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Short Communication

Ecologohelmintological study of *Squalius cephalus* (Linnaeus, 1758) from the Danube River, Bulgaria

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Abstract: For 2019-2021, seven specimens of chub *Squalius cephalus* (Linnaeus, 1758) caught from the upper section of the Danube River in Bulgaria were examined for helminths. The studied habitat (Kudelin biotope) is a border section of the Danube River between Bulgaria, Serbia, and Romania. During the helminthological examination, seven helminth species were found – one trematode species (*Sphaerostoma bramae* (Müller, 1776) Lühe, 1909); one cestode species (*Caryophyllaeides fennica* (Schneider, 1902) Nybelin, 1922); two acanthocephalan species (*Acanthocephalus anguillae* (Müller, 1780) Lühe, 1911 and *Pomphorhynchus laevis* (Zoega in Müller, 1776) Porta, 1908); three nematode species (*Eustrongylides excisus* Jägerskiöld, 1909 (larvae); *Pseudocapillaria tomentosa* (Dujardin, 1845) Moravec, 1987 and *Rhabdochona denudata* (Dujardin, 1845) Railliet, 1916). Kudelin biotope is a new habitat for the seven endohelminth species of chub that were found. New data on the ecological indices (mean intensity, mean abundance, prevalence) of the endohelminths are provided. *Squalis cephalus* is a new host record for two of the found helminth species. Knowledge of the helminths and the ecological indices of helminths is important for protecting fish resources and human health.

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Introduction

Chub, *Squalius cephalus* (Linnaeus, 1758) is a freshwater, brackish, benthopelagic, predatory fish. Adult specimens consume insects, frogs, fish, and others for food; young specimens feed on algae and crustaceans. In Bulgaria, the species occurs in most rivers, including the Danube River; it also inhabits some dams. Chub is subject to sport fishing (Karapetkova and Zhivkov, 2006; Froese and Pauly, 2023). *Squalius cephalus* is included on the IUCN Red List in the "LC = Least Concern" (Freyhof and Brooks, 2011; IUCN, 2024).

The life cycles of the parasites occur with the participation of different fish species, which are their hosts (Amer, 2014). Parasites can be found in different food webs at different trophic levels, thus providing information about changes in the ecosystems. The absence of a host can affect the transmission of parasites along the food chain (Marcogliese, 2004, 2005). Different authors studied the parasite fauna of *S. cephalus* from the Danube River (Kakacheva-Avramova, 1977; Kakacheva-Avramova et al., 1978; Cakic et al., 2004; Atanasov, 2012; Reier et al., 2019) and the river basin (Kakacheva-Avramova, 1973; Margaritov, 1977; Nedeva-Menkova, 1977; Kakacheva-Avramova and Menkova, 1978; Oros and Hanzelová, 2009; Hanzelová et al., 2011; Djikanovic et al., 2011; Kuzmanova et al., 2019; Chunchukova et al., 2020). This study aims to provide new data on the endohelminths of chub from the Bulgarian section of the Danube River and on the ecological indices of the endohelminth species found there.

Materials and Methods

During the research period (2019-2021), seven specimens of chub were examined for the presence of parasites. The fish were caught from the border section of the Danube River, Northwestern Bulgaria, in the

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Table 1. Species diversity and ecological indices in the helminth community of *Squalius cephalus* from the Danube River (N – number of investigated fish; n – number of infected fish; p – number of fish helminths; MI – mean intensity; MA – mean abundance; P% – prevalence; R – range).

Squalius cephalus **(N = 7 / Kudelin)** **Helminth species**	**n**	**p**	**MI**	**MA**	**P%**	**R**
Sphaerostoma bramae (Müller, 1776) Lühe, 1909	1	1	1.00	0.14	14.29	1
Caryophyllaeides fennica (Schneider, 1902) Nybelin, 1922	2	5	2.50	0.71	28.57	1-4
Acanthocephalus anguillae (Müller, 1780) Lühe, 1911	1	1	1.00	0.14	14.29	1
Pomphorhynchus laevis (Zoega in Müller, 1776) Porta, 1908	2	6	3.00	0.86	28.57	1-5
Eustrongylides excisus Jägerskiöld, 1909 (larvae)	1	1	1.00	0.14	14.29	1
Pseudocapillaria tomentosa (Dujardin, 1845) Moravec, 1987	1	8	8.00	1.14	14.29	8
Rhabdochona denudata (Dujardin, 1845) Railliet, 1916	1	3	3.00	0.43	14.29	3

vicinity of the village of Kudelin (indicated as a biotope; 44°12'07.9"N 22°41'28.2"E). The studied biotope is 844 km along the Danube River (Fig. 1).

The fish were caught with net fishing devices based on a permit for research fishing issued by the Executive Agency for Fisheries and Aquaculture in Bulgaria. Fish samples were collected in two seasons: spring and autumn. The species of the caught specimens were identified based on Froese and Pauly (2023). Each *S. cephalus* specimen was measured and weighed. Basic metric data were recorded: total body length (TL) in centimeters, maximum body height (MH) in centimeters, and weight (BW) in grams. The mean values (Mean±SD) for TL, MH, and BW were 22.88±7.24 cm, 5.50±1.80 cm, and 175.17±153.66 g, respectively. This study, conducted on fish, conformed to national regulations for the use of animals.

