FISHERIES & AQUATIC LIFE (2024) 32: 235 - 242
Archives of Polish Fisheries
DOI 10.2478/aopf-2024-0021

RESEARCH ARTICLE

Helminths and helminth communities of *Chondrostoma nasus* from the Danube River, northwestern Bulgaria

Radoslava G. Zaharieva, Diana A. Kirin, Petya G. Zaharieva

Received – 03 May 2023/Accepted – 29 April 2024. Published online: 30 December 2024; ©National Inland Fisheries Research Institute in Olsztyn, Poland
Citation: Zaharieva, R. G., Kirin, D. A., Zaharieva, P. G. (2024). Helminths and helminth communities of *Chondrostoma nasus* from the Danube River, northwestern Bulgaria. Fisheries & Aquatic Life 32, 235-242.

Abstract. In the 2019–2021 period, a total of 349 specimens of *Chondrostoma nasus* (L.) from the border zone of the Danube River (Kudelin, Koshava, and Yasen biotopes), in northwestern Bulgaria were subjected to interdisciplinary research. A total of 11 helminth taxa belonging to four classes (Trematoda, Cestoda, Acanthocephala, Nematoda) were identified. Two helminth species (*Pomphorhynchus laevis* and *Contracaecum* sp.) were common to common nase from the three biotopes studied. The helminth communities of the species at the level of the component communities and the infracommunities were analyzed for the first time in Bulgaria. Helminth species pathogenic to fishes and humans were found in the helminth communities of *Ch. nasus*.

Keywords: common nase, Danube border zone, ecological indices, endohelminth communities, endohelminth diversity

R.G. Zaharieva [✉], D.A. Kirin, P.G. Zaharieva
Hydrology and Water Management Research Center,
National Institute of Geophysics, Geodesy and Geography,
Bulgarian Academy of Sciences, Acad. G. Bonchev Str., bl. 3, 1113
Sofia, Bulgaria
E-mail: radoslava.zaharieva7@gmail.com

D.A. Kirin
Department of Agroecology and Environmental Protection,
Faculty of Plant Protection and Agroecology, Agricultural
University-Plovdiv, 12 Mendeleev Blvd., 4000 Plovdiv, Bulgaria

Introduction

The Danube River is characterized by extremely rich ichthyofauna (Ibănescu et al. 2020). In the Bulgarian section of the river, with a length of 470 km (Zarev et al. 2013), 44 fish species are found (Polačik et al. 2008). Fishing is one of the main livelihoods for the population living along the river (Nedić et al. 2018). Common nase, *Chondrostoma nasus* (Linnaeus, 1758) (Cyprinidae), is a gregarious, benthopelagic, freshwater fish. The species is found in sections of rivers where currents are moderate to fast. Common nase is a herbivorous species that feeds mainly on algae that it scrapes off stones. In Bulgaria, it is found in the Danube River and the rivers flowing into it (Karapetkova and Zhivkov 2006, Fröse and Pauly 2022). *Ch. nasus* is on the IUCN Red List with the category Least Concern (LC) and in Annex No. 3 of the Bern Convention (Freyhof and Brooks 2011, IUCN 2023). Common nase is among species targeted for sport fishing (Karapetkova and Zhivkov 2006). Parasites of fishes reflect the condition of the environment because their life cycles involve several hosts (Kirin 2014, Todorova-Traykova and Chunchukova 2018). Various authors have conducted studies on the species composition and diversity of parasites of freshwater fish species from the

