

PARASITOFUNA OF THE OHRID TROUT (*SALMO LETNICA* KARAMAN, 1924) FROM LAKE OHRID (MACEDONIA)

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In the period from April, 1995 to March, 1996, 131 specimens of the Ohrid trout (*Salmo letnica*, Karaman) 1924 from the Macedonian part of Lake Ohrid were examined parasitologically. A total of 99 fishes (75.57%) were found to be infected.

The presence of 6 parasite species: *Diclybothrium* sp., *Eubothrium crassum*, *Eubothrium salvelini*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis*. The highest prevalence occurred with *Eubothrium crassum* (48.09%) and the lowest with *Pomphorhynchus laevis* (0.76%). The greatest number of parasite specimens was found in the cases of infection with *Eubothrium crassum* (55) followed by *Proteocephalus neglectus* (45) and *Cyathocephalus truncatus* (40).

Fulton's condition coefficient among the infected fishes was 1.03 (average) and among the uninfected trouts it was 1.10. A high prevalence (75.57%) was noted which was higher than in other fish species of Lake Ohrid.

The finding of 3 parasite species mentioned in our study: is the first time they have been detected among the parasitofauna of Lake Ohrid and Macedonia: *Diclybothrium* sp., *Eubothrium salvelini* and *Proteocephalus neglectus*.

From the results of our investigations, we can add a new host, *Salmo letnica*, for some parasite species: *Diclybothrium* sp., *Eubothrium salvelini*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis* to the list of known hosts.

Key words: *Salmo letnica*, parasites, lake Ohrid

INTRODUCTION

Lake Ohrid is situated in the Ohrid valley and occupies the farthest southwest part of the Republic of Macedonia, while a smaller part belongs to the Republic of Albania. It is placed at 693 m above sea level, and is one of the biggest European lakes with a surface area of 358.2 km² and a 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. The geographic isolation of the West Balkan area, especially Lake Ohrid from other parts of the Balkan Peninsula and its great age, were the basic reasons for maintenance in this region of the most tertiary fauna remains of the Mediterranean area. Undoubtedly, both trout species *Salmo letnica* and *Acantholingua ochridana* and the minnow moranec *Pachychilon pictus* are relicts, which stand alone among European freshwater fauna. The lake is inhabited with 17 autochthonous species, of which 10 species (60%) are endemic, and one of them is *Salmo letnica*.

Little research has been occupied with investigations of the parasitofauna of the Lake Ohrid fishes. Primarily investigations were carried out by Šinžar (1956), who recorded *Cyatocephalus truncatus* in 2% of examined trout specimens (*Acantholingua ochridana*) and *Metechinorhynchus truttae* in the Ohrid trout (*Salmo letnica*). The most extensive investigations of the Ohrid trout, alone or in collaboration with other authors were carried out by Hristovski (1983, 1987, 1987a, 1994, 1994a), who found the following parasites: *Nicola testibliqua*, *Sphaerostomum grobiporum*, *Eubothrium crassum*, *Diphyllbothrium latum* (plerocercoid), *Ligula intestinalis* (plerocercoid), *Raphidascaris acus*, *Sterliadochona tenuissima*, *Rhabdochona denudata*, *Metechinorhynchus salmonis*, *Metechinorhynchus truttae*, *Acanthocephalus anguillae* and *Pomphorhynchus bosniacus*.

MATERIALS AND METHODS

The fish material was sampled at the following localities, of Lake Ohrid: Peštani, Ohrid Bay and Radožda. Fishing was performed in season, in the period from April, 1995 to March, 1996. During that time, 131 specimens of Ohrid trout, were caught.

For every fish a separated protocol was opened which comprised: 1. Biometrical data: total length, weight, age and sex; 2. Findings after external examination; 3. Findings after examination of internal organs. The total length and weight was measured in order to calculate the condition coefficient by Fulton's formula: $Q = 100 \times \text{weight}/\text{length}^3$.

Fishes were subjected to the routine methods of section and observation and separated parasites were put in fixatives. Depending on the classes, the parasites were prepared for detailed classification using standard techniques of staining and clearing.

The following keys: Bauer, vol. 2, 3 (1985, 1987) and Byhovskaja-Pavlovskaja et al. (1962) were used for determining the species of parasites.

