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PARASITOFAUNA OF THE OHRID BELVICA (*ACANTHOLINGUA OHRIDANA* HADŽIŠČE, 1961) FROM LAKE OHRID (MACEDONIA)

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Parasitological examination showed that out of 316 specimens of the Ohrid belvica (Acantholingua ohridana Hadžišče, 1961; former term Salmothymus ohridanus Steindachner, 1892) from the Macedonian part of Lake Ohrid 172 fishes (54.43%) were infected.

In our case study the presence of 13 parasite species was established: Diplozoon sp., Nicolla testiobliquum, Eubothrium crassum, Eubothrium salvelini, Cythocephalus truncatus, Proteoceephalus neglectus, Proteocephalus torulosus, Raphidascaris acus, Cystidicoloides tenuissima, Metechinorhynchus truttae, Metechinorhynchus salmonis, Acanthocephalus anguillae and Pomphorhynchus bosniacus. Individually, the highest prevalence was found for Cythocephalus truncatus (17.72%). The greatest number of parasite specimens was evident in the cases of infection with Cyathocephalus truncatus (32).

With the exception of Cyathocephalus truncatus, the other 12 parasite species in our study are recorded for the first time in the ichthyoparasitofauna of Lake Ohrid and Macedonia.

Key words: Acantholingua ohridana, parasites, Ohrid lake

INTRODUCTION

Lake Ohrid is situated in the Ohrid valley and occupies the farthest southwest part of the Republic of Macedonia, while a part of its surface belongs to the Republic of Albania. It is situated at 693 m above sea level and is one of the biggest European lakes with a surface area of 358.2 km^2 and maximum depth of 288.7 m. It belongs to the category of oligotrophic lakes. The lake is more than 2 million years old and is the oldest lake in Europe Geographic isolation of the West Balkan area,

especially Lake Ohrid, from the other parts of the Balkan Peninsula and its age, were the primary reasons for the survival in this region of the greatest number of tertiary fauna remain in the mediterranean area. Undoubtedly, both trout species *Salmo letnica* and *Acantholingua ochridana* and the minnow moranec *Pachychilon pictus* are relicts, which stand alone among the European freshwater fauna. The lake is inhabited by 17 autochotonous species, of which 10 species (60%) are endemic, and one of these is *Salmo letnica*.

Investigations of the parasitofauna of the Lake Ohrid fishes were fust carried out by Šinžar (1956), who found *Cyatocephalus truncatus* among 2% of examined belvica *(Acantholingua ochridana)* and *Metechinorhynchus truttae* in the Ohrid trout (*Salmo letnica*).

MATERIALS AND METHODS

Fish material was sampled over several year, at the following localities of Lake Ohrid: Peštani, Ohrid Bay and Radožda. A total of 316 specimens of Ohrid belvica were examined.

Fishes were subjected to the routine methods of identification, dissection and observation. Cleaned parasites were separated and put in certain fixatives, and prepared classification with standard techniques of staining and clearing.

For identiffication of the parasite species we usd the following keys: Byhovskaja-Pavlovskaja et al. (1962) and Bauer (1985, 1987). The most successful preparations for every parasite species were photographed and are displayed.

RESULTS AND DISCUSSION

The presence of 13 parasite species was established: *Diplozoon sp., Nicolla testiobliquum, Eubothrium crassum, Eubothrium salvelini, Cyathocephalus truncatus, Proteocephalus neglectus, Proteocephalus torulosus, Raphidascaris acus, Cystidicoloides tenuissima, Metechinorhynchus truttae, Metechinorhynchus salmonis, Acanthocephalus anguillae* and *Pomphorhynchus bosniacus.*

With the exception of *Cyathocephalus truncatus*, the other 12 parasite species were detected in our study for the first time in the ichthyoparasitofauna of Lake Ohrid and Macedonia.

Among the 316 specimens of Ohrid belvica examined, 172 specimens i. e. 54.43%, were infected with parasites.

Tust 1 *Diplozoon sp.* was found in 1 belvica (0.32%); in 4 fishes (1.27%) 1-4 parasites of *Nicolla testiobliquum*, were found in 23 fishes (7.28%) 1-10 *Eubothrium crassum;* 1 *Eubothrium salvelini* was established in 1 belvica (0.32%); in 56 specimens (17.72%) 1-32 parasites of *Cyathocephalus truncatus* were found; in 22 fishes (6.96%) 2-28 *Proteocephalus neglectus*; in 5 fishes (1.58%) 1 - 10 *Proteocephalus torulosus*; in 2 belvica (0.63%) 1 *Raphidascaris acus;* in 40 specimens (12.26%) 1-7 helminths of etechinorhynchus truttae were found in 20 specimens (6.33%) 1-2 *Metechinorhynchus salmonis*; in 4 fishes (1.27%) 1

Acanthocephalus anguillae; whereas 1-10 *Pomphorhynchus bosniacus* were found in 18 belvica (Tabe 1).

