whole process of circulation of matter and energy in the lake ecosystem. It also represents a habitat, food, shelter and a place for spawning of many fish species and plays a major role in protecting fish from their predators.

In Lake Ohrid macrophyte vegetation is distributed *in the littoral region* in more or less continuous belts around the entire lake: belt of Cladophora, belt of reed Phragmites, belt of pondweed Potamogeton and belt of stonewort Chara (Talevska 2002, 2003; Talevska and Trajanovska 2002, 2004; Talevska et al., 2009).

Fish fauna of Lake Ohrid is represented by the 20 autochthonous species: five species of the family Salmonidae – Trouts, twelve species of the family Cyprinidae – Carps,

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two species of the family Cobitidae – Clips and one species of the family Angulidae – Eels (Talevski, 2001, 2003; Talevski and Talevska 2007, 2008; Talevski et al., 2009b). From cyprinid fish in researched localities were evidenced *Alburnoides ohridanus*, *Alburnus scoranza*, *Chondrostoma ohridanus*, *Cyprinis carpio*, *Gobio ohridanus*, *Pachychilon pictum*, *Rutilus ohridanus* and *Scardinius knezevici*.

Materials and Methods

The researches of the macrophyte vegetation and the cyprinid fauna were performed in the course of 2012 and 2013 on 9 localities which cover the whole coastline of Lake Ohrid in the territory of R. Macedonia (Radozda, Kalishta, Sateska, Andon Dukov, Mazija, St. Stephan, Metropol, Velidab and Ljubanishta (Figure 1).

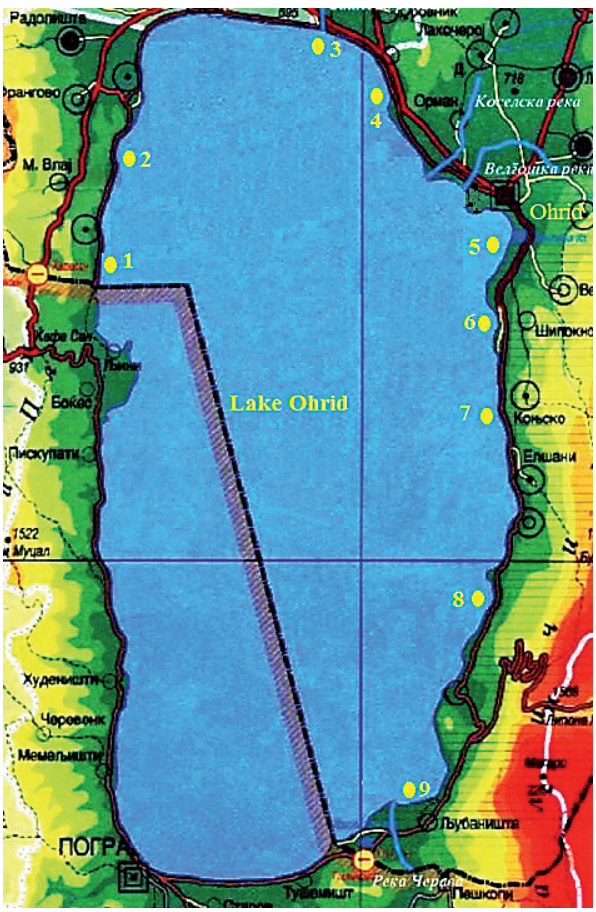

Fig. 1. Map of Lake Ohrid with researched localities *1* – Radozda; *2* – Kalishta; *3* – Sateska; *4* – Andon Dukov; *5* – Mazija; *6* – St. Stephan; *7* – Metropol; *8* – Velidab; *9* – Ljubanishta

Collections of macrophyte vegetation were performed by application of the standard lymnological methods (Wetzel and Likens, 1979).

The researches of the Ohrid cyprinid fish were made by daytime and the nighttime experimental fishing (performed during the summer period – June, July and August). A cast net was used for daytime fishing with mesh size of 13 mm, whereas the nighttime fishing was performed with bleak nets (mesh size from 12 mm and 13 mm), barbel nets with mesh size of 22 mm, 24 mm, 26 mm and 28 mm, as well as nets with mesh size of 45 mm and 50 mm. The height of each fishing gear is basically a hundred heights per each mesh, and the length is about 50 m.

