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BIODIVERSITY OF THE HELMINTH COMMUNITIES OF *Scardinius erythrophthalmus* (Linnaeus, 1758) FROM MARITSA RIVER, BULGARIA

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Abstract

This study is the first that presents the rudd's (Scardinius erythrophthalmus (Linnaeus, 1758)) endohelminth species and structure of helminth communities from Maritsa River, Bulgaria. During 2018, 13 specimens of Scardinius erythrophthalmus were collected and examined with standard techniques for parasites from Maritsa River. Helminth parasites were recorded in all 13rudd specimens (100%) from Maritsa River.Three species of parasites were identified: one cestode species (Ligula intestinalis (Linnaeus, 1758)), one acantocephalan species (Pomphorhynchus laevis (Müller, 1776)) and one nematode species (Rhabdochona denudata (Dujardin, 1845, Raillet, 1916).The analysis of the dominant structure of the found parasite species is presented to the component level. All established parasite species are core for the component community of Scardinius erythrophthalmus from Maritsa River.The infracommunities data was used to be fixed principal biotic indices. Bioindicator significance of established parasite species was discussed for ecological evaluation of the state of the studied freshwater ecosystem.

Key words*: bioindication; helminth communities; Maritsa River; Scardinius erythrophthalmus.*

INTRODUCTION

The length of the Maritsa River on Bulgarian territory is 321.6 km. Thus, Maritsa is fourth in length among the Bulgarian rivers - after the Danube, Iskar and Tundja. The river is related to Aegean Basin and is included in the National monitoring program (Water Body Type BG3MA350R039 – Major Rivers) (Regulation 1/2011).

Parasites are well established sensitive bioindicators for the aquatic ecosystem state (Marcogliese, 2004). Parasite communities are useful indicators of food web structure and biodiversity (Marcogliese, 2005).

Fish parasite communities and biodiversity, heavy metal content of fish host and parasites and the state of the freshwater ecosystem of the Maritsa River were studied from few authors (Margaritov, 1965; Kirin, 2000a; 2000b; 2001; 2006; 2013; 2014).

This study is the first that presents the results of examinations of the rudd's (*Scardinius erythrophthalmus* (Linnaeus, 1758)) endohelminth species biodiversity and structure of helminth communities from Maritsa River, Bulgaria.

MATERIALS AND METHODS

During the summer of 2018, fish and fish parasites were collected and examined from the Maritsa River (before the city of Plovdiv). The city of Plovdiv (42°9′N 24°45′E) is situated on the two banks of the Maritsa River. The region of the town and the riverside are distinguished with a significant diversity of highly protected species and territories declared as protected with national and international nature protective status (Assyov, 2012). The Maritsa River springs from the Rila Mountains (2378 m altitude) in Western Bulgaria, flowing southeast between the Balkan and Rhodope Mountains, past Plovdiv to Edrine, Turkey and to Aegean Basin (41 m above sea level) (Dakova et al., 2004). After leaving Bulgaria, the river passes through the north-eastern part of Greece and the European part of Turkey and enters the Aegean Sea. The Maritsa River (Maritsa/Meriç/Evros) is the longest river that runs solely in the interior of the Balkan Peninsula.

A total of 13 rudd specimens (*Scardinius erythrophthalmus* (Linnaeus, 1758)) were collected and examined from the Maritsa

Riverduring the summer of 2018. The scientific and common names of the fish host are used according to the FishBase database (Fröse and Pauly, 2018).

The fish were immediately after their capture examined for gastrointestinal and tissue helminths (an incomplete parasitological study).

Helminthological examinations were carried out following recommendations and procedures described by Bauer et al. (1981), Bykhovskaya-Pavlovskaya (1985), Gusev et al. (1985), Georgiev et al. (1986), Moravec (2001, 2013).

The dominant structure of the component helminth communities was determined according to the criteria proposed by Kennedy (1993) on the basis of the prevalence (P%): accidental (P%<10), component (10<P%<20) and core (P%>20) species.