Table 1. Parasitofauna of the Ohrid belvica (Acantholingua ohridana)

Parasite species	Prevalence			Intensity of infection
	No. of exemined fishes	No. of infected fishes	% of infected fishes	
Diplozoon sp.	316	1	0.32	4
Nicolla testiobliquum	316	4	1.27	1–4
Eubothrium crassum	316	23	7.28	1–10
Eubothrium salvelini	316	1	0.32	11–32
Cyatocephalus truncatus	316	56	17.72	1–32
Proteocephalus neglectus	316	22	6.96	2–28
Proteocephalus torulosus	316	5	1.58	1–10
Raphidascaris acus	316	2	0.62	1
Cystidicoloides tenuissima	316	11	3.48	1–3
Metechinorhynchus trurrae	316	40	12.66	1–7
Metechinorhynchus salmonis	316	20	6.33	1–2
Acanthocephalus anguillae	316	4	1.27	1
Pomphorhynchus bosniacus	316	18	5.70	1–10
TOTAL INFECTION	316	172	54.43	

Figure 1. *Diplozoon sp.* (clamps) - original

The highest prevalence of a single species was ishownby *Cyathocephalus truncatus* (17.72%) followed by *Metechinorhynchus truttae* (12.66%). The lowest prevalence occurred with *Diplozoon sp.* and *Eubothrium salvelini* (0.32%). The greatest number of parasite specimens was evident in the cases of infection with *Cyathocephalus truncatus* (32) and *Proteocephalus neglectus* (28) (Table 1).

Claass MONOGENEA (Beneden) Bychowsky, 1937

Species *DIPLOZOON SP.* (Figure 1)

The adult parasites are localized on the fish gills and two individuals are cross connected. At favorable temperature, the eggs hatch from which larvae emerge. They enter the host through the mouth, and then they reach the gills, where the next process of development and maturation takes place. Young individuals live separately and they will develop only if they meet another individual. On the contrary they will die.

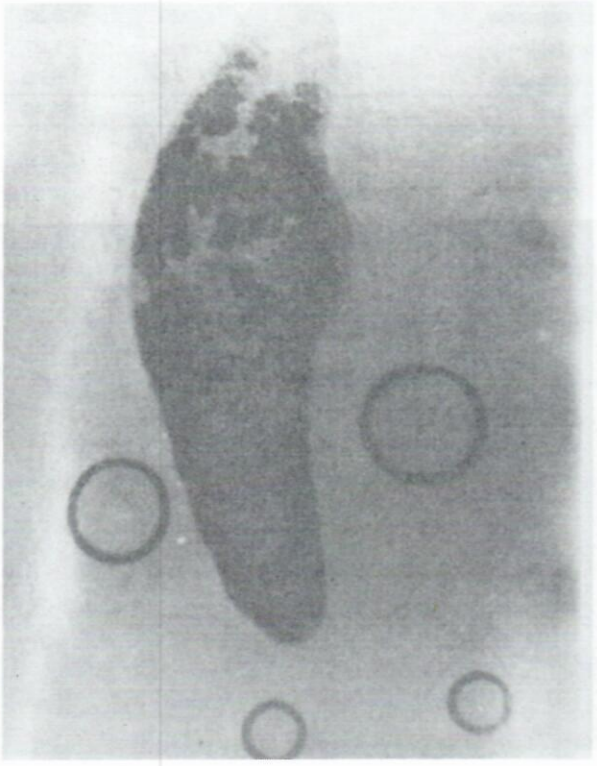

Figure 2. Nicolla testiobliquum - original

We found this parasite on the gills. Unfortunately, we found only 4 parasite specimens in 1 fish and they were injured, so we could not perform closer determination.

Class *Trematoda* Rudolphi, 1808

Species *Nicolla Testiobliquum* Wisniewski, 1932 (Figure 2)

Synonym: *Coitocaecum testiobliquum* Wisniewski, 1932.

The parasite development in the external environment is takes place with the help of 2 intermediate hosts. The first is an unknown species of mollusc, and the second transitional host is a copepods: *Pontogammarus bosniacus* and *Rivulogammarus spinicaudatus*, in which are found encysted metacercariae (Kakačeva-Avramova, 1983).

Čanković et al. (1968), reported that this trematode is found in fishes of the famillies: Salmonidae, Cyprinidae and Cottidae. *Nicolla testiobliquum* occurs from the Balkan Peninsula to the Ukraine; in the Mediterranean waters on the salmonid fishes, while in the East Europe waters it is specific for cyprinids

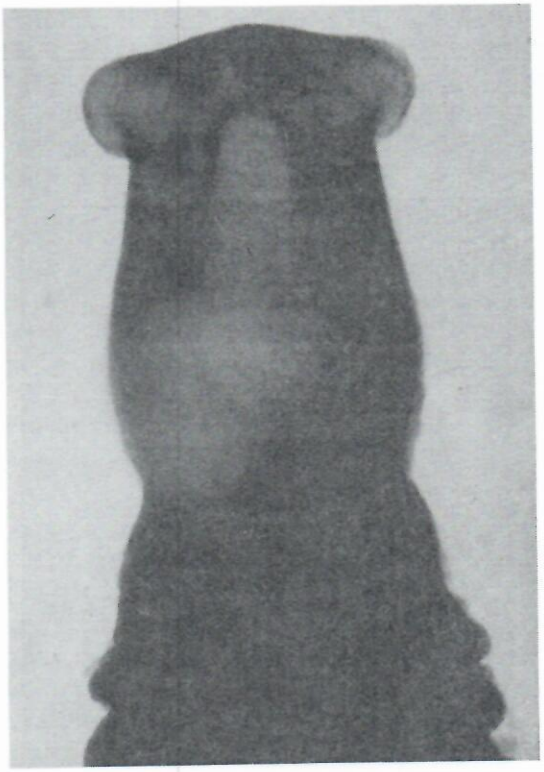

Figure 3. *Eubothrium crassum* (scolex) - original

(Hristovski, 1984). In our case, it behaves like a Mediterranean species. This parasite was also in Macedonia in *Salmo letnica* and *Rutilus rubilio ohridanus.*