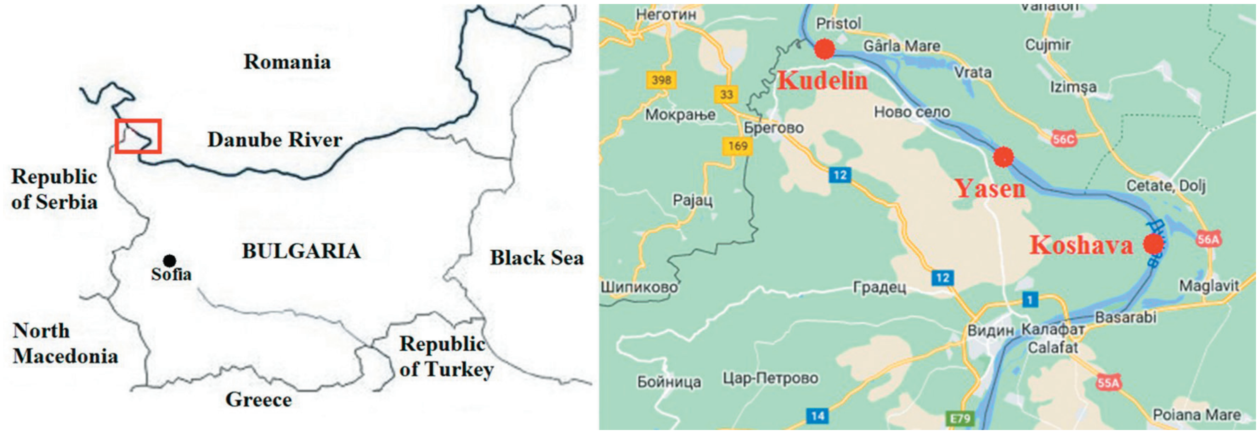

Figure 1. Location of the biotopes studied (Kudelin, Yasen, Koshava) along the Danube River (https://www.google.bg/maps/pla - ce/Видин).

Danube River in Bulgaria (Margaritov 1959, 1964, 1966, Kakacheva-Avramova 1976, 1977, Nedeva et al. 2003, Nachev and Sures 2009, Nachev 2010). Few authors have studied the helminths and helminth communities of fishes from the Bulgarian section of the Danube River (Chunchukova and Kirin 2017, 2018, 2020). Interdisciplinary research on common nase from the Bulgarian section of the river is rare (Kakacheva-Avramova et al. 1978, Atanasov 2012, Kirin et al. 2013). All this gives rise to the need for more scientific research on the helminths of common nase in Bulgaria.

The present study aimed to examine the helminth communities of common nase from the Kudelin biotope and to provide data on the species composition and ecological indices of the helminths of common nase from three biotopes (Kudelin, Koshava, and Yasen) in the Danube border zone in northwestern Bulgaria.

Materials and Methods

In the 2019–2021 period, a total of 349 specimens of common nase were caught in the vicinities of the villages of Kudelin, Koshava, and Yasen (indicated as biotopes) located in the border section of the Danube River in northwestern Bulgaria and were examined for helminths. The village of Kudelin is located at 844 river km (44°12’07.9" N 22°41’27.0" E); the village of Yasen at 825 river km (44°07’26.5" N 22°52’40.5" E); the village of Koshava at 807 river km (44°03’32.3" N 23°02’02.8" E) on the Danube River. The three biotopes are located on the right bank of the river and are in the Vidin District (Fig. 1).

The fish were caught under research catch requirements of the Ministry of Agriculture and the Executive Agency for Fisheries and Aquaculture. The fish were caught with gill nets specified in the permits issued and in accordance with BDS EN 14757:2015 Water quality - Sampling of fish with multi-mesh gillnets. The fish samples were collected during the spring, summer, and fall seasons. The fish species were identified according to Fröse and Pauly (2022). Metric data (total length (TL; in cm); maximum height (H; in cm); body weight (BW; in g)) were recorded for each common nase specimen (Zashev and Margaritov 1966, Karapetkova and Zhivkov 2006) (Table 1).

During the 2019–2021 period, a total of 349 specimens of common nase were collected from the three biotopes along the Danube River (298 specimens from Kudelin biotope; 42 specimens from Koshava biotope, and 9 specimens from Yasen biotope). All common nase specimens caught were examined for parasites.

The interdisciplinary examination of the *Ch. nasus* specimens caught was performed according to standard methods (Zashev and Margaritov 1966, Bauer 1987, Moravec 2013). Common nase helminth communities were examined at the levels of component communities and infracommunities. The

Table 1
Metric data (TL, H, BW) of the *Chondrostoma nasus* specimens examined

Danube River		TL (cm)	H (cm)	BW (g)
Chondrostoma nasus	min – max	9.7 – 39.6	2 – 9.8	5 – 792
N = 248	Mean ± SD	31.96 ± 4.02	7.13 ± 1.09	320.78 ± 109.04
Kudelin biotope				
Chondrostoma nasus	min – max	23 – 40.5	4.5 – 9.5	97 – 589
N = 42	Mean ± SD	29.91 ± 4.95	6.52 ± 1.30	244.98 ± 129.71
Koshava biotope				
Chondrostoma nasus	min – max	11.2 – 17	2.7 – 3.8	9 – 32
N = 9	Mean ± SD	14.47 ± 1.62	3.32 ± 0.33	20.33 ± 6.42
Yasen biotope				

component community was characterized by the ecological indices of mean intensity (MI), mean abundance (MA), and prevalence (P%) for each of the helminth species found (Bush et al. 1997):

(1) Mean intensity (MI) was calculated with the formula:

$$MI = \frac{p}{n}$$

where: p – number of parasites;
n – number of infected fish.