The ecological terms prevalence, mean intensity are used, based on the terminology of Bush et al. (1997). Analyses of helminth community structure were carried out in both levels: infracommunity and component community.

The component data were used to determine the total number of species, Shannon diversity index (H'), Pielou evenness index (E), Berger-Parker dominance index (d) according to Magurran (2004).

The infracommunity data was used to calculate the mean number of species, the mean number of helminth specimens, Brillouin diversity index (HB) (Kennedy, 1993; 1997; Magurran, 2004).

RESULTS AND DISCUSSIONS

A total of 13 specimens of rudd (*Scardinius erythrophthalmus* (Linnaeus, 1758)) were collected and examined from the Maritsa River. *Scardinius erythrophthalmus* is estimated as least concern species (LC=Least Concern; IUCN Red List Status). Rudd is freshwater, brackish, benthopelagic, potamodromous fish species. *S. erythrophthalmus* inhabit mainly rich of nutrients, well-vegetated lowland rivers, backwaters, oxbows, ponds and lakes. This fish species feeds on plankton, terrestrial insects and plant material. Rudd can adapt to an unfavourable environmental condition (Fröse and Pauly, 2018).

Helminth parasites were recorded in 13 rudd specimens (100%) from the Maritsa River. Three species of parasites were identified: one cestode species (*Ligula intestinalis* (Linnaeus, 1758)), one acantocephalan (*Pomphorhynchus laevis* (Müller, 1776)) and one nematode species (*Rhabdochona denudata* (Dujardin, 1845) Raillet, 1916) (Table 1). All helminth species occurred as adults with the exception of *L. intestinalis*. *P. laevis* and *R. denudata* are autogenic species, matured in fish. *L. intestinalis* is allogenic species. The larval stages of *L. intestinalis* develop in the body cavity of carp fishes – *Abramis brama, A. sapa, S. erythrophtalmus, A. alburnus, A. bipunctatus, Gobio gobio, Rutilus rutilus, Barbus barbus, B. m. petenyi, Leuciscus cephalus, L. idus* and *Phoxinus phoxinus* (Kakacheva-Avramova, 1983).

In an adult state *L. intestinalis* parasitized in fish-eating birds, mainly gulls (*Larus*), less commonly in fish-eating ducks (*Bucephala* and *Mergus*) and in *Podiceps* (Kakacheva-Avramova, 1983).

In the component community of *Scardinius erythrophthalmus* from the Maritsa River *L. intestinalis* (P%=100), *P. laevis* (P%=61.54) and *R. denudata* (P%=30.77) are core species (Table 1).

In the component community of *Scardinius erythrophthalmus* from the Maritsa River cestodes are presented with the highest number of specimens, with 1 species and 38 specimens.

Table 1. Helminth parasites of *Scardinius erythrophthalmus* from Maritsa River (N – number of examined hosts, n– number of infected hosts, p – number of parasites, P – prevalence, MI – mean intensity, MA – mean abundance)

Helminth species	N=13					
	n	P	P%	MI±SD	MA±SD	Range
Ligula intestinalis (Linnaeus, 1758)	13	38	100	2.92±1.38	2.92±1.38	1-5
Pomphorhynchus laevis (Müller, 1776)	8	14	61.54	1.75±0.83	1.08±1.07	1-3
Rhabdochona denudata (Dujardin, 1845) Raillet, 1916	4	5	30.77	1.25±0.43	0.38±0.62	1-2

Acanthocephalans are presented with one species and 14 specimens. Nematodes are represented by one species and 5 specimens.

L. intestinalis was found in *Scardinius erythrophtalmus, Gobio gobio, Rutilus rutilus* and *Alburnus alburnus* from River Danube (Kakacheva-Avramova et al., 1978; Chunchukova et al., 2018). *L. intestinalis* was reported also as a parasite of *Alburnus alburnus* from Arda River (Maritsa Basin) (Kirin et al., 2002).

Ligula intestinalis (Diphyllobothriidae) is widely distributed cestode species with a complex life cycle, which involves a copepod as the first intermediate host, fish as a second intermediate host and an avian definitive host (Dubinina, 1980).