Class *Cestoda* Rudolphi, 1808

Species *Eubothrium Crassum* Bloch, 1779 (Figure 3)

Synonyms: *Taenia crassa* (Bloch, 1779); *Bothriocephalus infundibiliforis* Rudolphi, 1809; *B. proboscidaeus Rudolphi,* 1809; *Abothriumm longissimum* Cholodkowsky, 1918; *Eubothrium oncorhynchi* Wardle, 1932 etc.

In salmonid fishes adult parasites are found (Byhovskaja-Pavlovskaja et al., 1962). Plerocercoids develop in the intestines of the perch, gibel-carp and some other smaller fishes, and procercoids in the body cavity of copepods of the genera *Cyclops and Eucyclops*. The prevalence and intensity of infection increase during the spring-summer priod. During the winter, parasites exist in the fish organism.

Eubothrium crassum is distributed in the areas of salmonid fishes of Europe, Asia and North America, and it can be found both in fresh and marine waters (Protasova, 1977). We found this parasite in the intestines. This parasite was also detected in Salmo letnica.

Species *Eubothrium Salvelini* Schrank, 1790 (Figure 4)

Figure 4. *Eubothrium salvelini* (scolex) - original

Synonyms: *Taenia salvelini* Schrank, 1790; *Rhytus salvelini* Zeder, 1803; *Bothriocephalus carpionis* Rudolphi, 1819; *Taenia rugosa* Lunel, 1880; *Eubothrium oncorhynchy* Wardle, 1932 etc.

The developmental cycle goes through transitional hosts - copepods from the genera: *Cyclops, Macrocyclops, Microcyclops,* in whose body cavity the procercoid developed.

Eubothrium salvelini is distributed in the areas of salmonid fishes, in Europe, Asia and North America (Protasova, 1977). We found this parasite in the intestines. This parasite was also detected in Salmo letnica.

Species *Cyathocephalus Truncatus* Pallas, 1781 (Figure 5)

Synonyms: *Taenia truncata Pallas,* 1781; *Acrobothrium typicum* Olsson, 1872.

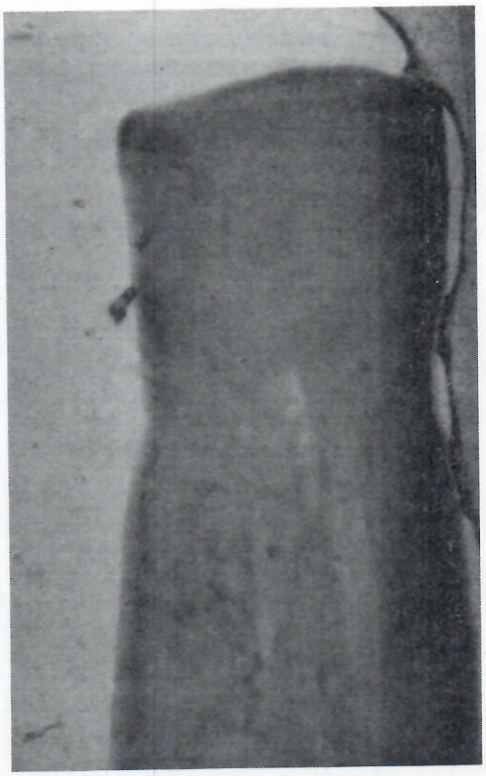

Figure 5. *Cyathocephalus truncatus* (scolex) - original

Adult parasites in the fish intestines produce eggs, which pass out with excrement into the external environment. The embryo - coracidium develops from the eggs. The following development goes through transitional hosts - copepods of the genera: *Gammarus, Pontogammarus, Rivulogammarus, Carinogammarus,*

Pontoporeia, Pallasea. In theirintestines are liberated embryos that reach the body cavity and there larva - procercoid will develop. When salmonid fishes eat infected copepods, adult parasite will develop in their intestines. During the winter, parasites exist in the fish intestines.

Cyathocephalus truncatus is distributed in Europe, Asia and North America, in fishes of the families: Salmonidae, Thymallidae, Esocidae etc. (Čanković et al., 1968). According to the data of Šinžar (1956), this parasite was found in *Acantholinqua ohridana* from Lake Ohrid. We found this parasite in the intestines. This parasite was detected in Salmo letnica, too.

Species *Proteocephalus Neglectus* La Rue, 1911 (Figure 6)

Synonymms: *Ichthyotaenia neglecta* (La Rue, 1911), Meggit, 1927; *Proteocephalus exiguus* (Kiškarolj, 1965).