(2) Mean abundance (MA) was calculated with the formula:

$$MA = \frac{p}{N}$$

where: p – number of parasites;
N – number of fish examined.

(3) Prevalence (P%) was calculated with the formula:

$$P\% = \left(\frac{n}{N}\right) \times 100$$

where: n – number of infected fish;
N – number of fish examined.

According to the prevalence (P%), the parasite species are divided into core (P% > 20), component (10 < P% < 20), and accidental species (P% < 10) in the component communities of the hosts (Kennedy 1993).

The infracommunity was characterized by the indicators of total number of species, mean number of species, total number of specimens, mean number of specimens, Brillouin's diversity index (HB), Pielou's evenness index (E), and Simpson's dominance index (C) (Magurran 1988):

(4) Brillouin's diversity index (HB) was calculated with the formula:

$$HB = \frac{\ln N! - \sum \ln ni!}{N}$$

where: ni – number of specimens of each species (i = 1, 2, … S);
$N = \Sigma ni$ – total number of specimens;
S – total number of species.

(5) Pielou's evenness index (E) was calculated with the formula:

$$E = \frac{H}{\log_2 N}$$

where: H – the Shannon diversity index;
N – number of specimens.

(6) Simpson's dominance index (C) was calculated with the formula:

$$C = \sum \left(\frac{n_i}{N}\right)^2$$

where: ni – number of specimens in the ith species;
N – number of specimens of all species (total number).

Statistical data analysis was performed with MS Excel (Microsoft 2010), Statistica 10 (StatSoft Inc. 2011), and others.

Results

Structure of helminth communities

Interdisciplinary research of 298 specimens of *Ch. nasus* from Kudelin biotope revealed infection with 11 helminth species belonging to four classes: Trematoda (3 species – *Allocreadium isoporum* (Looss, 1894) Looss, 1902; *Nicolla skrjabini* (Iwanitzky, 1928) Dollfus, 1960; *Sphaerostoma bramae* (Müller, 1776) Lühe, 1909); Cestoda (2 species – *Proteocephalus torulosus* (Batsch, 1786) Nufer, 1905; *Schyzocotyle acheilognathi* (Yamaguti, 1934) Brabec, Waeschenbach, Scholz, Littlewood & Kuchta, 2015); Acanthocephala (2 species – *Acanthocephalus anguillae* (Müller, 1780) Lühe, 1911; *Pomphorhynchus laevis* (Zoega in Müller, 1776) Porta, 1908); Nematoda (4 species – *Contracaecum* sp.; *Hysterothylacium* sp.; *Pseudocapillaria tomentosa* (Dujardin, 1843) Moravec, 1987; *Raphidascaris acus* (Boch, 1779)). Forty-two specimens of *Ch. nasus* from Koshava biotope were examined that were infected with seven endohelminth species that were representatives of the classes of Trematoda (3 species – *All. isoporum*, *N. skrjabini*, *Sph. bramae*), Cestoda (1 species – *Sch. acheilognathi*), Acanthocephala (1 species – *P. laevis*) and Nematoda (2 species – *Contracaecum* sp., *R. acus*). During the examination of nine specimens *Ch. nasus* from Yasen biotope, two helminth species of the classes of Acanthocephala (*P. laevis*) and Nematoda (*Contracaecum* sp.) were found. Two helminth species (*P. laevis* and *Contracaecum* sp.) were common to common nase from the three biotopes studied (Kudelin, Koshava, and Yasen). Five helminth species (*All. isoporum*, *N. skrjabini*, *Sph. bramae*, *Sch. acheilognathi*, *R. acus*) were common to common nase from the Kudelin and Koshava biotopes. Four endohelminth species (*Pr. torulosus*, *Ac. anguillae*, *Hysterothylacium* sp., *Ps. tomentosa*) were found only in the Kudelin biotope.

Component community of Chondrostoma nasus from the Danube River

The component and infracommunity of common nase from the Danube River, Kudelin biotope (2019–2021) are presented since they are most representative of the sample. The largest number of specimens was nematodes (4 species with 7,521 specimens), followed by trematodes (3 species with 14 specimens), acanthocephalans, and cestodes (2 species with 7 specimens each). One core species (*Contracaecum* sp.) was in the component community of common nase from the Danube River (Kudelin biotope). The remaining 10 species were accidental helminth species in the helminth community of *Ch. nasus* (with P < 10%). The nematode *Contracaecum* sp. had the highest mean intensity, mean abundance, and prevalence (Table 2).