P. laevis was found in *S. erythrophtalmus* from Strumeshnitsa River and Danube River (Kakacheva-Avramova, 1962, 1977; Atanasov, 2012). For Maritsa River, *P. Laevis* was reported as a parasite of *Squalius cephalus* (*Leuciscus cephalus*) and *Esox lucius* (Kirin, 2000a; 2000b; 2001; 2006). *P. Laevis* was reported also as parasite of *Sq. cephalus* (*L. cephalus*) from Stryama River (Maritsa Basin) (Kirin et al., 2005).

Intermediate host of *P. laevis* is *Gamma ruspulex* and definitive hosts are fish most often from family Cyprinidae, and less often from families Salminidae, Percidae, Siluridae etc. (Kakacheva-Avramova, 1983). *G. pulex* is a bioindicator for β-mesosaprobity (Johnson et al., 1993).

Paratenic hosts of *P. laevis* are small fish of the family Cyprinidae (Kakacheva-Avramova, 1983). For Bulgaria *P. laevis* was also reported as parasite of Eurasian otter (*Lutra lutra*) originating from the vicinities of the village of Yunatsite (Pazardzhik Region) (Dimitrova et al., 2008). A village of Yunatsite is situated on the southern bank (right) of the Topolnitsa River, which is left tributary of the Maritsa River. Dimitrova et al. (2008) suggested that both postcyclic and paratenic transmission routes seem possible for the establishment of *P. laevis* as parasite of *L. lutra.*

Rhabdochona denudata is an intestinal parasite of many species of family Cyprinidae (Moravec, 2013). *R. denudata* was reported as a parasite of *S. erythrophthalmus* for river Strumeshnica, Lake Srebarna and Danube River (Kakacheva-Avramova, 1962; Shukerova and Kirin, 2008; Atanasov, 2012). For Maritsa River, *R. denudata* was reported as a parasite of *Squalius cephalus* (*Leuciscus cephalus*), *Vimba melanops* (Heckel, 1837), (*Vimba vimba melanops*), *Alburnus alburnus* and *Barbus cyclolepis* (Heckel, 1837) (*Barbus tauricus cyclolepis*) (Margaritov, 1965). *R. denudata* was reported also as parasite of *Sq. cephalus* from Chepelarska River, Arda River and Stryama River (all belong to Maritsa Basin) (Kirin, 2002; Kirin et al., 2002; Kirin et al., 2005). *R. denudata* was established as parasite of *A. alburnus* from Arda River (Maritsa Basin) (Kirin et al., 2002; Kirin, 2003).

Intermediate hosts of *R. denudata* are insect larvae: *Heptagenia* sp., *Ephemerella* sp. and *Hydropsyche* sp. (Bauer, 1987; Kakacheva-Avramova, 1983). Representatives of the genera *Heptagenia* and *Ephemerella* are bioindicators for β-mesosaprobity. *Hydropsyche* sp. Is bioindicator for 0-α-mesosaprobity (Johnson et al., 1993).

Moravec (2007) studied experimentally the life cycle of *R. denudata.* The author obtained encapsulated infective larvae of *R. Denudate* in mayfly nymphs *Habroleptoides modesta* and *Habrophlebia lauta.* Moravec (2013) suggested that in addition to mayflies also some other aquatic arthropods may serve as intermediate hosts of *R. denudata.*

Species richness in infracommunity of rudd ranges from 1 to 2species. With 1 helminth species was infected only one fish (7.69%; one rudd with 4 specimens of *L. intestinalis*), with 2 helminth species - 12 fishes (92.31%; 8 rudds (61.54%) - with *L. intestinalis* and *P. laevis*; 4 rudds (30.77%) - with *L. intestinalis* and *R. denudata*).

The largest number of helminth specimens established in a single host specimen is 8. The average species richness (mean number of species for a fish specimen) in infracommunityof rudd is 1.92 species (Table 2). Average abundance (mean number of helminths in fish) in these infracommunities is 4.38±1.68. The parasite communities of *S. erythrophthalmus* from the Maritsa River showed Brillouin diversity index, HB=0.762 (Table 2).

