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Fish helminths in Lithuanian inner waters

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During the present investigation, 23 species of fish in Lithuanian inner waters were examined for helminth parasites. Of these, 63 taxa of helminths – 56 taxa of Plathyhelminthes, five of Nematoda, and two of Acanthocephales – were found. Monogenea *Gyrodactylus truttae* was registered in Lithuania for the first time. Metacercariae of flukes *Diplostomum* sp., *Posthodiplostomum cuticula*, and *Tylodelphys clavata* were found in the highest number of host species: 16, 11, and 12, respectively. A generalized linear mixed model (GLMM) shows that six cyprinid species – *Rutilus rutilus, Scardinius erythrophthalmus*, *Leuciscus leuciscus, Squalius cephalus*, *Blicca bjoerkna,* and *Abramis brama* – have greater probability of infection with *Diplostomum* sp. metacercariae. The GLMM also shows that the random effect (the type of Lithuanian inner water body) was statistically significant. Differences in the prevalence of infection with *Diplostomum* sp., *P. cuticula*, and *T. clavata* metacercariae in different water body types were established for some fish species.

Keywords: helminths, fish, inner waters, Lithuania

INTRODUCTION

There are far more kinds of parasitic than non-parasitic organisms in the world and parasites may be one of the factors that regulate host populations (Roberts, Janovy, 2008). Parasitic diseases decrease fish growth rate and fertility, influence development of anomaly, decrease the quality of fish meat, and can cause mass death of fish. Manifestation of parasites can be different. Infected by digestive tract parasites, fish cannot assimilate a great part of nutrients and become exhausted. Parasites of the digestive tract, gill, and skin cause mechanical injuries with their attachment organs sometimes leading to necrosis. Sites of injuries are a favourable medium for bacteria and fungi, which cause infectious diseases. Gill lamella hypertrophy, tumour formation, tissue injuries, and emergence of haemorrhages caused by monogenean infestation lead to a decrease of the respiratory surface and fish death because of hypoxia or anaemia. In aquaculture, diseases are among the most serious threats to commercial success (Noga, 2010). All these facts make the study of fish helminths relevant.

In Lithuania, investigation into fish helminths started at the beginning of the twentieth century. In 1909, Wegener studied helminths and other parasites in the Curonian Lagoon. Later, Szidat (1926, 1944) studied fish parasites in the Curonian Lagoon. In the Soviet period, a number of researchers studied fish parasites in natural water

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bodies and aquacultures: Sabina Gecevičiūtė, Rostislavas Krotas, S. A. Paškevičiūtė, Edvardas Rauckis, Vytautas Kemėža, A. D. Žaliūnienė, V. V. Marazas, V. A. Dogel, G. K. Petrushevskij, E. A. Bogdanova, B. E. Kazakov, E. N. Protasova, V. A. Rojtman, D. G. Tsejtlin, D. Kh. Khussein, A. A. Shigin and others. The bibliography of these works can be found in Rauckis's (1988) book in which the author provided an overview of fish parasites in Lithuania. Vytautas Oškinis (1993) studied fish helminths in the Lake Drūkšiai. The following researchers studied fish parasites in the Curonian Lagoon and the coastal region of the Baltic Sea: Stankus (1996), Bacevičius (2002, 2003, 2004, 2009), Bacevičius and Karalius (2008), Rakauskas et al. (2008), and Bagdonas et al. (2011). Bacevičius (2003) provided an overview of the studies on fish parasites in the Curonian Lagoon and the costal region of the Baltic Sea. Pilecka-Rapacz and Kesminas (2006) investigated the occurrence and intensity of the nematode *Anguillicola crassus* infection in eels in Lake Dringis. Rakauskas and Blaževičius (2009, 2010) studied parasites of the roach (*Rutilus rutilus*).