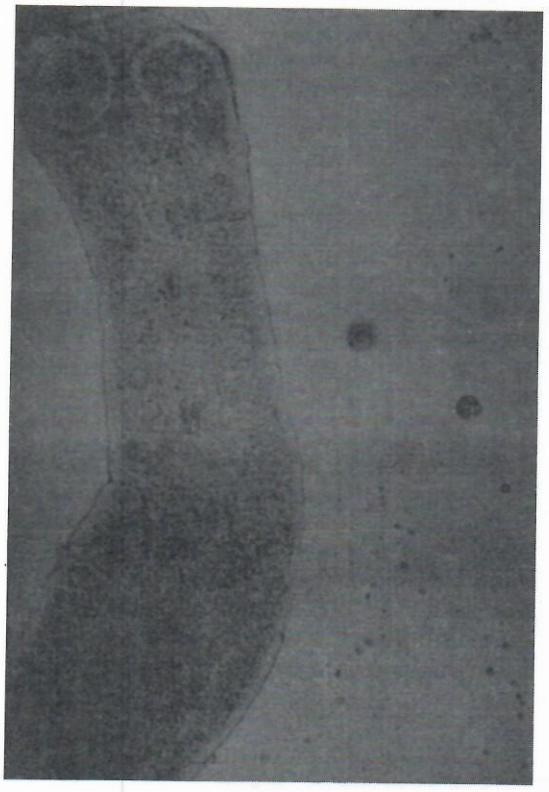

Figure 6. Proteocephalus neglectus (scolex) - original

Adult helminths in the fish intestines produce embryonic eggs, that reach the water. The following development goes through transitional hosts - copepods of the genera: *Cyclops, Eucyclops, Macrocyclops, Mesocyclops etc.* In their body

develop larva - procercoids. Infected copepods are eaten by fishes and in their intestines the procercoid changies into the following larval stage - plerocercoid, and after that into the adult parasite able to produce eggs. (Vasiljkov, 1983).

Proteocephalus neglectus is distributed in the Baltic and the Caspian Sea and their rivers, then in the Caucasian rivers and Swiss lakes, among the fishes of the families Salmonidae and Cobitidae (Čanković et al., 1968). We found this parasite in the intestines. This parasite was also established in Salmo letnica.

Species *Proteocephalus torulosus* (Batsch, 1786), Nufer, 1905 (Figure 7)

Synonyms: *Taenia torulosa* Batsch, 1786; *Taenia articules rotundis* Bloch, 1782; *Taenia orbicularis* Schrank, 1788; *Taenia simplex* Frölich, 1791; *Taenia cypriniidi* Viborg, 1795; *Rhitelminthus cyprini* Zeder, 1800; *Taenia torulosa* (Batsch, 1786), Van Beneden, 1861; *Ichthyotaenia torulosa* (Batsch, 1786), sensu Zcshokke, 1884; *Proteocephalus ruzsky* Titova and Razmaškin, 1974.

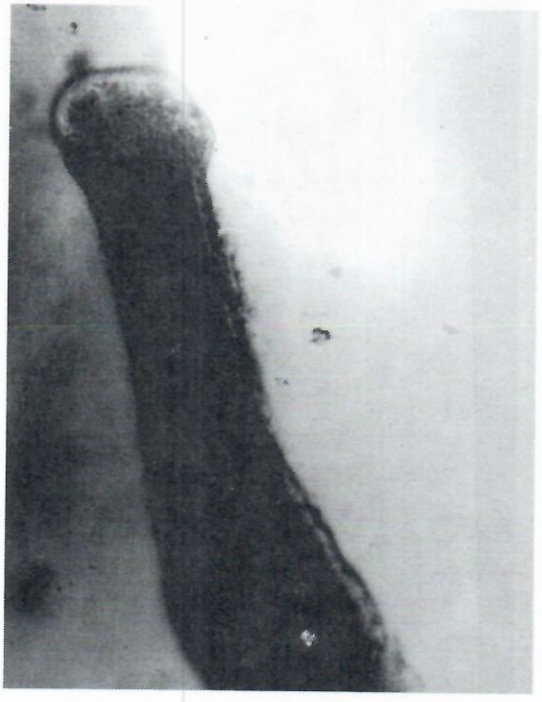

Figure 7. *Proteocephalus torulosus* (scolex) - original

Freze (1965) states that the parasite development takes place through copeepods of the genera: *Cyclops, Eucyclops* and *Diaptomus*, in whose body larvae - procercoid are formed. The subsequent development proceeds in the fishes, when they eat transitional hosts.

Proteocephalus torulosus is found in numerous cyprinid fishes (most frequently) and other fishes (Cobitiadae, Percidaeetc) in the rivers of North and East Europe and Asia (Čanković et al., 1968). Edelenyi (1975; cit. by Cakić, 1992), states that this cestode is a common parasite in cyprinid fishes, but it is spcific for the eel. We found this parasite in the intines. This parasite was established in: *Albumus albidus alborella, Cyprinus carpio, Carassius auratus gibelio* and *Anguilla anguilla,* too.