RESULTS AND DISCUSSION

Out of 131 examined specimens of Ohrid trout (*Salmo letnica*), 99 specimens, (75.57%) were infected with parasites (Table 1). In 2 trouts (1.53%) 1 - 2 parasites of *Diclybothrium* sp. were found in 63 fishes (48.09% 1-55 parasites of *Eubothrium crassum* were found in 2 fishes (1.53%) 2-5 *Eubothrium salvelini*, in 29 specimens (22.14%) 1 - 40 parasites of *Cyathocephalus truncatus*; in 21 trouts (16.03%) 1 - 45 *Proteocephalus neglectus* were found, while 1 *Pomphorhynchus laevis* was detected in 1 trout (0.76%).

Table 1. Parasitofauna of Ohrid trout (*Salmo letnica*)

Parasite species	Prevalence			Intensity of infection	Locality
	No. of examined fishes	No. of infected fishes	% of infected fishes		
<i>Diclybothrium</i> sp.	131	2	1.53	1-2	Ohrid, Radožda
<i>Eubothrium crassum</i>	131	63	48.09	1-55	Ohrid, Peštani, Radožda
<i>Eubothrium salvelini</i>	131	2	1.53	2-5	Ohrid, Radožda
<i>Cyathocephalus truncatus</i>	131	29	22.14	1-40	Ohrid, Peštani, Radožda
<i>Proteocephalus neglectus</i>	131	21	16.03	1-45	Ohrid, Peštani, Radožda
<i>Pomphorhynchus laevis</i>	131	1	0.76	1	Peštani
TOTAL	131	99	75.57		

The high prevalence (75.57%) should be noted. Thus, it is higher than with other fish species, which were examined by Stojanovski (1997). This suggests that, the fish species, which have a larger participation of animal components in their nutrition, have a higher prevalence and intensity of infection with parasites. This finding confirms with the conclusion of Poulin (1995), who considered that the prevalence and intensity of infection are decreased by reducing the consumption of animals.

The highest prevalence occurred with *Eubothrium crassum* (48.09%), and the lowest with *Pomphorhynchus laevis* (0.76%). The greatest number of parasite specimens was found in the cases of infection with *Eubothrium crassum* (55), followed by *Proteocephalus neglectus* (45) and *Cyathocephalus truncatus* (40).

Fulton's condition coefficient among the infected trouts was 1.03 (average) and among the uninfected trouts it was 1.10. This difference shows the influence of parasites on the health and condition of the fishes and confirms many investigations in the world.

To the list of known hosts we can add a new host, *Salmo letnica*, for some parasite species: *Diclybothrium* sp., *Eubothrium salvelini*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* and *Pomphorhynchus laevis*.

The presence of 3 parasite species, is mentioned in our study for the first time for the parasitofauna of Lake Ohrid and Macedonia. namely: (*Diclybothrium* sp., *Eubothrium salvelini* and *Proteocephalus neglectus*. They may be described as follows.

Class MONOGENEA (Beneden) Bychowsky, 1937

Subclass OLIGONCHOINEA Bychowsky, 1937

Order DICLYBOTHRIDEA Bychowsky, 1937

Faily DICLYBOTHRIDAE Bychowsky et Gussev, 1950

Genus *Diclybothrium* Leuckart, 1835

Species *Diclybothrium* sp.

On the anterior part of the adults are 2 suckers like shallow holes (bothridia), which are not connected with the oral opening, 3 groups of glands and 2 pairs of little eyes. The oral opening is situated sublerinally. The adhesive disc has 6 big covering suckers and any of these has one big "sclerit" with a hooked end which is very similar to the second pair of middle hooks. On the posterior part of the disc, there is an elongation, the so-called "narrow part of the disc", which carries 3 pairs of big middle hooks, 1 pair of very small peripheral hooks and a pair of rudimental suckers.

Testes are numerous, situated in the middle of the middle of the body, behind the ovaria, between the gut trunks. The copulatory organ is muscular. One ovary exists, which looks like a coiled tube. Vitellaria are well expressed and

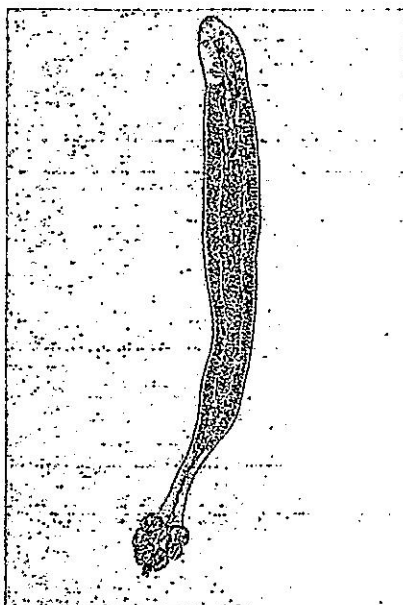


Figure 1. *Diclybothrium armatum* (graphic presentation by Bauer, 1985)

they lie on the sides of the body like long stripes. The uterus is placed between the testes and it has 1 egg inside. Eggs have an ellipsoid shape, without cilia and filaments (Figure 1).