The collected materials (macrophytes and cyprinids) were determined in a laboratory according to respective floras and keys for the determination of species and then the same preserved in 4% formaldehyde.

Results

The main objective of this paper was to researches the macrophyte vegetation and the cyprinid fish from Lake.

In researched localities were evidenced total of 32 macrophyte species (Table 1) which belong to 14 families: Cladophoraceae, Poaceae, Typhaceae, Cyperaceae, Polygonaceae, Nymphaceae, Potamogetonaceae, Haloragaceae, Ceratophyllaceae, Hydrocharitaceae, Ranunculaceae, Najadaceae, Characeae and Nitellaceae. In particular localities was present water moss *Fontinalis antipyretica.*

Also in researched localities were evidenced and 8 species of cyprinid fish: *Alburnoides ohridanus*, *Alburnus scoranza*, *Chondrostoma ohridanus*, *Cyprinis carpio*, *Gobio ohridanus*, *Pachychilon pictum*, *Rutilus ohridanus* and *Scardinius knezevici* (Table 2).

1. In the locality Radozda (near to the village Radozda) macrophyte vegetation begins from shore at a depth of 1 m and is present up to 11.5 m depth. There were present following macrophytes: *Phragmites australis, Potamogeton perfoliatus, Potamogeton lucens, Myriophyllum spicatum, Ceratophylum demersum, Elodea canadensis, Vallisneria spiralis, Chara tomentosa,* and alga *Cladophora* sp. (Table 1). The substrate near the shore is stony and sandy, then sandy and muddy, and in the deepest parts is muddy. In this locality at 3.5–6 m depth and 75 m distance from shore (Figure 2) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where *Alburnoides ohridanus, Alburnus scoranza, Cyprinis carpio, Gobio ohridanus, Pachychilon pictum, Rutilus ohridanus* and *Scardinius knezevici* live and performed spawning.

2. In the locality Kalishta (near to the village Kalishta) the macrophyte vegetation begins from shore at a depth of

Table 1

Evidenced macrophytes in researched localities from Lake Ohrid

N⁰	Species	Researched Localities								
		R	K	S	A.D	Ma	SS	Me	V	Lj
1.	*Phragmites australis* (Cav.) Trin. ex Steud.	+	+	+	+	+	+			+
2.	*Typha latifolia* L.			+						
3.	*Typha angustifolia* L.			+						
4.	*Shoenoplectus lacustris* (L.) Palla		+	+						
5.	*Polygonum amphibium* L.		+							
6.	*Nuphar lutea* (L.) Smith.		+							
7.	*Potamogeton perfoliatus* L.	+	+	+	+	+	+	+	+	+
8.	*Potamogeton crispus* L.		+			+				
9.	*Potamogeton gramineus* L.			+						
10.	*Potamogeton lucens* L.	+	+	+	+	+	+			
11.	*Potamogeton pectinatus* L.		+	+	+	+		+		
12.	*Potamogeton pusillus* L.		+						+	
13.	*Potamogeton nitens* Weber							+		
14.	*Potamogeton acutifolius* Link									+
15.	*Zannichellia palustris* L.				+	+	+	+	+	
16.	*Myriophyllum spicatum* L.	+	+	+	+	+		+	+	+
17.	*Ceratophyllum demersum* L.	+	+	+		+				
18.	*Ceratophyllum submersum* L.					+				
19.	*Elodea canadensis* Rich. & Michx.	+	+	+		+			+	+
20.	*Vallisneria spiralis* L.	+	+		+	+			+	+
21.	*Ranunculus trichophyllus* Chaix.								+	+
22.	*Najas minor* All.					+				
23.	*Najas marina* L.			+		+	+			+
24.	*Chara tomentosa* L.,1753	+	+		+	+	+	+	+	+
25.	*Chara aspera* Deth.ex Willd.,1809					+	+	+		
26.	*Chara gymnophylla A*.Braun,1835					+				
27.	*Chara globularis* Thuillier, 1799		+				+		+	
28.	*Chara imperfecta* A.Braun,1845							+		
29.	*Chara ohridana* (Kostic) Krause, 1997		+	+		+		+		+
30.	*Nitella opaca* (Bruzelius) C.Agardh 1824					+	+			
31.	*Nitellopsis obtusa* (Desv.in Loisel.) J.Groves, 1919			+						
32.	*Cladophora spec.* Kutz., 1843	+	+	+	+	+	+	+	+	+
	Total	9	17	15	9	19	10	10	10	11

