



**PARASITE FAUNA OF ENDEMIC FISHES (*Salmo letnica* Karaman, 1924 and *Salmo ohridanus* Steindachner 1892) FROM LAKE OHRID (MACEDONIA)**

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**SYNOPSIS**

**Key words:**  
parasite fauna,  
*Salmo letnica*,  
*Salmo ohridanus*,  
Lake Ohrid.

In order to explore the parasite fauna of endemic fishes from Lake Ohrid, sampling of fish material was carried out by seasons, during the year 2012.

During that period, 203 specimens of fish were caught, which belong to 2 species: Ohrid Trout - *Salmo letnica* and Ohrid Belvica - *Salmo ohridanus*.

Parasitological examinations of the fish from the Macedonian part of Lake Ohrid were made on 78 specimens of Ohrid's trout (*Salmo letnica* Karaman, 1924), of which 59 fishes (75,64 %) were infected. We determined the presence of 4 parasite species in Ohrid's trout (*Salmo letnica*): *Eubothrium crassum*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis*.

Parasitological examinations were made on 125 specimens of the Ohrid's belvica (*Salmo ohridanus* Steindachner 1892), of which 68 fishes (54,40 %) were infected. We determined the presence of 6 parasite species in Ohrid's belvica (*Salmo ochridanus*): *Nicolla testiobliqua*, *Eubothrium salvelini*, *Metechinorhynchus truttae*, *Metechinorhynchus salmonis*, *Acanthocephalus anguillae* and *Pomphorhynchus bosniacus*.

**INTRODUCTION**

Lake Ohrid is situated in the Ohrid valley and occupies the farthest southwest part of the Republic of Macedonia, while a smaller part of its surface belongs to the Republic of Albania. It belongs to the category of oligotrophic lakes. The lake is more than 2 million years old, and it's the oldest lake in Europe.

Lake Ohrid fish fauna is represented with 17 autochthonous species, among which 60% are endemic in terms of species or subspecies. Ten species are commercially important, priority being given to the two endemic and relic trout

species - Ohrid trout (*Salmo letnica* Karaman, 1924) and Belvica (*Salmo ohridanus* Steindachner, 1892). The quality and economic importance of the fish population of the Lake Ohrid are of a far higher level than that of the rest of Balkan's lakes, even higher than the shallow and highly productive lakes of the Aegean region.

The Ohrid trout is represented with four forms whose taxonomic state is still unsolved. They differ according to their ecological characteristics - period and locality of their spawning, and with these the possibility for their crossed reproduction is excluded.

Belvica (*Salmo ohridanus* Steindachner, 1892) belongs to the species with the slowest growth among macrostome' salmonids. It is an expressive lake's and depth form. Belvica is endemic for the Lake Ohrid, although it may be found in some Albanian waters. It has less numerous populations than Ohrid trout.

Primarily investigations of the parasitofauna of the Lake Ohrid fishes were carried out by Šinžar (1956), who found *Cyatocephalus truncatus* among 2% of examined belvica (*Salmo ohridanus* Steindachner, 1892) and *Metechinorhynchus truttae* in the Ohrid trout (*Salmo letnica*).

## MATERIALS AND METHODS

In order to explore the parasite fauna of endemic fish from Lake Ohrid, sampling of fish material was carried out by seasons during the year 2012. Fish taxonomy is according to Kottelat & Freyhof (2007).

During that period, 203 specimens of fish were caught, which belong to 2 species: Ohrid Trout - *Salmo letnica* and Ohrid Belvica - *Salmo ohridanus*. The material was obtained from professional fishermen.

Special protocols for dissection were adopted for each fish. The protocols contain the following data:

1. Biometrical data (identification of the fish species, total length, weight and sex) (Labropoulou & Eleftheriou, 1997);
2. External examination (oral cavity, eyes, skin, scales, fins, gill slips and gills).
3. Examination of the internal organs (body cavity, heart, urinary bladder, stomach, gut, liver, spleen, sexual organs, kidney, musculature, eyes and brain).