According to Bauer (1985), 2 species of the genus *Diclybothrium* exist of which one, *Diclybothrium armatum*, is found on the territory of the former SSSR, and the other is found in North America. Both species are parasites of fishes from the family Acipenseridae. Unfortunately, we found only 3 parasite specimens in 2 fishes and they were injured, so we could not perform closer determination. In any case, finding a parasite of the genus *Diclybothrium*, among fishes from the family Salmonidae is a new discovery for the ichthyoparasitofauna.

Class CESTODA Rudolphi, 1808

Order PSEUDOPHYLLIDEA Carus, 1863

Suborder BOTHRIOCEPHALATA Frese, 1974

Family AMPHICOTYLIDAE Ariola, 1899

Genus *Eubothrium* Nybelyn, 1922

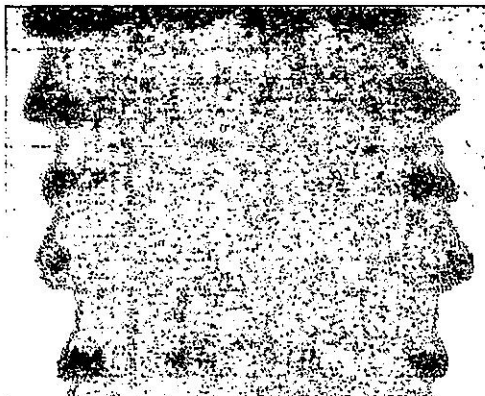
Species *Eubothrium salvelini* Schrank, 1790

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

The length of this parasite is 6-12 cm, and the width is about 2.0 - 2.5 cm. The scolex is shorter than the scolex of *Eubothrium crassum*, with a trapezoid-shape, with deeper bothridia and a less expressed apical plane. It measures 0.6 - 0.75x0.38 - 0.45 mm. The neck is little developed. The body muscles are poorly expressed, also. The width of the proglottides is greater than the length, across all the length of the strobila.

The testes are few, with ellipsoid shape, situated on both of the poles of the proglottida and they are connected to each other with transversal commisures. They develop earlier than other reproductive organs. In the proglottides, where the uterus is full of eggs, they are diminished and very deformed. The cirrus-sac is well expressed (size 0.18 - 0.26 mm), ovoid and passes over the nerve trunk. The cirrus is not armed. The ovary is double-winged (in the European specimens), or kidney-shaped (in American specimens). Vitelline follicles are very big, but few. They form 2 semmicircles, leaving a free medial field which is 1/5 of the proglottida width. Genital pores are irregularly arranged at the proglottida ends across all the length of the strobila. The female genital pores are in front of the male. The uterus is bag-shaped, with well expressed lateral branches and it opens medially, on the ventral side. The eggs are oval, with a delicate external membrane, without cover, with dimensions 0.09 - 0.10x0.05 - 0.07 mm. Their embryonal development is finished in the uterus (Figure 2,3).

Eubothrium salvelini is distributed in the areas with salmonid fishes, in Europe, Asia and North America (Protasova, 1977). We found this parasite in the intestines. Our finding is the first for Macedonia and *Salmo letnica* is a new host for this parasite.

Figure 2. *Eubothrium salvelini* (scolex) - originalFigure 3. *Eubothrium salvelini* (proglottides) - original

Order PROTEOCEPHALIDEA Mola, 1908

Family PROTEOCEPHAIDAE La Rue, 1911

Subfamily PROTEOCEPHALINAE Mola, 1929

Genus *Proteocephalus* Weinland, 1858

Species *Proteocephalus neglectus* La Rue, 1911

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

This cestofda has average dimensions. The length of this parasite is 5 - 15 cm, and the width is up to 2 cm. The scolex measures 0.2 - 0.25 x 0.08 - 0.12 mm. It has a circular form, with 4 big lateral suckers and 1 less developed apical sucker. The neck is not clearly separated from the head, because behind the head the equally wide strobila begins. Segmentation of the strobila is well expressed. The body segments are always more bread than long.