1.5 m and is present up to 9 m depth. In this locality were present: *Phragmites australis, Shoenoplectus lacustris, Polygonum amphibium, Nuphar lutea, Potamogeton perfoliatus, Potamogeton crispus, Potamogeton lucens, Potamogeton pectinatus, Potamogeton pusillus, Myriophyllum spicatum, Ceratophylum demersum, Elodea canadensis, Vallisneria spiralis, Chara tomentosa, Chara globularis, Chara ohridana,* and *Cladophora* sp. (Table 1). The substrate along this profile is mud.

In this locality at 2.5–6 m depth and 330 m distance from shore (Figure 3) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Chondrostoma ohridanus, Cyprinis carpio,* and *Pachychilon pictum.*

3. In the locality Sateska (in the inflow of the River Sateska into Lake Ohrid) the vegetation begins from depth of 1.5 m and is present up to 7.5 m depth. There were present:

Table 2

Evidenced cyprinid fish species in the researched localities from Lake Ohrid

1.	*Alburnoides ohridanus* Karaman, 1928 – Ohrid spirlin
2.	*Alburnus scoranza* Heckel et Kner, 1858 – Bleak
3.	*Chondrostoma ohridanus* Karaman, 1924 – Ohrid nase
4.	*Cyprinis carpio* Linnaeus, 1758 – Carp
5.	*Gobio ohridanus*, Karaman, 1924 – Ohrid gudgeon
6.	*Pachychilon pictum* Heckel et Kner, 1858 – Moranec
7.	*Rutilus ohridanus* Karaman, 1924 – Ohrid roach
8.	*Scardinius knezevici* Bianco & Kottelat, 2005 – Skadar rudd

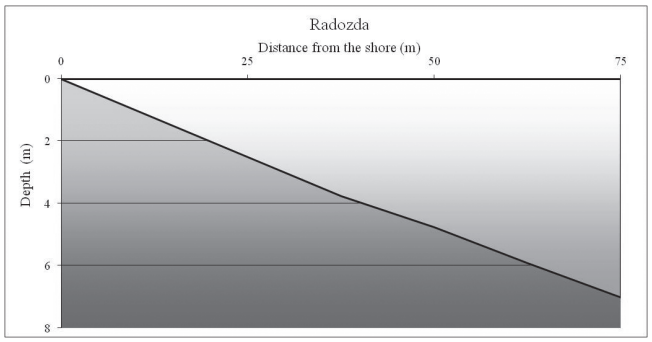

Fig. 2. Slope of littoral and distance from the shore in locality Radozda

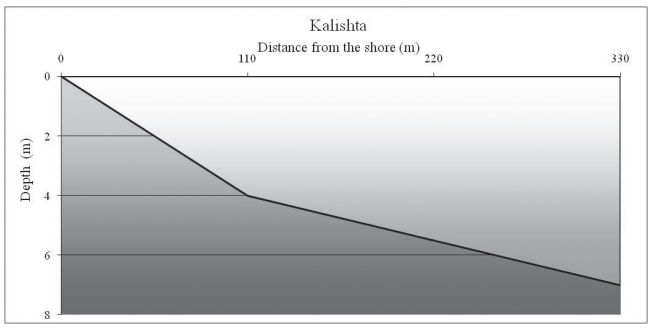

Fig. 3. Slope of littoral and distance from the shore in locality Kalishta

Phragmites australis, Typha latifolia, Typha angustifolia, Shoenoplectus lacustris, Potamogeton perfoliatus, Potamogeton gramineus, Potamogeton lucens, Potamogeton pectinatus, Myriophyllum spicatum, Ceratophylum demersum, Elodea canadensis, Najas marina, Chara ohridana, Nitellopsis optusa, and *Cladophora* sp. (Table 1).