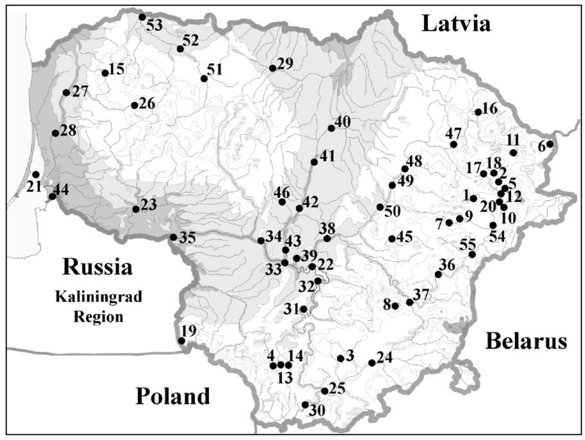

Figure. Study sites of fish helminths in Lithuania. Lakes: 1 – Aisetas, 2 – Baluošas, 3 – Didžiulis (Daugai), 4 – Dusia, 5 – Dringis, 6 – Drūkšiai, 7 – Galuonai, 8 – Galvė, 9 – Kertuojai, 10 – Kretuonas, 11 – Luodis, 12 – Lūšiai, 13 – Metelys, 14 – Obelija, 15 – Plateliai, 16 – Sartai, 17 – Tauragnas, 18 – Utenas, 19 – Vištytis, 20 – Žeimenys; 21 – Curonian Lagoon; 22 – Kaunas hydropower plant reservoir; Rivers: 23 – Jūra under Tauragė, 24 – Merkys under Valkininkai, 25 – Merkys under Merkinė, 26 – Minija under Žarėnai, 27 – Minija under Kartena, 28 – Minija under Gargždai, 29 – Mūša under Kulpė, 30 – Nemunas under Druskininkai, 31 – Nemunas under Prienai, 32 – Nemunas under Piliuona, 33 – Nemunas under Kaunas, 34 – Nemunas under Vilkija, 35 – Nemunas under Jurbarkas, 36 – Neris under Nemenčinė, 37 – Neris under Vilnius, 38 – Neris under Jonava, 39 – Neris at Kaunas confluence, 40 – Nevėžis under Panevėžys, 41 – Nevėžis under Krekenava, 42 – Nevėžis under Kėdainiai, 43 – Nevėžis under Babtai, 44 – Skirvytė under Rusnė, 45 – Širvinta under Širvintos, 46 – Šušvė under Josvainiai, 47 – Šventoji under Užpaliai, 48 – Šventoji under Anykščiai, 49 – Šventoji under Kovarskas, 50 – Šventoji under Ukmergė, 51 – Venta under Kuršėnai, 52 – Venta under Venta, 53 – Venta under Mažeikiai, 54 – Žeimena under Švenčionėliai, 55 – Žeimena under Pabradė

However, the composition of helminths may have undergone changes over time. The aim of the present study is to investigate helminths of freshwater fish in Lithuanian inner waters.

MATERIALS AND METHODS

Fish were sampled from June to November 2005 using electro-fishing and fyke nets at 55 study sites in 20 lakes, the Kaunas Hydroelectric Power Plant reservoir, the Curonian Lagoon and 13 different rivers (Figure). In total, 947 individuals of 23 fish species were examined for helminths:ten brown trouts *Salmo trutta* morpha *fario* L., 1758, two European whitefish *Coregonus lavaretus* (L., 1758), two vendaces *Coregonus albula* (L., 1758), 193 Northern pikes *Esox Lucius* L., 1758, 217 roaches *Rutilus rutilus* (L., 1758), 41 chubs *Squalius cephalus* (L., 1758), 42 common daces *Leuciscus leuciscus* (L., 1758), 140 rudds *Scardinius erythrophthalmus* (L., 1758), five belicas *Leucaspius delineatus* (Heckel, 1843), 28 tenches *Tinca tinca* (L., 1758), four gudgeons *Gobio gobio* (L., 1758), three bleaks *Alburnus alburnus* (L., 1758), 37 white breams *Blicca bjoerkna* (L., 1758), 16 freshwater breams *Abramis brama* (L., 1758), four vimba breams *Vimba vimba* (L., 1758), 12 crucian carps *Carassius carassius* (L., 1758), ten Prussian carps *Carassius gibelio* (Bloch, 1782), five stone loaches *Barbatula barbatula* (L., 1758), four weatherfish *Misgurnus fossilis* (L., 1758), five burbots *Lota lota* (L., 1758), 29 ruffes *Gymnocephalus cernua* (L., 1758), 132 European perches *Perca fluviatilis* L., 1758, and six bullheads *Cottus gobio* L., 1758.

Lithuanian water bodies are divided into lakes, rivers, and the Curonian Lagoon; the Kaunas Hydroelectric Power Plant reservoir was considered as part of the Nemunas River. Fish distribution in different types of Lithuanian water bodies in samples for helminthological studies is provided in Table 1.

Before necropsy, fish were killed by severing the spinal cord. Skin, fins, gills, mouth cavity, eyes, and viscera (intestine, mesentery, gall-bladder, gonads, liver, and kidney) were examined under a stereomicroscope following conventional methods described by Bykhovskaya-Pavlovskaya (1969).