Class *Nematoda* Rudophi, 1808

Species *Cystidicoloides Tenuissima* Zeder, 1800 (Figure 8,9)

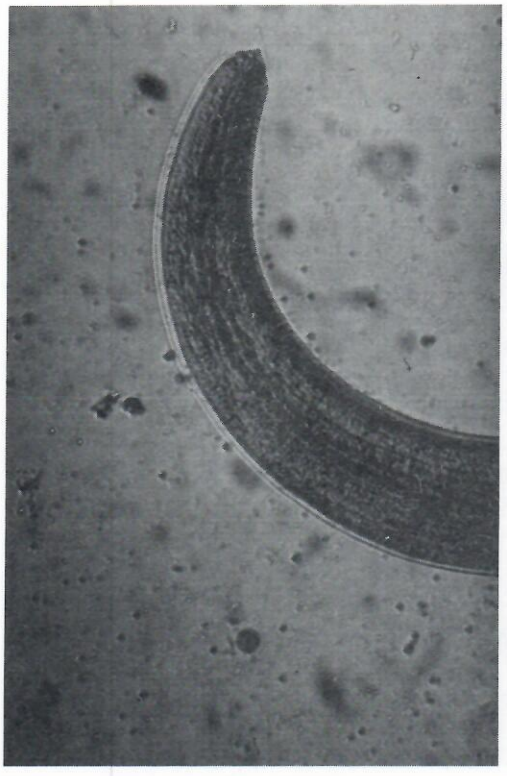

Figure 8. *Cystidicoloides tenuissima* (anterior part) - original

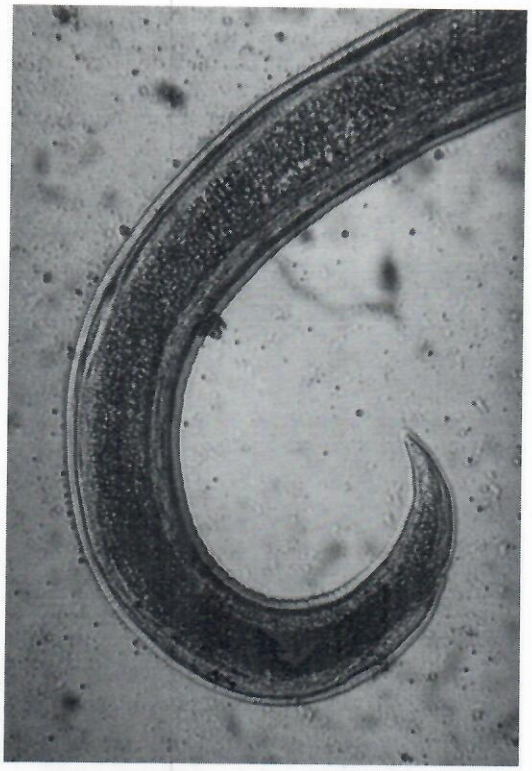

Figure 9. *Cystidicoloides tenuissima* (posterior part) - original

Synonyms: *Steriadochona tenuissima* (Zeder, 1800), Spasky and Roytman, 1959, Skrjabin, 1946; *Sterliadochona salvelini* (Fujita, 1920), Roytman, 1967; *Steriadochona ssavini* Skrjabin, 1946; *Sterliadochona pedispicula* Maggenti and Paxman, 1971; *Ichthyobronema tenuissima* (Zeder, 1800), Gnedina and Savina, 1930; *Metabronema truttae* Bayilis, 1935 (Chandler, 1931), Chitwwod, 1950; *Fusaria tenuissima* Zeder, 1800; *Ascarophis tenuissima* Chandler, 1931; *Ascarophis malmae* Achmerov, 1955; *Cystidicoloides salvelini* (Fujita, 1920), Dolifus et al Campana-Ruget, 1956.

The parasite developmental cycle takes place through transitional hosts, larvae and cocoons of the insects: *Habronema lauta, Habroleptoides modesta* and *Ephemeria danica* (Moravec, 1971, 1971a), and through paratenic transitional host - fish *Noemacheilus barbatulus* (Bauer, 1987).

Cystidicoloides tenussima is a widespread parasite in Europe and Asia, most frequently in fishes of the famillies Salmonidae and Thymallidae, rarely in others (Acipenseridae, Percidae, Esocidae, Anguillidae) (Kakačeva-Avramova,

1983). We found this parasite in the intestines and body cavity. This parasite was also detected in: *Salmo letnica, Albumus albumus belvica, Leuciscus cephalus albus, Barbus meridionalis petenyi Gobio gobio ohridanus, Rutilus rubilio ohridanus, Pachychilon pictus, Albumus aldidus alborella* and *Anguilla anguilla.*

Species *Raphidascaris Acus* Bloch, 1779 (Figure 10,11)
Synonyms: *Ascaris acus* Bloch, 1779; *Ascaris piscicola* Linstow, 1878.