The substrate near the shore is sand and in the deeper parts mud.

In this locality at 3.5–6.5 m depth and 680 m (Figure 4)

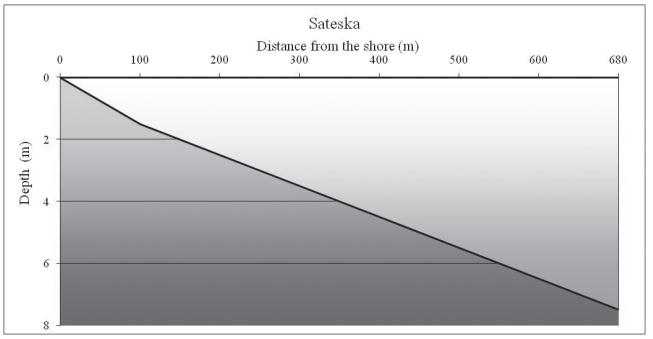

Fig. 4. Slope of littoral and distance from the shore in locality Sateska

distance from shore there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Cyprinis carpio* and *Pachychilon pictum.*

4. In the locality Andon Dukov (camp "Andon Dukov") macrophytes appear on 0.5 m deep and are present up to 11 m deep. There were present: *Phragmites australis*, *Potamogeton perfoliatus, Potamogeton lucens, Potamogeton pectinatus, Vallisneria spiralis, Myriophyllum spicatum, Zannichellia palustris, Chara tomentosa,* and *Cladophora* sp. (Table 1).

The substrate near the shore is sandy, and in the deeper parts muddy. In this locality at 1.5–3.5 m depth and 170 m distance from the shore (Figure 5) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Chondrostoma ohridanus, Cyprinis carpio* and *Pachychilon pictum.*

5. In locality Mazija macrophytes begin from the shore and are present up to 17 m depth. In this locality were present: *Phragmites australis, Potamogeton perfoliatus,*

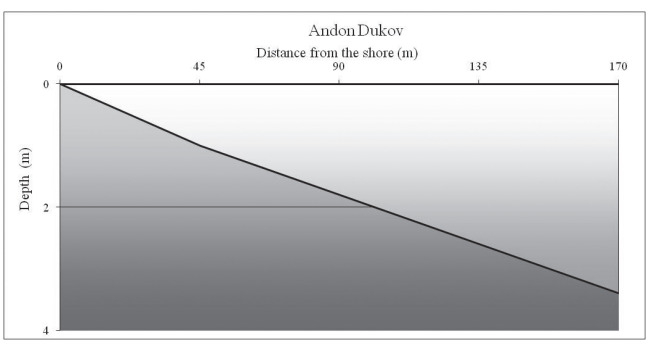

Fig. 5. Slope of littoral and distance from the shore in locality Andon Dukov

Potamogeton pectinatus, Potamogeton crispus, Potamogeton lucens, Myriophyllum spicatum, Ceratophyllum demersum, Ceratophyllum submersum, Vallisneria spiralis, Zannichellia palustris, Elodea canadensis, Najas marina, Najas minor, Chara tomentosa, Chara aspera, Chara gymnophylla, Chara ohridana, Nitella opaca, and *Cladophora* sp. (Table 1).

The substrate near the shore is stony – sandy, then sandy – muddy, and in the deepest parts muddy.