The ecologohelminthological examination of the caught fish specimens was carried out according to standard methods (Zashev and Margaritov, 1966). The laboratory studies were done in the Department of Agroecology and Environmental Protection laboratory at the Agricultural University, Plovdiv. The ecological indices (mean intensity (MI), mean abundance (MA), prevalence (P%)) were calculated (Bush et al., 1997).

Results and Discussions

Helminths were found in 5 of 7 examined *S. cephalus*

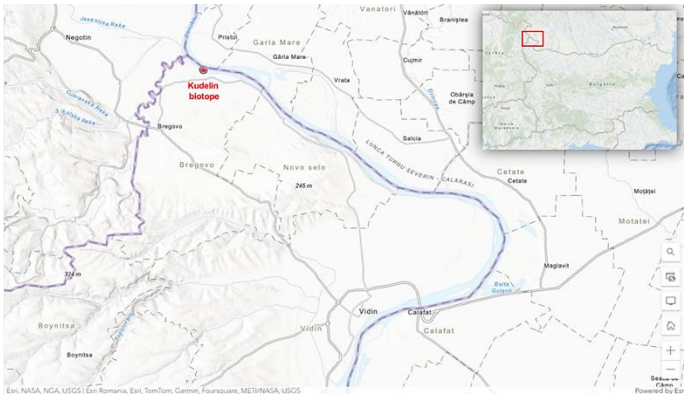

Figure 1. Kudelin biotope, Northwestern Bulgaria (ArcGIS Online).

specimens from the Kudelin biotope. Seven helminth species were discovered – *Sphaerostoma bramae* (class Trematoda); *Caryophyllaeides fennica* (class Cestoda); *Acanthocephalus anguillae*, *Pomphorhynchus laevis* (class Acanthocephala); *Eustrongylides excisus*, *Pseudocapillaria tomentosa*, and *Rhabdochona denudata* (class Nematoda). *Pseudocapillaria tomentosa* had the highest values for MI and MA. Two isolated helminth species (*C. fennica* and *P. laevis*) had the highest values for P%. The number of helminths in one specimen of chub varied from 1 to 8 (Table 1).

The present study reveals two species of endohelminths (*P. laevis*, and *E. excisus*) that threaten fish and endanger fish populations and one species (*E. excisus*) that poses a risk to human health. Intestinal damage and growth retardation were observed in fish infected with the acanthocephalan

Table 2. Species composition of helminths of *Squalius cephalus* from the Danube River and the river basin.

Helminths of *Squalius cephalus* from other works	**Danube River in other countries**	**Danube River Basin in other countries**	**Danube River in Bulgaria**	**Danube River Basin in Bulgaria**
Margaritov (1959)	-	-	-	*P. laevis*; *Acanthocephalus lucii* (Müller, 1776) Lühe, 1911; *Rh. denudata*
Bailozov et al. (1964)	-	-	-	*Ligula intestinalis* (Linnaeus, 1758) Gmelin, 1790
Kakacheva-Avramova (1969)	-	-	-	*Pseudochetosoma salmonicola* Dollfus, 1951; *Proteocephalus torulosus* (Batsch, 1786) Nufer, 1905; *Caryophyllaeus brachycollis* Janiszewska, 1953; *Caryophyllaeides fennica* (Schneider, 1902) Nybelin, 1922; *Ac. anquillae*; *Rh. denudata*; *Phylometra* sp.
Kakacheva-Avramova (1973)	-	-	-	*C. fennica*
Kakacheva-Avramova (1977)	-	-	*Apophallus muehlingi* (Jägerskiöld, 1899) Lühe, 1909 (metacercaria)	-
Margaritov (1977)	-	-	-	*C. fennica*; *Rh. denudata*
Nedeva-Menkova (1977)	-	-	-	*Nicolla skrjabini* (Iwanitzky, 1928) Dollfus, 1960
Kakacheva-Avramova and Menkova (1978)	-	-	-	*C. fennica*; *L. intestinalis*; *Pr. torulosus*; Cestoidea gen sp.; *Ac. anquillae*; *Acanthocephalus tenuirostris* (Achmerov & Dombrovskaja-Achmerova, 1941) Yamaguti, 1963; *Rh. denudata*
Kakacheva-Avramova et al. (1978)	-	-	*Ap. muehlingi* (metacercaria); *Metagonimus yokogawai* (Katsurada, 1912) Katsurada, 1912; *Ac. lucii*; *P. laevis*	-
Lucký and Král, 1983	-	*C. brachycollis*; *Nematoda* sp.	-	-
Moravec (1992)	-	*Allocreadium isoporum* (Looss, 1894) Looss, 1902	-	-
Gelnar et al. (1997)	-	*C. brachycollis*; *Philometra ovata* (Zeder, 1803); *Ac. anguillae*; *P. laevis*; *C. fennica*; *Asymphylodora imitans* (Mühling, 1898) Looss, 1899; *Sph. bramae*	-	-
Cojocaru (2003)	-	*C. brachycollis*	-	-
Cakic et al. (2004)	*All. isoporum*; *Sph. bramae*; *Rh. denudata*; *Raphidascaris acus* (Boch, 1779); *Schulmanela petruschewskii* (Shulman, 1948) Ivashkin, 1964; *Ph. ovata*; *Ac. lucii*; *Ac. anguillae*; *Neoechinorhynchus rutili* (Müller, 1780) Hamann in Stiles & Hassall, 1905; *P. laevis*; *L. intestinalis*; *Caryophyllaeus laticeps* (Pallas, 1781) Lühe, 1910; *C. brachycollis*; *C. fennica*; *Pr. torulosus*; *Cucullanus dogieli* Krotas, 1959	-	-	-
Oros and Hanzelová (2009); Hanzelová et al. (2011)	-	*Palaeorchis incognitus* Szidat, 1943; *Allocreadium markewitschi* Koval, 1949; *C. fennica*; *Pomphorhynchus tereticollis* (Rudolphi, 1809) Meyer, 1932	-	-