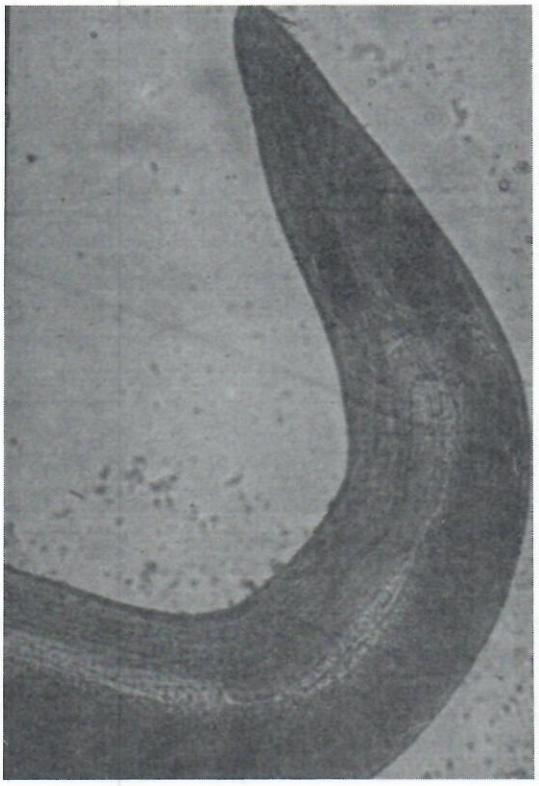

Figure 10. *Raphidascaris acus* (anterior part) - original

Adult parasites are localized in the intestinal wall of predatory fishes, where they produce eggs. Cyprinid and other benthophagous fishes and some water insects are second transitional hosts. The mesentery, liver, peritoneum and gonads are theirprimary living sites. The first transitional host can be oligochaetes of the families: Tubifecidae, Naididae and Lumbricidae, larvae of Chironomidae and other insects (Engašev, 1963).

Raphidascaris acus is a common parasite in marine fish species. It is very frequent in freshwater fishes, especially in euryhaline species which are able to migrate upstream, where they spread infection to freshwater fish populations (Hristovski and Riggio, 1977). We found this parasite in the intestines and body cavity, on the mesentery. This parasite was detected in Macedonia in: *Salmo letnica, Cobitiis taenia ohridiana, Rutilus rubilio ohridanus, Albuus albidus alborella, Barbus meridionalis petenyi, Anguilla anguilla, Salmo fariodes, Salmo macedonicus, Oncorthynchus mykiss, Cyprinus carpio, Barbus cyclolepsis strumicae, Rhodeus sericeus amarus* and *Cobitis taenia strumicae,* too.

Class *Acanthocephala* (Rudolphi, 1808)

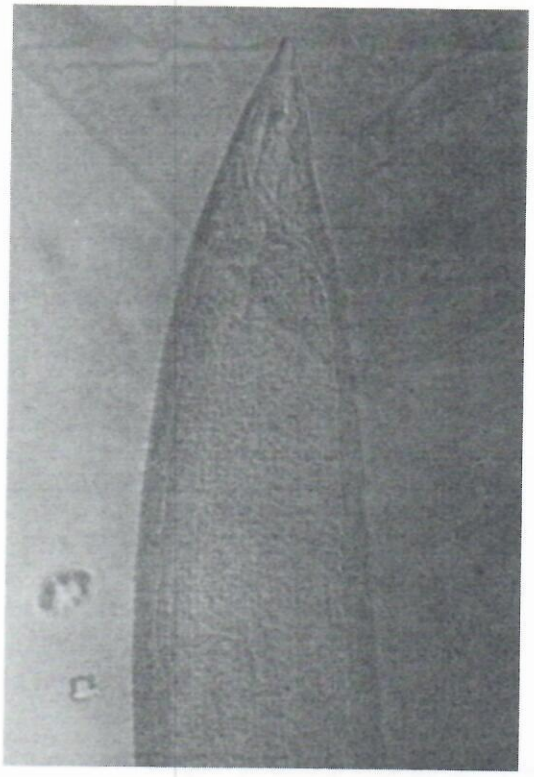

Figure 11. *Raphidascaris acus* (posterior part) - original

Species *Metechinorhynchus Salmonis* Müller, 1780 (Figure 12) Synonyms: *Echinorhynchus salmonis* (Müller, 1780); *Echinorhynchus pachysomus* Creplin, 1839; *Echinorhynchus phoenyx* Schneider, 1903; *Echinorhynchus inflatus* Rudolphi, 1809; *Echinorhynchus coregoni* Van Cleave, 1919.

Development of *Metechinorhynchus salmonis* in the external environment takes place through the transitional host, copepod *Pontoporeia affinis.*

Metechinorhynchus salmonis parasitises in different marine and freshwater fishes (of the families: Salmonidae, Thymallidae, Esocidae, Anguillidae, Cyprinidae etc.), and it can be found in the north parts of Europe and in North America (Čanković et al., 1968). We found this parasite in the intestines. This parasite was also detected in Macedonia in: *Salmo letnica, Anguilla anguilla, Pachychilon pictus, Barbus meridionalis petenyi, Rutilus rubilio ohridanus, Leuciscus cephalus albus, Salmo fariodes* and *Salmo macedonicus.*

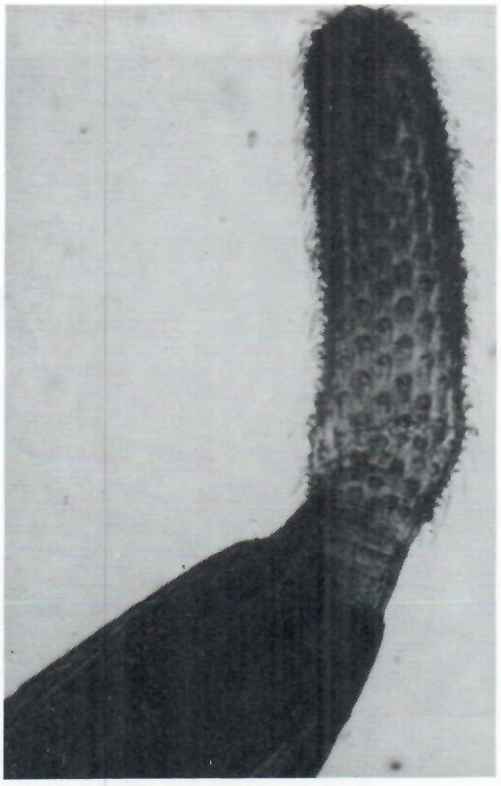

Figure 12. *Metechinorhynchus salmonis* (proboscis) - original

Species *Metechinorhynchus Truttae* Schrank, 1788 (Figure 13)

Synonyms: *Echinorhynchus truttae* Schrank, 1788; *Echinorhynchus fusiformis* Rudolphi; *Echinorhynchus clavula* Dujardin and Linstow, 1895.