Table 2. Infracommunities of *S. erythrophthalmus* from Maritsa River

Scardinius erythrophthalmus	Number of endohelminth species			
	1	2	Mean±SD	Range
	1	12	1.92±0.27	1-2
Scardinius erythrophthalmus	Number of endohelminth specimens			
	Total number	Mean±SD	Range	Brillouin's index HB
	57	4.38±1.68	2-8	0.762

In general, the parasite communities of *S. erythrophthalmus* are represented by 3 species of parasites belonging to three classes, three orders, and three families. The total number of isolated and studied helminth specimens was 57. The obtained results were related to a Brillouin diversity index HB=0.762, Shannon diversity index H'=0.829, Berger-Parker dominance index d=0.667 and Pielou evenness index E=0.754 (Figure 1).

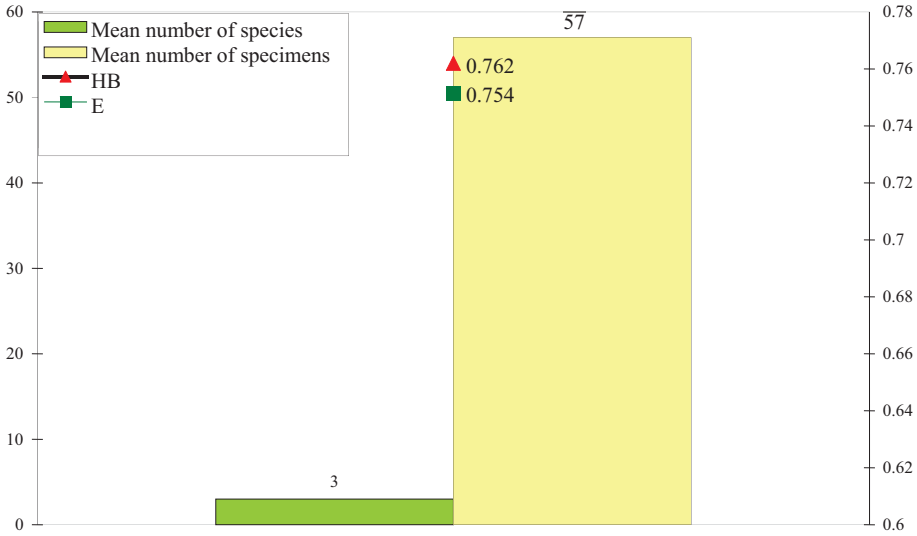

Figure 1. Biodiversity and ecological characteristics of the parasite communities of *Scardinius erythrophthalmus* (Linnaeus, 1758) from the freshwater ecosystem of the Maritsa River

The circulation of parasitic flow in the studied freshwater ecosystem can be represented as follows: class Cestoda: crustaceans - fish – birds (*Ligula intestinalis*); for class Acanthocephala: crustaceans - fish - fish (*Pomphorhynchus laevis*); Class Nematoda: insect larvae - fish (*Rhabdochona denudata*).

CONCLUSIONS

This study is the first that presents the rudd's (*Scardinius erythrophthalmus* (Linnaeus, 1758)) endohelminth species and structure of helminth communities from Maritsa River, Bulgaria. All of the established parasites are reported for the first time for *S. erythrophthalmus* from Maritsa River.

Helminth parasites were recorded in all 13 examined rudd specimens (100%) from the Maritsa River.

Three species of parasites were identified: one cestode species *Ligula intestinalis* (P%=100), one acantocephalan *Pomphorhynchus laevis* (P%=61.54) and one nematode species *Rhabdochona denudata* (P%=30.77).

All of the established parasites are core for the helminth communities of *S. erythrophthalmus* from Maritsa River.

The obtained results for the parasite communities are related to Brillouin diversity index HB=0.762 and Pielou evenness index E=0.754. The obtained results for the parasite communities and the bioindicative role of their intermediate hosts are demonstrating a favourable development of the studied freshwater ecosystem.

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