Contracaecum sp. is an allochthonous species while the remaining 10 helminth species are autochthonous species of endohelminth communities of common nase from the freshwater ecosystem of the Danube River.

Infracommunity of *Chondrostoma nasus* from the Danube River, Kudelin biotope

Two hundred and ninety-eight specimens of common nase from the Danube River (Kudelin biotope) were collected and examined for helminths, and infection was established at 262 specimens (87.92%). Two hundred and forty-one common nase specimens (80.87%) were infected with one helminth species; 19 specimens (6.38%) were infected with two helminth species; and two specimens (0.67%) were infected with three helminth species. The helminth infracommunities in single common nase specimens ranged from 1 to 315. A total of 7,549 helminth specimens were studied. Low indices of diversity and evenness were determined, which were explained by the extremely high number of one species (*Contracaecum* sp.). The dominance index was high (Table 3).

Table 2
Species diversity and ecological indices in the component community of *Chondrostoma nasus* (N = 298) from the Danube River, Kudelin biotope (N – number of fish examined; n – number of infected fish; p – number of fish parasites; MI – mean intensity; MA – mean abundance; P% – prevalence)

Helminth species	n	p	MI ± SD	MA ± SD	P% ± SD	Range
Allocreadium isoporum (Looss, 1894) Looss, 1902	1	1	1.00	0.003	0.34	1
Nicolla skrjabini (Iwanitzky, 1928) Dollfus, 1960	6	8	1.33 ± 0.28	0.03 ± 0.02	2.01 ± 1.61	1–2
Sphaerostoma bramae (Müller, 1776) Lühe, 1909	4	5	1.25 ± 0.26	0.02 ± 0.03	1.34 ± 2.35	1–2
Proteocephalus torulosus (Batsch, 1786) Nufer, 1905	2	3	1.50 ± 0.57	0.01 ± 0.02	0.67 ± 1.19	1–2
Schyzocotyle acheilognathi (Yamaguti, 1934) Brabec, Waeschenbach, Scholz, Littlewood & Kuchta, 2015	2	4	2.00 ± 0.38	0.01 ± 0.02	0.67 ± 0.85	2
Acanthocephalus anguillae (Müller, 1780) Lühe, 1911	1	1	1.00	0.003	0.34	1
Pomphorhynchus laevis (Zoega in Müller, 1776) Porta, 1908	6	6	1.00 ± 0.57	0.02 ± 0.01	2.01 ± 14.13	1
Contracaecum sp. (larvae)	256	7,496	29.28 ± 16.20	25.15 ± 13.88	85.91 ± 8.07	1–315
Hysterothylacium sp. (larvae)	1	3	3.00 ± 0.57	0.01 ± 0.01	0.34 ± 4.27	3
Pseudocapillaria tomentosa (Dujardin, 1843) Moravec, 1987	1	2	2.00 ± 0.38	0.01 ± 0.006	0.34 ± 0.85	2
Raphidascaris acus (Boch, 1779) (larvae)	5	20	4.00 ± 1.39	0.07 ± 0.53	1.68 ± 2.29	1–8

Table 3
Infracommunity of *Chondrostoma nasus* from the Danube River, Kudelin biotope

	Number of parasite species			
	0	1	2	3
Number of *Chondrostoma nasus* specimens	36	241	19	2
Total number of species (Mean number of species ± SD)	11 (1.75 ± 1.5)			
Total number of specimens (Mean number of specimens ± SD)	7,549 (76.25 ± 110.40)			
Range	1–315			
Brillouin's diversity index (HB)	0.05 ± 0.07			
Pielou's evenness index (E)	0.02 ± 0.03			
Simpson's dominance index (C)	0.98 ± 0.02			

The main ecological indices of the helminths of common nase caught in the Danube River Koshava and Yasen biotopes for the 2019–2021 period were tracked. In the present study of 42 specimens of *Ch. nasus* from the Koshava biotope, seven helminth taxa were found. *Contracaecum* sp. had the highest ecological indices, followed by *R. acus*. The lowest ecological indices were found for three endohelminth species – *N. skrjabini*, *Sph. bramae*, and *P. laevis*. During the interdisciplinary examination of nine specimens of *Ch. nasus* from the Yasen biotope, infections with two helminth taxa were found. Again, the nematode *Contracaecum* sp. had a higher mean intensity, mean abundance, and prevalence (Table 4).