The body cavity was opened by removing the lateral wall. Firstly, the cavity and the surface of the internal organs were washed and then the viscera were examined and dissected.

Living parasites were cleaned of mucus and put into small Petri dishes or a watch glass with warm water, which enables the parasite to die in an elongated position to facilitate the following procedure of measurement and determination.

Selected parasites were put into fixatives: 4% formalin or 70% ethyl alcohol and then, depending on their class, the parasites with certain techniques of staining (carmine for example) and clearing (lactophenol) were prepared for determination. Nematodes and some acanthocephalans were not stained. Acanthocephalans were cleared in glycerin or creosol. Then, by using Canada balsam, the parasites were embedded and permanent slides were made.

In order to determinate the parasite species, the keys of Bauer (1985, 1987) and Lom & Dykova (1992) were used. The taxonomy of the parasites found was according to: Lom & Dykova (1992) and World Register of Marine Species (2011).

In our work, stereomicroscope type "MBC 10" and "Reichart" microscope were used.

The best preparations for each species of parasites were photographed with apparatus type "Reichart".

## RESULTS AND DISCUSSION

### PARASITE FAUNA IN OHRID'S TROUT (*Salmo letnica* Karaman, 1924)

Parasitological examinations of the fish from the Macedonian part of Lake Ohrid were made on 78 specimens of Ohrid's trout (*Salmo letnica* Karaman, 1924), of which 59 fishes (75,64 %) were infected.

We determined the presence of 4 parasite species in *Salmo letnica*: *Eubothrium crassum*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis*, classified into 2 classes:

**Class Cestoda** - *Eubothrium crissum*, *Cyathocephalus truncates* and *Proteocephalus neglectus*.

**Class Acantocephala** - *Pomphorhynchus laevis*.

Individually, by the parasite species, the highest prevalence was with *Eubothrium crassum* (48.09%), and the lowest with *Pomphorhynchus laevis* (0.76%).

### **Species *Eubothrium crassum* (Bloch, 1779)**

According Hristovski (1983), *Eubothrium crassum* is found in *Salmo letnica* and *Salmo ohridanus* from Lake Ohrid.

In our investigation, we found this parasite in the intestines of *Salmo letnica* throughout all year.

### **Species *Proteocephalus neglectus* (La Rue, 1911)**

*Proteocephalus neglectus* is found in Baltic and Caspian Sea and their rivers, Caucasian rivers and Swiss lakes, in the fishes of the families Salmonidae and Cobitidae (Čanković et al., 1968).

In our investigations, *Proteocephalus neglectus* is found in the intestines of *Salmo letnica*.

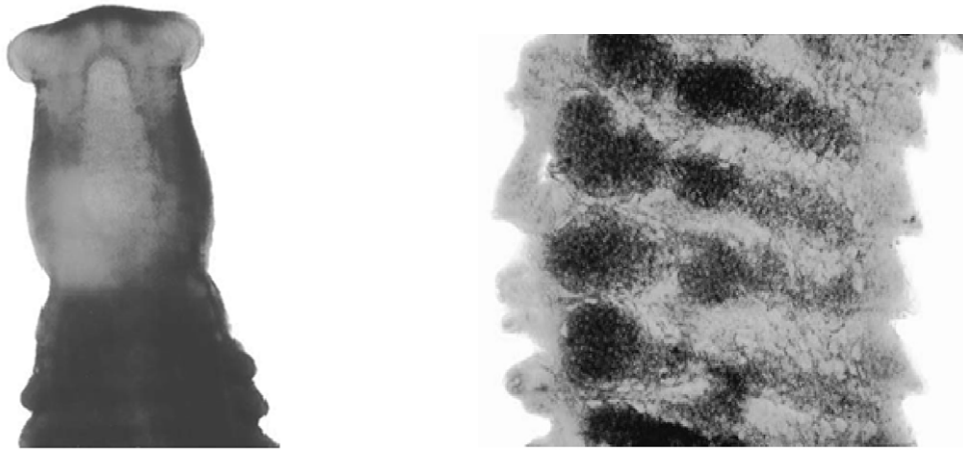


Figure 1: *Eubothrium crassum* - original (left – scolex; right – proglottides).