Helminths were identified to the lowest possible taxa according to fish parasite keys (Bauer, 1985, 1987). Helminths were identified to the taxonomical level of species or at

Table 1. **Fish distribution in different types of Lithuanian water bodies in sample for helminthological studies**

	Fish species	Lakes		Rivers		Curonian Lagoon		Total number
		Number	%	Number	%	Number	%	
1.	*Salmo trutta* morpha *fario*	0	0.0	10	100.0	0	0.0	10
2.	*Coregonus lavaretus*	2	100.0	0	0.0	0	0.0	2
3.	*Coregonus albula*	2	100.0	0	0.0	0	0.0	2
4.	*Esox lucius*	15	7.8	178	92.2	0	0.0	193
5.	*Rutilus rutilus*	44	20.3	168	77.4	5	2.3	217
6.	*Squalius cephalus*	0	0.0	41	100.0	0	0.0	41
7.	*Leuciscus leuciscus*	0	0.0	42	100.0	0	0.0	42
8.	*Scardinius erythrophthalmus*	85	60.7	55	39.3	0	0.0	140
9.	*Leucaspius delineatus*	0	0.0	5	100.0	0	0.0	5
10.	*Tinca tinca*	21	75.0	7	25.0	0	0.0	28
11	*Gobio gobio*	0	0.0	4	100.0	0	0.0	4
12.	*Alburnus alburnus*	0	0.0	3	100.0	0	0.0	3
13.	*Blicca bjoerkna*	32	86.5	5	13.5	0	0.0	37
14.	*Abramis brama*	16	100.0	0	0.0	0	0.0	16
15.	*Vimba vimba*	0	0.0	4	100.0	0	0.0	4
16.	*Carassius carassius*	7	58.3	5	41.7	0	0.0	12
17.	*Carassius gibelio*	1	10.0	9	90.0	0	0.0	10
18.	*Barbatula barbatula*	0	0.0	5	100.0	0	0.0	5
19.	*Misgurnus fossilis*	0	0.0	4	100.0	0	0.0	4
20.	*Lota lota*	1	20.0	4	80.0	0	0.0	5
21.	*Gymnocephalus cernua*	21	72.4	8	27.6	0	0.0	29
22.	*Perca fluviatilis*	60	45.5	61	46.2	11	8.3	132
23.	*Cottus gobio*	0	0.0	6	100.0	0	0.0	6
	Total number	307	–	624	–	16	–	947

least genus. A small number of nematodes were not identified.

Helminthological terms were used according to the recommendations of Bush et al. (1997). The 95% confidence intervals for prevalence were calculated as described by Rojtman and Lobanov (1985).

A generalized linear mixed model (GLMM) with negative binomial distribution and a log link was used to model particular helminth abundance data in 23 fish species. The GLMM was performed using IBM SPSS Statistics, version 20. Fish species was used as fixed effects and the type of Lithuanian inner water (lake, river or the Curonian Lagoon) was used as random effects. The primary statistical analysis using non-parametric χ^2 criteria shows that it is possible to create a GLMM for just three helminths (*Diplostomum* sp. metacercariae, *Posthodiplostomum cuticola* (Nordmann, 1832) metacercariae, *Tylodelphys clavata* (Nordmann, 1832) metacercariae).

RESULTS AND DISCUSSION

In two examined *C. lavaretus*, two *C. albula*, four *G. gobio*, and five *B. barbatula*, no helminths were found. The examined fish of all other species were infected with helminths (Table 2). Sixty-three taxa of helminths were found. The largest number of helminth taxa was found in predatory fish *E. lucius* and *P. fluviatilis*, 20 and 18, respectively. A relatively high number of helminth taxa was also found in abundant cyprinids *R. rutilus* and *S. erythrophthalmus*, 15 and 17, respectively. From two to 11 helminth taxa were found in fish of other species.

Helminths of three phyla were found: 56 taxa of Plathyhelminthes (17 Trematoda, 27 Monogenea, 12 Cestoda), five Nematoda, and two Acanthocephales. Monogenea was the most diverse taxon of the class rank.

Host numbers varied among the found helminths. Metacercariae of flukes *Diplostomum* sp., *P. cuticola* and *T. clavata* were found in the biggest number of host species; 16, 11, and 12, respectively. All other helminths were found in hosts of 1–7 species.

All helminths identified to species taxonomic level, except *Gyrodactylus truttae* Glaser, 1974, had already been found in Lithuania and mentioned by Rauckis (1988). Fluke *Rhipidocotyle campanula* (Dujardin, 1845) was mentioned by Rauckis (1988) under the name of *Rhipidocotyle illense* (Ziegler, 1883). Tapeworm *Neogryporhynchus cheilancristrotus* (Wedl, 1855) was mentioned by Rauckis (1988) under the name of *Gryporhynchus cheilancristrotus* (Wedl, 1855). *Valipora campylocristrota* (Wedl, 1855) was registered by Rauckis (1988) under the name of *Valipora unilateralis* (Rudolphi, 1819) Spasssky 1965.