Table 4
Species diversity and ecological indices in the component community of *Chondrostoma nasus* from the Danube River, Koshava and Yasen biotopes (N – number of fish examined; n – number of infected fish; p – number of fish parasites; MI – mean intensity; MA – mean abundance; P% – prevalence)

Helminth species	n	p	MI	MA	P%	Range
Chondrostoma nasus Koshava (N = 42)						
Allocreadium isoporum (Looss, 1894) Looss, 1902	3	3	1.00	0.07	7.14	1
Nicolla skrjabini (Iwanitzky, 1928) Dollfus, 1960	1	1	1.00	0.02	2.38	1
Sphaerostoma bramae (Müller, 1776) Lühe, 1909	1	1	1.00	0.02	2.38	1
Schyzocotyle acheilognathi (Yamaguti, 1934) Brabec, Waeschenbach, Scholz, Littlewood & Kuchta, 2015	3	7	2.33	0.17	7.14	1–4
Pomphorhynchus laevis (Zoega in Müller, 1776) Porta, 1908	1	1	1.00	0.02	2.38	1
Contracaecum sp. (larvae)	20	202	10.10	4.81	47.62	1–85
Raphidascaris acus (Boch, 1779) (larvae)	10	60	6.00	1.43	23.81	1–19
Chondrostoma nasus Yasen (N = 9)						
Pomphorhynchus laevis (Zoega in Müller, 1776) Porta, 1908	1	1	1.00	0.11	11.11	1
Contracaecum sp. (larvae)	2	3	1.50	0.33	22.22	1–2

The ecological indices (MI, MA, and P%) of the common endohelminth species noted (*P. laevis* and *Contracaecum* sp.) in common nase from the Kudelin, Koshava, and Yasen biotopes were compared. *Contracaecum* sp. had the highest ecological indices in the helminth communities of *Ch. nasus* from the three biotopes. The highest values for MI, MA, and P% of *Contracaecum* sp. were reported in Kudelin biotope, followed by the Koshava and Yasen biotopes.

Discussion

The interdisciplinary research of 349 specimens *Ch. nasus* revealed a total of 11 helminth species, of which four are pathogenic to fish and one species to humans. *Sch. acheilognathi* and *P. laevis* are pathogenic species to fishes, causing the diseases botryocephalosis and pomphorhynchosis, respectively (Novakov et al. 2015), and *R. acus* is also pathogenic to fish (Zashev and Margaritov 1966). Larvae of *Contracaecum* sp. are pathogenic to fish and humans, causing the disease anisakidosis in humans (Zashev and Margaritov 1966, Demir and Karakişi 2014).

Few authors have studied the helminths and helminth communities of common nase from the Danube River and its basin in other countries. The cestode *Pr. torulosus* and cestode cysts were reported in common nase from the Serbian section of the Danube River (Đikanović et al. 2013), as were *Caryophyllaeus laticeps* (Pallas, 1781) Lühe, 1910 and *P. laevis* in common nase from the Austrian section of the river (Jirsa et al. 2011).

Studies of helminths in common nase from the Bulgarian section of the Danube River and its basin are few. The acanthocephalan *P. laevis* was reported in common nase from the Danube River (Kakacheva-Avramova et al. 1978) and in common nase from the Ogosta River and the Nishava River (Kakacheva-Avramova 1969). *Pseudochetosoma salmonicola* Dollfus, 1951 and *C. laticeps* were reported in common nase from the Danube River (Atanasov 2012). Kirin et al. (2013) examined the presence of helminths in common nase specimens from the lower section of the Danube River in Bulgaria (Vetren), but they did not detect infection.

Ch. nasus is a new host for ten of the helminth taxa found (*All. isoporum*, *N. skrjabini*, *Sph. bramae*, *Pr. torulosus*, *Sch. acheilognathi*, *Ac. anguillae*, *Contracaecum* sp., *Hysterothylacium* sp., *Ps. tomentosa*, and *R. acus*) in Bulgaria. *Sch.*

acheilognathi is a new species for the Bulgarian section of the Danube River. The Kudelin, Koshava, and Yasen biotopes are new habitats for the helminths of *Ch. nasus* found in the present study.

Due to the presence of pathogenic helminth species, it is recommended to conduct systematic studies on helminths and helminth communities of common nase from Bulgaria.

Acknowledgments. This article was written in connection with the development of a PhD thesis at the Department of Agroecology and Environmental Protection at the Agricultural University – Plovdiv. We also thank the leadership of the Centre of Research, Technology Transfer, and Protection of Intellectual Property Rights at the Agricultural University – Plovdiv for financial support.

Author contributions. R.G.Z., D.A.K., P.G.Z.: Investigation, Samples Collection, Data Processing, Writing Manuscript. All authors approved the final version of the manuscript.

ORCID iD

Diana A. Kirin https://orcid.org/0000-0002-9543-7816

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