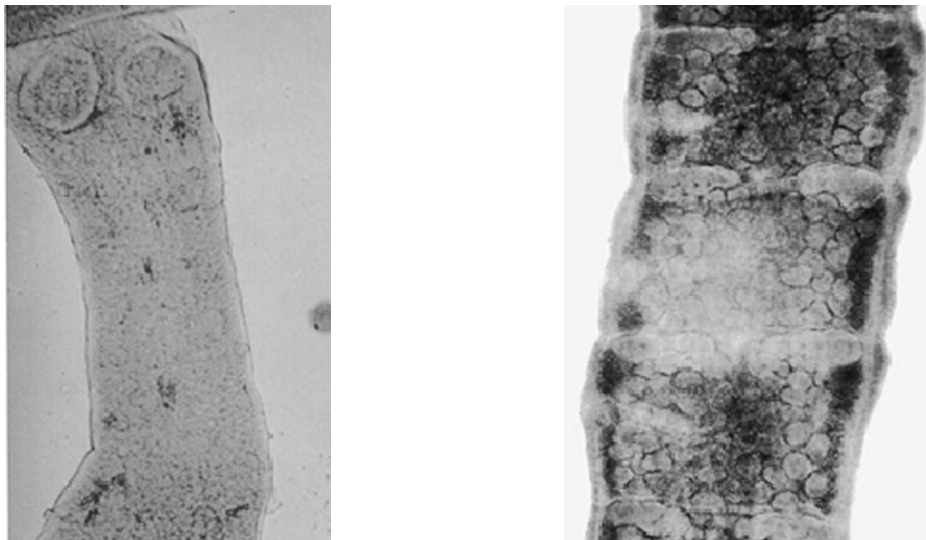


Figure 2: *Proteocephalus neglectus* - original (left – scolex; right – proglottides).

**Species *Cyathocephalus truncatus* (Pallas, 1781)**

According **Reimchen** (1981), usual hosts of *Cyathocephalus truncates* are much larger fishes such as those of Salmonidae, Esocidae, Gadidae, and Percidae. Pathological effects of the tapeworm infection in fish are seen as swelling and proliferation of tissues of the caecal wall where the tapeworm forms an attachment. In long established infections erosion of the caecal wall penetration by worms through the caecal wall into the body cavity and their attachment to the abdominal musculature of the fish host are common notable features.

In our investigations, *Cyathocephalus truncatus* is found in the intestines of Ohrid's trout (*Salmo letnica*) in Lake Ohrid.

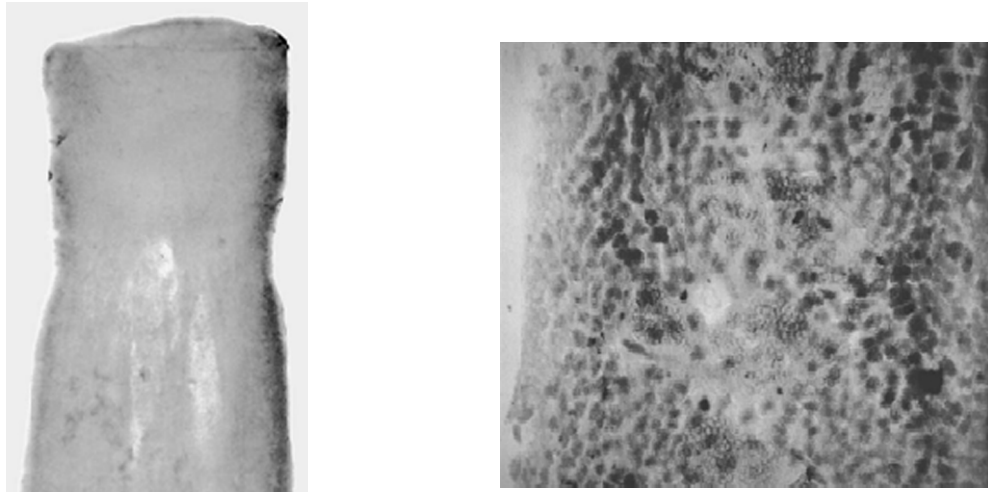


Figure 3: *Cyathocephalus truncatus* - original (left – scolex; right – proglottides).