The testes have an irregularly circular shape and number 70-80 in one proglottida. They occupy all the space ahead of the ovary and between the vitelline follicles, those are placed laterally. Their arrangement is unequal. They are more concentrated near the vitellaria, where, they occur in 2 layers, while, in the middle of the segment they are in 1 or 2 layers. The cirrus-sac always covers

the vitellarium with all its length. The cirrus is sausage-shaped and it is slightly wider at its base. It terminates with little thorns, which are turned back at their tips. The ovary is relatively well expressed, granulated, and its width takes up the greater part of the posterior part of the proglottida. It has 2 lobes, which are shaped like butterfly wings inter connected with thin commisura. On the left and right side of the proglottides are placed compact small-granulated vitelline follicles, which touch the sides of the ovary with their distal ends; so they close the space where the testes are situated. The uterus is bag-shaped in sexually mature proglottides, with 5-9 branches on every side. Between the branches of the uterus is situated a space, that splits light, well because it is empty. The eggs are round, 0.04 - 0.05 mm, in diameter with a delicate smooth membrane. The round embryo of the proceroid is placed in their interior (Figure 4,5).

Proteocephalus neglectus is spread in the Baltic and Caspian Sea and their rivers, in the Caucasian rivers, in the Caucasian rivers and Swiss lakes, among fishes of the families Salmonidae and Cobitidae (Čanković, 1968). We found this parasite in the intestines. This is the first record for Lake Ohrid and Macedonia, and *Salmo letnica* is a new host for this parasite.

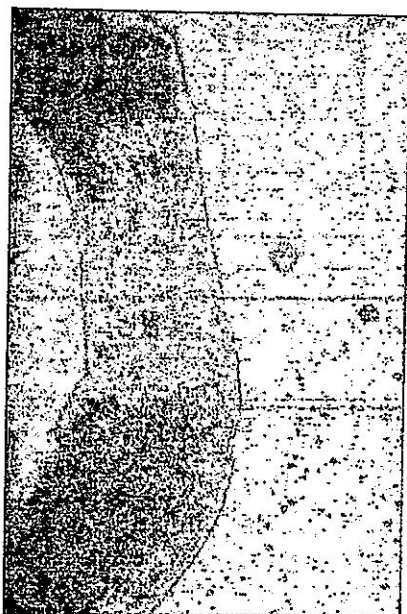


Figure 4. *Proteocephalus neglectus* (scolex) - original

Figure 5. *Proteocephalus neglectus* (proglottides) - original

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PARAZITOFUNA OHRIDSKE PASTRMKE (*SALMO LETNICA* KARAMAN, 1924) IZ OHRIDSKOG JEZERA

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SADRŽAJ

U periodu od aprila meseca 1995. do marta 1996. godine, parazitološkim pregledom riba makedonskog dela Ohridskog jezera, obuhvaćen je 131 primerak

ohridske pastrmke (*Salmo letnica* Karaman, 1924), od kojih je 99 (75,57%) bilo inficirano.

Konstatovano je prisustvo 6 vrsta parazita: *Diclybothrium* sp., *Eubothrium crassum*, *Eubothrium salvelini*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* i *Pomphorhynchus laevis*. Pojedinačno, po vrstama parazita, najveći ekstenzitet infekcije je sa *Eubothrium crassum* (48,09%), a najmanji sa *Pomphorhynchus laevis* (0,76%). Najveći broj primeraka parazita je ustanovljenim u slučajevima infekcije sa *Eubothrium crassum* (55), sa *Proteocephalus neglectus* (45) i *Cyathocephalus truncatus* (40).

Rezultati određivanja Fultonovog koeficijenta uhranjenosti kod inficiranih i neinficiranih riba pokazuju da on, kod inficiranih pastrmki iznosi 1,03, a kod neinficiranih 1,10. Zapaža se visok ekstenzitet infekcije (75,57%), tako da je on najviši, upoređeno sa drugim vrstama riba Ohridskog jezera.

U našem radu su po prvi put opisane 3 vrsta parazita u parazitofauni riba Ohridskog jezera i Makedonije: *Diclybothrium* sp., *Eubothrium salvelini* i *Proteocephalus neglectus*.

Iz rezultata naših istraživanja, listi poznatih domaćina - riba možemo dodati novog domaćina - *Salmo letnica* za neke vrste parazita, odnosno za: *Diclybothrium* sp., *Eubothrium salvelini*, *Cyathocephalus truncatus*, *Proteocephalus neglectus* i *Pomphorhynchus laevis*.