Table 2. To be continued.

Helminths of *Squalius cephalus* from other works	Danube River in other countries	Danube River Basin in other countries	Danube River in Bulgaria	Danube River Basin in Bulgaria
Djikanovic et al. (2011)	-	*All. isoporum*; *Allocreadium* sp.; *Sph. bramae*; *C. fennica*; *C. brachycollis*; *C. laticeps*; *Proteocephalus longicollis* (Zeder, 1800) Benedict, 1900; *Proteocephalus* sp.; *L. intestinalis*; *Rh. denudata*; *Ac. anguillae*; *P. laevis*	-	-
Atanasov (2012)	-	-	*Ps. salmonicola*; *P. laevis*; *Ph. ovata*; *Rh. denudata*	-
Kuzmanova et al. (2019)	-	-	-	*Ichthyocotylurus pileatus* (Rudolphi, 1802) Odening, 1969 (metacercaria); *C. brachycollis*; *Rh. denudata*
Reier et al. (2019)	*P. bosniacus*	-	-	-
Chunchukova et al. (2020)	-	-	-	*All. isoporum*; *Rh. denudata*; *Ac. lucii*; *L. intestinalis*

Table 3. Distribution of the found helminths (in the present study) of *Squalius cephalus* from the Danube River and its basin.

Studies / Endohelminth species	Present study	Danube River in other countries	Danube River Basin in other countries	Danube River in Bulgaria	Danube River Basin in Bulgaria
Sphaerostoma bramae	•	•	•		
Caryophyllaeides fennica	•	•	•		•
Acanthocephalus anguillae	•	•	•		•
Pomphorhynchus laevis	•	•	•	•	•
Eustrongylides excisus	•				
Pseudocapillaria tomentosa	•				
Rhabdochona denudata	•	•	•	•	•

P. laevis. Organ damage was found in fish infected with the nematode *E. excisus*, and intestinal perforation in humans (Novakov et al., 2015; Juhásová et al., 2019).

A number of authors have studied the parasite fauna of *S. cephalus* from the Danube River and the river basin on the territory of other countries and in Bulgaria (Table 2). Five of the helminths found in the chub of the present study were reported for the Danube River and the river basin on the territory of other countries (Cakic et al., 2004; Djikanovic et al., 2011). Two of the helminths found in chub in this study viz. *P. laevis* (Kakacheva-Avramova et al., 1978; Atanasov, 2012) and *Rh. denudata* (Atanasov, 2012) were reported for the Bulgarian section of the Danube River. Four helminth species viz. *C. fennica* (Kakacheva-Avramova, 1969, 1973; Margaritov, 1977; Kakacheva-Avramova and Menkova, 1978), *Ac. anguillae* (Kakacheva-Avramova, 1969; Kakacheva-Avramova and Menkova, 1978), *P. laevis* (Margaritov, 1959) and *Rh. denudata* (Margaritov, 1959, 1977; Kakacheva-Avramova, 1969; Kakacheva-Avramova and Menkova, 1978; Kuzmanova et al., 2019; Chunchukova et al., 2020) were reported for the Danube River basin in Bulgaria (Table 3).

Based on the helminthological examination of seven *S. cephalus* specimens from the Danube River (Kudelin, Northwestern Bulgaria), seven helminth species were found (*Sph. bramae*, *C. fennica*, *Ac. anguillae*, *P. laevis*, *E. excisus*, *Ps. tomentosa*, nad *Rh. denudata*). Kudelin biotope is a new habitat for the found endohelminths of chub. *Squalis cephalus* is a new host record for *E. excisus* and *Ps. tomentosa*. *E. excisus* and *Ps. tomentosa* are new to the chub helminth fauna from the Danube Basin.

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