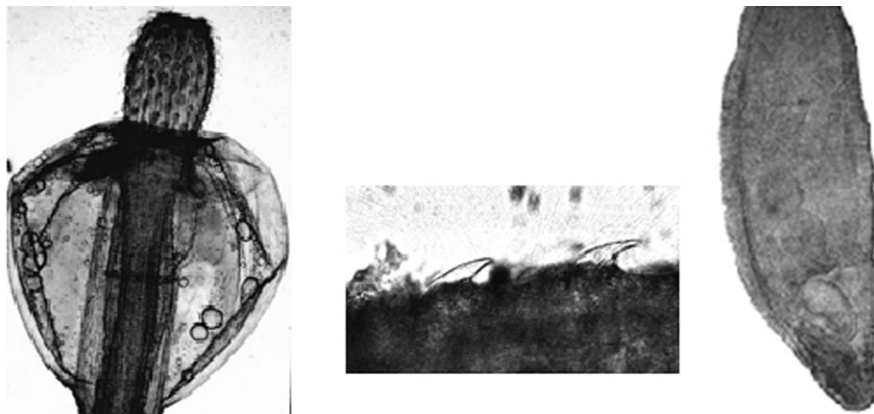


Figure 4: *Pomphorhynchus laevis* - original (left – proboscis; middle – hooklets; right – body).

#### **Species *Pomphorhynchus laevis* (Müller, 1776)**

According to the data of researchers from neighboring countries (**Brglez**, 1973 and **Cakić**, 1992) it is the most common species of parasites in freshwater fishes in Slovenia and Serbia.

According **Hristovski** (1989), this parasite is found in natural lakes from Macedonia in following fish species: *Alburnus alburnus macedonicus*, *Perca fluviatilis*, *Scardinius erythrophthalmus dojranensis*, *Tinca tinca*, *Rhodeus sericeus amarus*, *Carassius auratus gibelio*.

In our investigations, *Pomphorhynchus laevis* is found in Ohrid's trout (*Salmo letnica*).

PARASITE FAUNA IN OHRID'S BELVICA (***Salmo ohridanus* Steindachner 1892**)

Parasitological examinations of the fishes from the Macedonian part of Lake Ohrid were made on 125 specimens of the Ohrid's belvica (*Salmo ohridanus* Steindachner 1892), of which 68 fishes (54,40 %) were infected.

We determined the presence of 6 parasite species in *Salmo ohridanus*, classified into 3 classes:

**Class Trematoda** - *Nicolla testiobliqua*;

**Class Cestoda** - *Eubothrium salvelini*;

**Class Acantocephala** - *Metechinorhynchus truttae*, *Metechinorhynchus salmonis*, *Acanthocephalus anguillae* and *Pomphorhynchus bosniacus*.

Individually, by the parasite species, the highest prevalence was with *Metechinorhynchus truttae* (12,66 %). The lowest one was with *Eubothrium salvelini* (0,32 %).

**Species *Nicolla testiobliqua* (Wisniewski, 1932)**

*Nicolla testiobliqua* is widespread from the Balkan Peninsula to the Ukraine, and also in Mediterranean waters in salmonid fish species. In East-European waters it is specific to cyprinid fish species (**Hristovski, 1989**).

**Čanković et al.**, (1968) noticed that this trematode parasitizes in fishes from the families Salmonidae, Cyprinidae and Cottidae. In our case, it behaves as an East-European species.

According **Hristovski** (1989) and **Stojanovski** (1997), *Nicolla testiobliqua* is found in *Salmo letnica* and *Rutilus rubilio ohridanus* from Lake Ohrid.