In this locality at 2–6.5 m depth and 500 m distance from the shore (Figure 6) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Chondrostoma ohridanus, Cyprinis carpio, Gobio ohridanus*, *Pachychilon pictum, Rutilus ohridanus,* and *Scardinius knezevici.*

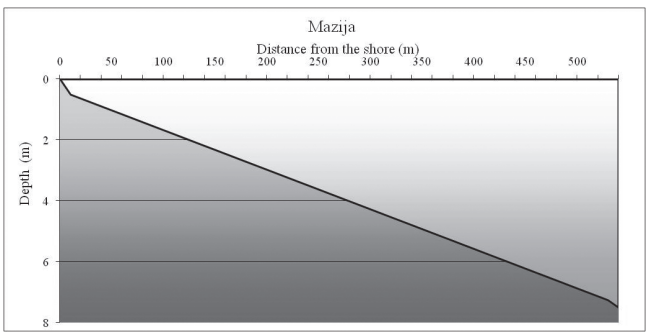

Fig. 6. Slope of littoral and distance from the shore in locality Mazija

6. In the locality St. Stephan (in front of church "St. Stephan") macrophytes begin from the shore at depth of 2 m and are present up to 12.5 m depth. In this locality were present: *Phragmites australis, Potamogeton perfoliatus, Potamogeton lucens, Zannichellia palustris, Najas marina, Chara tomentosa, Chara aspera, Chara globularis, Nitella opaca,* and *Cladophora* sp. (Table 1).

The substrate near the shore is sandy and muddy, and in the deeper parts muddy. In this locality at 2–6 m depth and 325 m distance from the shore (Figure 7) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Cyprinis carpio, Gobio ohridanus*, *Pachychilon pictum, Rutilus ohridanus,* and *Scardinius knezevici.*

7. In the locality Metropol (in front of hotel "Metropol") vegetation begins at depth of 1.5 m and is present up to 9 m depth. In this locality were present: *Potamogeton perfoliatus, Potamogeton pectinatus, Potamogeton nitens, Zannichellia palustris, Myriophyllum spicatum, Chara tomentosa, Chara aspera, Chara imperfecta, Chara ohridana,* and *Cladophora* sp. (Table 1).

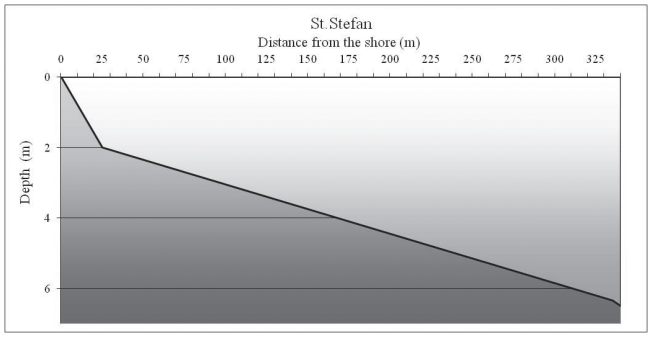

Fig. 7. Slope of littoral and distance from the shore in locality St. Stephan

The substrate near the shore is stones (covered with *Cladophora* sp.), and sand, and in the deeper parts mud.

In this locality at 2.5–4 m depth and 50 m distance from the shore (Figure 8) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Cyprinis carpio, Pachychilon pictum* and *Rutilus ohridanus.*

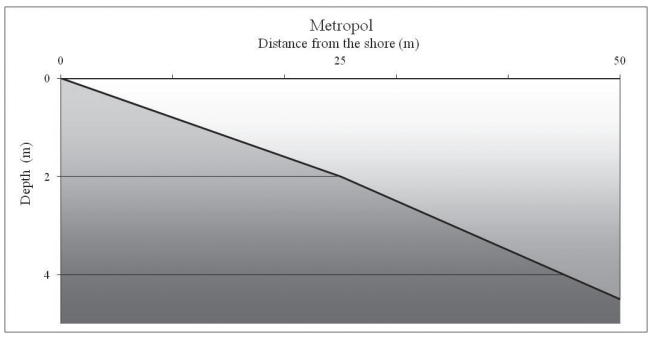

Fig. 8. Slope of littoral and distance from the shore in locality Metropol

8. In the locality Velidab vegetation begins at depth of 3 m and is present up to 11 m depth. In this locality were present: *Potamogeton perfoliatus, Potamogeton pusillus, Zannichellia palustris, Myriophyllum spicatum, Elodea canadensis, Vallisneria spiralis, Ranunculus trichophyllus, Chara tomentosa, Chara globularis,* and *Cladophora* sp. (Table 1).