Transitional hosts for etechinorhynchus truttae are the copepods *Gammarus pulex* and *Gammarus lacustris.*

Metechinorhynchus truttae occurred in the north parts of Europe and Asia in the fishes of the families: *Salmonidae, Thymallidae* and *Esocidae* (Bauer, 1987). We found this parasite in the intestines. This parasite was also detected in Macedonia in: *Salmo letnica, Leuciscus cephalus albus, Cyprinus carpio, Barbus meridionalis petenyi, Scardinius erythrophthalmus scardafa, Pachychilon pictus, Anguilla anguilla, Salmo fariodes, Salmo macedonicus, Oncorhynchus mykiss, Salmo pelagonicus, Salmo peristericus, Albumus albumus belvica, Rutilus rubilio prespensis, Barbus prespensis, Leuciscus cephalus vardarensis, Chondrostoma nasus vardarensis* and *Tinca tinca*.

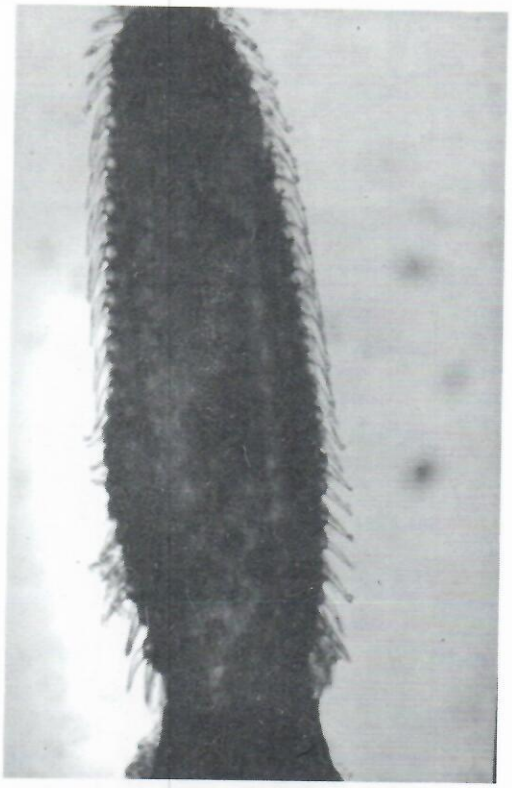

Figure 13. *Metechinorhynchus truttae* (proboscis) - original

Species *Acanthocephalus Anguillae* (Müller, 1780), Lühe, 1911 (Figure 14) Synonyms: *Echinorhynchus anguillae* Üller, 1780; *Echinorhynchus globulosus* Rudolphi, 1809.

According to the data of Byhovskaja-Pavlovskaja et al. (1962), postembryonic larval development takes place through the copepod *Asselus*

aquaticus, in which the acanthela is developed. The fish is infected it eats the infected transitional host.

Acanthocephalus anguillae has been identified in Germany and the former USSR, in fishes of the families; Cyprinidae (primarily), Salmonidae, Thymalidae, Cobitidae, Cottidae, Esocidae, Anguilidae, Percidae and Siluridae (Čanković et al., 1968). We found this parasite in the intestines. This parasite was also detected in Macedonia in: *Salmo letnica, Anguilla anguilla, Leuciscus cephalus albus, Cyprinus carpio, Barbus meridionalispetenyi, Scardinius erythrophthalmus scardafa, Salmo macedonicus, Salmo pelagonicus, Oncorhynchus mykiss, Silurus glanis, Tinca tinca, Perca fluviatilis, Silurus glanis, Leuciscus cephalus vardarensis, Barbus barbus macedonicus* and *Gambusia affinis*.

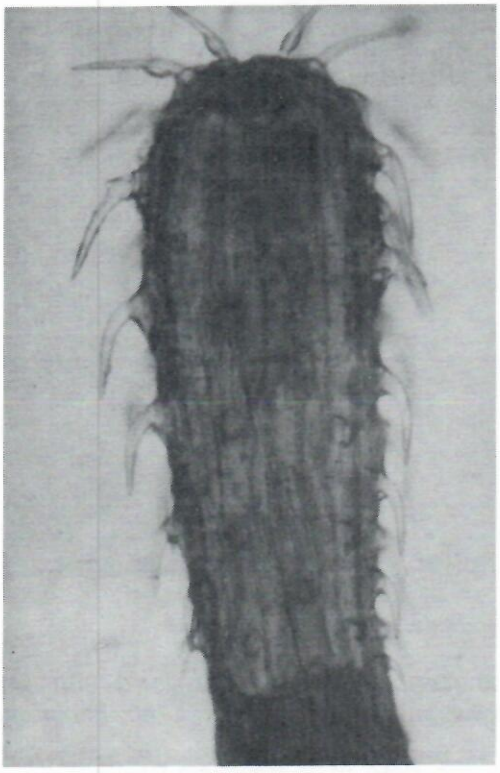

Figure 14. *Acanthocephalus anguillae* (proboscis) - original

Species *Pomphorhynchus Bosniacus* (Kiškarolj and Čanković, 1967 (Figure 15)

The developmental cycle is unknown.