In our investigations, *Nicolla testiobliqua* is found in the intestines *Salmo ohridanus*.



**Figure 5: *Nicolla testiobliqua* - original.**

**Species *Eubothrium salvelini* (Schrank, 1790)**

According **Protasova** (1977), *Eubothrium salvelini* is widespread in the salmonid fish throughout Europe, Asia and North America.

In our investigations, *Eubothrium salvelini* is found in the intestines of *Salmo ohridanus*.

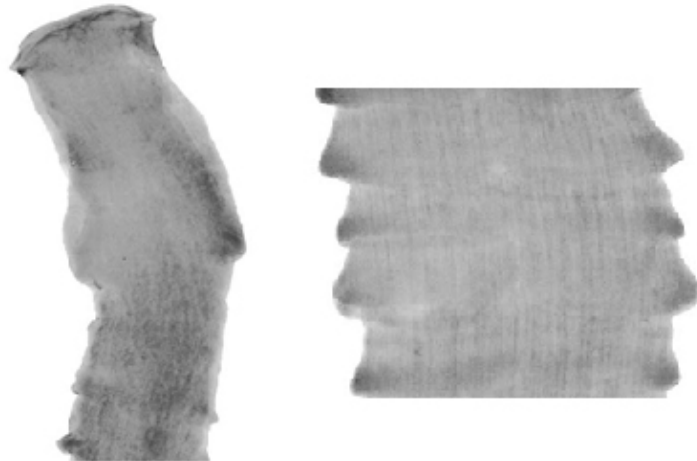


Figure 6: *Eubothrium salvelini* - original (left – scolex; right – proglottides)

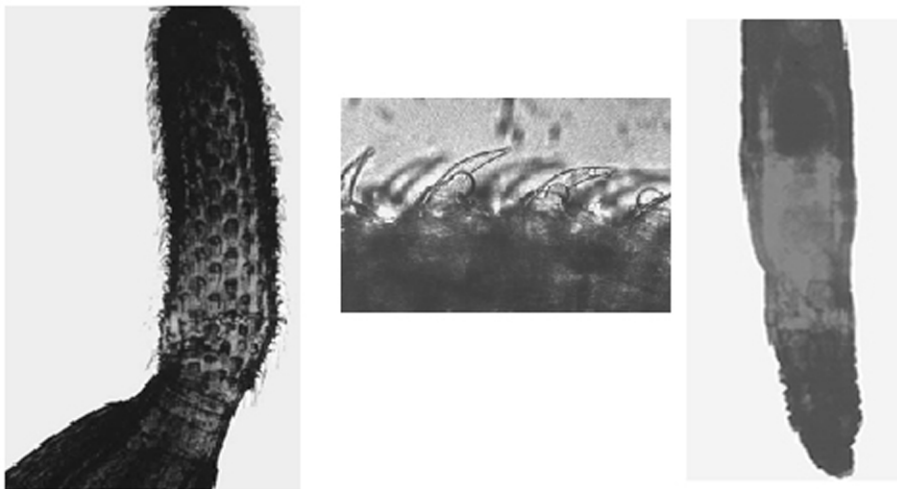


Figure 7: *Metechinorhynchus salmonis* - original (left – proboscis; middle – hooklets; right – body).

**Species *Metechinorhynchus salmonis* (Müller, 1780)**

*Metechinorhynchus salmonis* is found as a parasite in many marine and freshwater fishes (families Salmonidae, Thymallidae, Esocidae, Anguillidae, Cyprinidae etc.), and it is found in the northern parts of Europe and North America (Čanković et al., 1968).

According Hristovski et al., (2012), *Metechinorhynchus salmonis* is also found in the intestine of *Chondrostoma prespense* and *Barbus prespensis* in Lake Prespa.

In our investigations, *Metechinorhynchus salmonis* is found in the intestines of *Salmo ohridanus* in Lake Ohrid.