The substrate near shore is rocks and large stones, then is sand, and is the deepest parts mud.

In this locality at 1.5–6 m depth and 40 m distance from the shore (Figure 9) there are favourable conditions (sub-

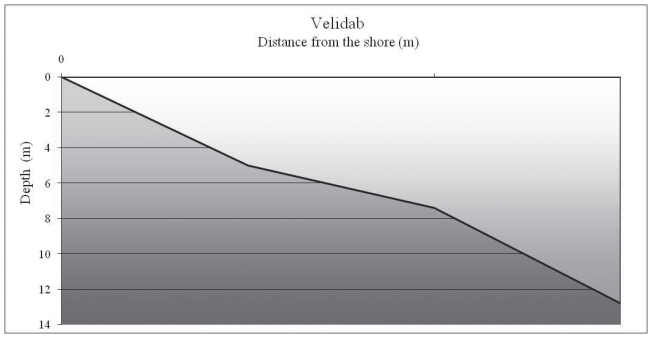

Fig. 9. Slope of littoral and distance from the shore in locality Velidab

strate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnus scoranza, Rutilus ohridanus, Scardinius knezevici* and *Pachychilon pictum.*

9. In the locality Ljubanishta (the auto camp "Ljubanishta") vegetation begins from shore at depth of 1 m and is present up to 9.5 m depth. In this locality were present: *Phragmites australis, Potamogeton perfoliatus, Potamogeton acutifolius, Myriophyllum spicatum, Vallisneria spiralis, Ranunculus trichophyllus, Elodea canadensis, Najas marina, Chara tomentosa, Chara ohridana,* and *Cladophora* sp. (Table 1).

The substrate near shore is rocks and large stones, then is sand, and is the deepest parts mud.

In this locality at 2–4.5 m depth and 100 m distance from the shore (Figure 10) there are favourable conditions (substrate, qualitative composition and density of macrophytes) where live and performed spawning *Alburnoides ohridanus, Alburnus scoranza, Chondrostoma ohridanus, Cyprinis carpio, Gobio ohridanus*, *Pachychilon pictum, Rutilus ohridanus,* and *Scardinius knezevici.*

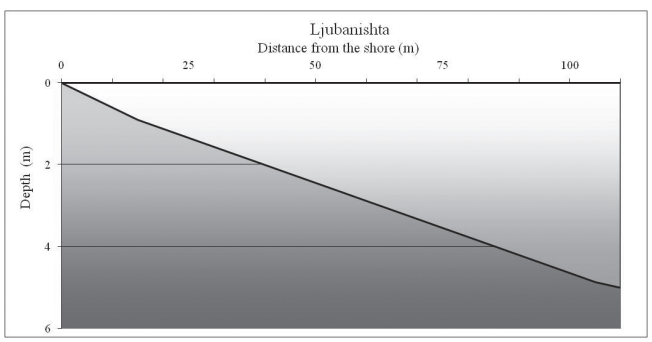

Fig. 10. Slope of littoral and distance from the shore in locality Ljubanishta

Discussion

The results show that in Lake Ohrid start of the cyprinid fish spawning period is at the same time with the development of macrophyte vegetation. In the researched localities from Lake Ohrid were evidenced different macrophyte species (emerged and mostly submerged). They primarily serve as a place for spawning of many species of cyprinid fish, as well as food and shelter. The composition of catch in researched localities and the period of fishing are different and primarily dependent on fishing networks used for fishing, type of substrate and lake bottom coverage with macrophytes. It also depends on the weather conditions during the fishing, as well as many other factors that affect on qualitative and quantitative composition of fishing.

Tourism development, the creation of new beaches and hotels, and more increased use of boats that pollute the lake and disturbs the peace of cyprinid fish spawning areas, have an enormous influence on the reduction in the number of individuals who are returning to the former spawning areas. This is even more important if we consider the fact that almost all cyprinids are spawning in the sites and at times when the number of tourists on Lake Ohrid is highest (this includes the scope of their effect).