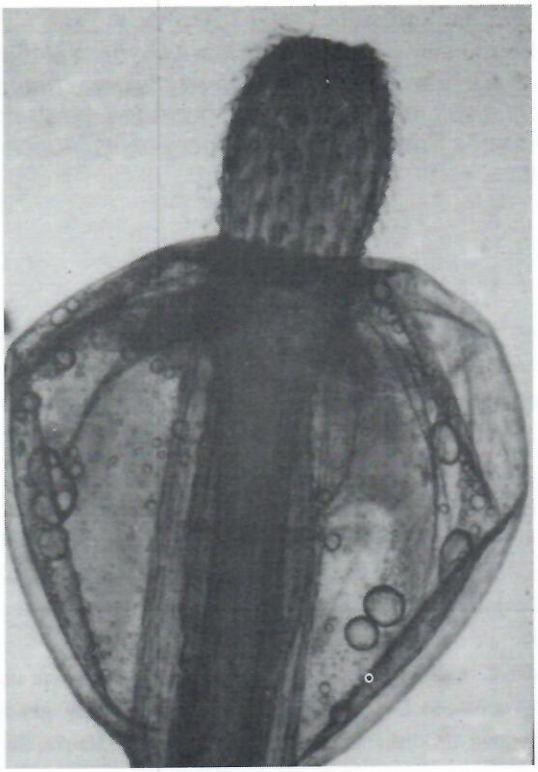

Figure 15. *Pomphorhynchus bosniacus* (proboscis) - original

Distribution of *Pomphorhynchus bosniacus* is restricted to the Balkan Peninsula, especially to its west part (Hristovski, 1983). We found this parasite in the intestines. This parasite was also detected in Macedonia in: *Salmo letnica, Anguilla anguilla, Albumus albidus alborela, Rutilus rublio ohridanus, Pachychilon pictus, Leuciscus cephalus albus, Cyprinus carpio, Scardinius erythrophthalmus scardafa, Barbus meridionalis petenyi, Gobio gobio ohridanus, Salmo peristericus, Rutilus rubilio prespensis, Barbus prespensis* and *Leuciscus cephalus vardarensis.*

Comparing our results with the sindings of other authors (Byhovskaja-Pavlovskaja et al., 1962; Čanković et al., 1968; Kakačeva-Avramova, 1983; Hristovski, 1983; Bauer, 1985; Bauer, 1987; Hristovski, 1987; Hristovski 1987 a; Cakić, 1992

and Hristovski et al., 1994) we can say that the parasitofauna of this salmonid species is specific for the fishes of the family Salmonidae, with the exception of Diplozoon sp. and *Proteocephalus torulosus*, which are found among the cyprinid fishes.

The parasitofauna of the Lake Ohrid fishes is mostly freshwater, with some elements that occur both in marine and fresh waters (*Raphidascaris acus, Metechinorhynchus salmonis* etc.).

Some of the parasites identified have a wide area of distribution and a wide spectar of hosts, such as *Cystidicoloides tenuissima, Raphidascaris acus* and *Metechinorhynchus truttae*. The remaining parasites are stenoparasites or on the border of stenoparasitism suchas *Cyathocephalus truncatus,* and *Pomphorhynchus bosniacus.*

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PARAZITOFAUNA OHRIDSKE BELVICE (*ACANTHOLINGUA OHRIDANA* HADŽIŠČE, 1961) IZ OHRIDSKOG JEZERA (MAKEDONIJA)

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SADRŽAJ

Parazitološkim pregledom riba makedonskog dela Ohridskog jezera obuhvaćeno je 316 primeraka ohridske belvice (*Acantholingua ohridana* Hadžišče, 1961; raniji naziv *Salmothymus ohridanus* Steindachner, 1892) od kojih 172 ribe (54.43%) su bile inficirane.

Konstatovano je prisustvo 13 vrsta parazita: *Diplozoon* sp., *Nicolla testiobliquum, Eubothrium crassum, Eubothrium salvelini, Cyathocephalus truncatus, Proteocephalus neglectus, Proteocephalus torulosus, Raphidascaris acus, Cystidicoloides tenuissima, Metechinorhynchus truttae, Metechinorhynchus salmonis, Acanthocephalus anguillae* i *Pophorhynchus bosniacus.* Pojedinačno, po vrstama parazita, najveći ekstenzitet infekcije je sa *Cyathocephalus truncatus* (17.72%), a najmanji sa *Diplozoon* sp. i *Eubothrium salvelini* (0.32%). Najveći broj primeraka parazita je ustanovljenim u slučajevima infekcije sa *Cyathocephalus truncatus* (32).

Sa izuzetkom *Cyathocephalus truncatus,* dvanaest ostalih vrsta parazita su spomenutih u našem radu poprvi put u parazitofauni riba Ohridskog jezera i u Makedoniji.

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