**Species *Metechinorhynchus truttae* (Schrank, 1788)**

*Metechinorhynchus truttae* was found in the northern parts of Europe and Asia, in fishes of the families Salmonidae, Thymallidae and Esocidae (Bauer, 1987).

Hristovski et al., (2012) found *Metechinorhynchus truttae* in the intestine of *Rutilus prespensis* and *Cyprinus carpio* in Lake Prespa.

In our investigations, *Metechinorhynchus truttae* is found in the intestines of *Salmo ohridanus*.

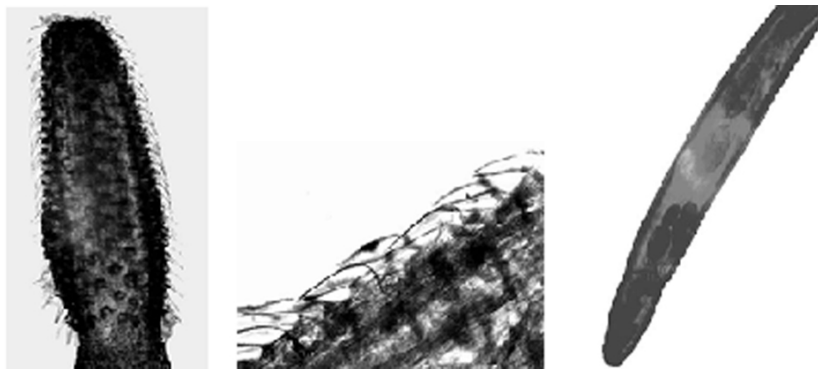


Figure 8: *Metechinorhynchus truttae* - original (left – proboscis; middle – hooklets; right – body).

**Species *Acanthocephalus anguillae* (Müller, 1780)**

*Acanthocephalus anguillae* is found in Germany and in the ex USSR, in fishes of the families Cyprinidae (primarely), Salmonidae, Thymallidae, Cobitidae, Cottidae, Esocidae, Anguillidae, Percidae and Siluridae (Čanković et al., 1968).

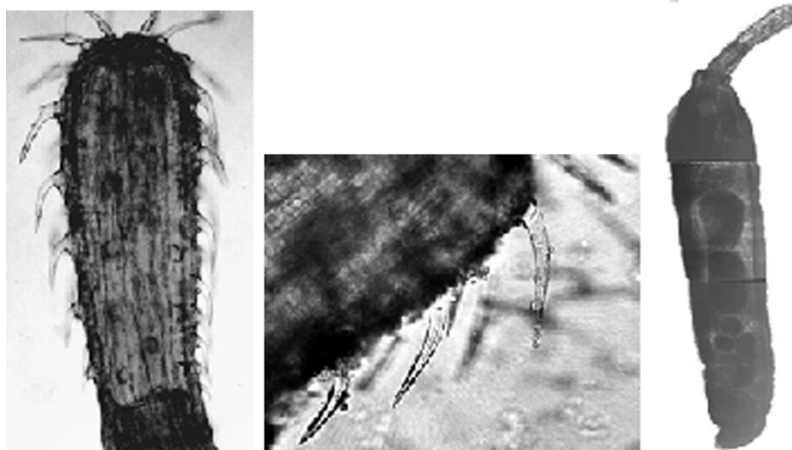


Figure 9: *Acanthocephalus anguillae* - original (left – proboscis; middle – hooklets; right – body)



According **Hristovski** (1975, 1980, 1983, 1987, 1989) and **Stojanovski** (1997), this parasite is found in Macedonia in: *Salmo letnica*, *Salmo faroides*, *Salmo macedonicus*, *Oncorhynchus mykiss*, *Salmo pelagonicus*, *Perca fluviatilis*, *Anguilla anguilla*, *Siluris glans*, *Squalius squalius*, *Cyprinus carpio*, *Barbus barbus macedonicus*, *Barbus meridionalis petenyi*, *Scardinius erythrophthalmus scardafa*, *Tinca tinca* and *Gambusia affinis*.