The anthropogenic pressure in certain localities causes changes of water quality and the composition of the substrate. As a result of these undesired effects new macrophyte species with high density appear (especially submerged). It may result with changes in composition of fish species which are spawn in these localities or to cyprinid fish did not spawn there (Talevski et al., 2009a, 2010).

This was confirmed in our previous researches for the performance of spawning of cyprinid fish species (Talevska and Talevski, 2003; Talevski and Talevska, 2002, 2003, 2008).

According to substrate where fishes are spawning, they are mostly distinguished in the following groups: lithophilic, phytophilic and psammophilic fishes. In our researches was established that cyprinid fishes from Lake Ohrid are spawning in different substrates: Ohrid spirlin, *Alburnoides ohridanus* spawn at rocky bottom**,** bleak, *Alburnus scoranza* – muddy bottom with *Cladophora* sp., Ohrid nase, *Chondrostoma ohridanus* – rocks and sand, carp, *Cyprinis carpio* – reed belt, *Cladophora* sp. and Chara meadows, Ohrid gudgeon, *Gobio ohridanus* – fine sand between the reed belt and the shore, moranec, *Pachychilon pictum* – reed belts, *Cladophora* sp.*,* and often on rocky bottom, Ohrid roach, *Rutilus ohridanus* – rocks covered with *Draissena* shells (littoral), and Skadar

rudd, *Scardinius knezevici* – surrounding of marshlands with macrophyte vegetation.

Nevertheless, in relation to the grounds where they lay their eggs, Ohrid cyprinids are mainly phytophyllic species, because they lay eggs upon plants, and their spawning period is in spring-summer period. Any change in the qualitative and quantitative composition of the macrophyte vegetation inevitably causes a change in their spawning grounds.

Conclusion

From the performed researches and also from the previous long-term experience in this field, the results can be summarized in a following conclusions:

The researches were performed on 9 localities which cover the whole Lake's coastline in the territory of R. Macedonia (Radozda, Kalishta, Sateska, Andon Dukov, Mazija, St. Stephan, Metropol, Velidab and Ljubanishta).

Macrophyte vegetation represents habitat, food, shelter and place for spawning of many cyprinid fish species. Also, it plays a major role in protecting fish from their predators.

In researched localities were evidenced total of 32 macrophyte species which belong to 14 families: *Phragmites australis, Typha latifolia,* T*ypha angustifolia*, *Shoenoplectus lacustris, Polygonum amphibium, Nuphar lutea, Potamogeton perfoliatus, Potamogeton pectinatus, Potamogeton crispus, Potamogeton lucens, Potamogeton gramineus, Potamogeton pusillus, Potamogeton nitens, Potamogeton acutifolius, Zannichellia palustris, Myriophyllum spicatum, Ceratophyllum demersum, Ceratophylllum submersum, Vallisneria spiralis, Elodea canadensis, Ranunculus trichophyllus, Najas marina, Najas minor, Chara tomentosa. Chara aspera, Chara gymnophylla, Chara globularis, Chara imperfecta, Chara ohridana, Nitella opaca, Nitellopsis obtusa* and alga *Cladophora sp*. Also in particular localities was present water moss *Fontinalis antipyretica.*

Type of substrate and the composition of the macrophyte vegetation in the researched localities from Lake Ohrid represent a favorable place for living and the spawning for cyprinid fish: *Alburnoides ohridanus*, *Alburnus scoranza*, *Chondrostoma ohridanus*, *Cyprinis carpio*, *Gobio ohridanus*, *Pachychilon pictum*, *Rutilus ohridanus* and *Scardinius knezevici*.

The start of the cyprinid fish spawning period is at the same time with the development of macrophyte vegetation.

In relation to the grounds where they lay their eggs, Ohrid cyprinids are mainly phytophyllic species because they lay eggs upon plants. Any change in the qualitative and quantitative composition of the macrophyte vegetation inevitably causes a change in their spawning grounds.

In the future it is necessary to continue these researches to provide optimum conditions of the fish population. Special attention should be given to the places where the cyprinids performed spawning, and must be undertaking certain measures to protect these places from the negative anthropogenic pressure.

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