In our investigations, *Acanthocephalus anguillae* is found in the intestines of *Salmo ohridanus*.

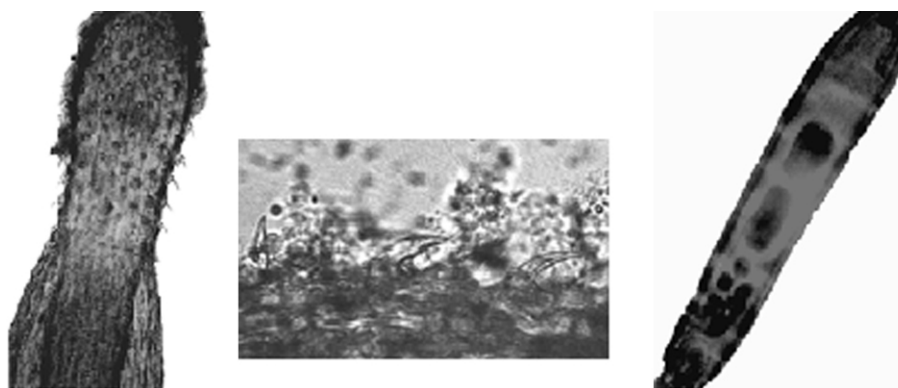
**Species *Pomphorhynchus bosniacus* (Kiškarolj & Čanković, 1967)**

This parasite is found only in the Balkans, especially on western part (**Hristovski**, 1983).

According **Hristovski** (1975, 1980, 1983, 1987, 1989) and **Stojanovski** (1997), this parasite is found in Macedonia in: *Salmo letnica*, *Salmo peristericus*, *Anguilla anguilla*, *Squalius squalius*, *Cyprinus carpio*, *Pachychilon pictus*, *Rutilus rubilio*, *Scardinius erythrophthalmus*, *Barbus meridionalis petenyi* and *Gobio gobio*.

**Hristovski et al.**, (2012) found *Pomphorhynchus bosniacus* in the intestine of *Squalius prespensis* in Lake Prespa.

In our investigations, *Pomphorhynchus bosniacus* is found in the intestines of *Salmo ohridanus*.



**Figure 10: *Pomphorhynchus bosniacus* - original (left – proboscis; middle – hooklets; right – body).**

## CONCLUSION

During our investigation on parasite fauna in endemic fish species from Lake Ohrid, 75,64 % from examined Ohrid's trout (*Salmo letnica* Karaman, 1924), as well as 54,40 % of examined Ohrid's belvica (*Salmo ohridanus* Steindachner, 1892) were infected.

Four parasite species in Ohrid's trout (*Salmo letnica*) are established: *Eubothrium crassum*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis*. Individually, by the parasite species, the highest prevalence was with *Eubothrium crassum* (48.09%), and the lowest with *Pomphorhynchus laevis* (0.76%).

Six parasite species in Ohrid's belvica (*Salmo ohridanus*) are established: *Nicolia testiobliqua*, *Eubothrium salvelini*, *Metechinorhynchus truttae*, *Metechinorhynchus salmonis*, *Acanthocephalus anguillae* and *Pomphorhynchus bosniacus*. Individually, by the parasite species, the highest prevalence was with *Metechinorhynchus truttae* (12,66 %). The lowest one was with *Eubothrium salvelini* (0,32 %).

Fish are an indispensable source of proteins for humans, notwithstanding their importance as an object of sport fishery and pets in the case of ornamental fish. Development of aquaculture during the last decades has resulted in much greater attention being paid to problems posed by parasites and their importance for fishery leading to constraints in the productivity of aquaculture.

Besides direct losses caused by mortality, parasites may have considerable impact on growth and behavior of fish, their resistance to other stressing factors, susceptibility to predation, etc.; their presence may also reduce marketability of fish.

Most fish health problems occur because of environmental problems: poor water quality, crowding, dietary deficiencies, or "stress". The best cure for any fish health problem is prevention.

Good water quality management and proper fish husbandry techniques will eliminate most parasites described here.

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