Fluke *Bucephalus polymorphus* Baer, 1827 is a widespread fish parasite in Eurasia. The adult stage of this fluke parasitises predatory fish. The first intermediate host of the parasite is bivalve molluscs of the genera *Unio*, *Anodonta* and also *Dreissena polymorpha* (Pallas, 1771), metacercariae are found in different fish, mostly in cyprinids (Bykhovskaya-Pavlovskaya, Kulakova, 1987; Rauckis, 1988). In this study, *B. polymorphus* were found in *E. lucius*, *R. rutilus*, *S. cephalus* and *P. fluviatilis*.

Fluke *R. campanula* is a widespread fish parasite in Eurasia (Bykhovskaya-Pavlovskaya, Kulakova, 1987; Rauckis, 1988). The adult stages of the species parasitise predatory fish. The first intermediate host is bivalves (Rauckis, 1988), metacercariae are found in different fish, mostly in cyprinids (Bykhovskaya-Pavlovskaya, Kulakova, 1987). In this study, fluke *R. campanula* was found in *E. lucius*.

Phyllodistomum folium (Olfers, 1816) was found in fish of three species, *E. lucius*, *R. rutilus*, and *P. fluviatilis*. Intermediate hosts of the genus *Phyllodistomum* flukes are molluscs of the *Anodonta* and *Dreissena* genus and the Spheridae family (Rauckis, 1988). For the genus *Phyllodistomum*, encystment of cercariae inside sporocysts in an intermediate host is typical (Shultz, Gvozdev, 1972). *P. folium* is a characteristic parasite of *E. lucius*, yet it is found in other fish as well and its distribution coincides with the distribution of *E. lucius* in the Northern hemisphere (Bykhovskaya-Pavlovskaya, Kulakova, 1987).

Table 2. **Freshwater fish infection with helminths in 2005 in Lithuania. A±SD – mean abundance ± standard deviation; P (%) (CI95%) – prevalence (95% confidence interval)**

			1	2	3	4	5	6	7	8	9	10
	Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
Number of hosts examined			10	193	217	41	42	140	5	28	3	37
Number of helminth taxa in host species			4	20	15	5	5	17	2	7	2	9
PLATHYHELMINTES												
Trematoda												
1. *Bucephalus polymorphus* Baer, 1827	4	A±SD		0.01±0.10	0.2±2.3	0.3±1.5						
		E(%) (CI95%)		1.0 (0.1–2.9)	1.4 (0.3–3.4)	7.3 (1.5–17.1)						
2. *Rhipidocotyle campanula* (Dujardin, 1845)	1	A±SD		5.3±31.4								
		E(%) (CI95%)		12.4 (8.2–17.4)								
3. *Phyllodistomum folium* (Olfers, 1816)	3	A±SD		0.01±0.14	0.02±0.34							
		E(%) (CI95%)		0.5 (0.0–2.0)	0.5 (0.0–1.8)							
4. *Asymphylodora imitans* (Mühling, 1898)	1	A±SD										
		E(%) (CI95%)										

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
5.	*Asymphylodora tincae* (Modeer, 1790)	2	A±SD			0.06±0.57					5.3±8.8		
			E(%)			1.4					32.1		
			(CI95%)			(0.3–3.4)					16.4–50.3)		
6.	*Palaeorchis incognitus* Szidat, 1943	2	A±SD			0.005±0.068	0.07±0.35						
			E(%)			0.5	4.9						
			(CI95%)			(0.0–1.8)	(0.5–13.5)						
7.	*Bunodera luciopercae* (Müller, 1776)	2	A±SD		0.8±6.3								
			E(%)		3.6								
			(CI95%)		(1.5–6.7)								
8.	*Plagioporus* sp.	1	A±SD										
			E(%)										
			(CI95%)										
9.	*Sphaerostomum bramae* (Müller, 1776)	1	A±SD			0.005±0.068							
			E(%)			0.5							
			(CI95%)			(0.0–1.8)							
10.	*Azygia lucii* (Müller, 1776)	2	A±SD		0.005±0.07								
			E(%)		0.5								
			(CI95%)		(0.0–2.0)								
11.	*Ichthyocotylurus pileatus* (Rudolphi, 1802) metacercariae	2	A±SD		0.02±0.22								
			E(%)		0.5								
			(CI95%)		(0.0–2.0)								

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
12.	*Ichthyocotylurus platycephalus* (Creplin, 1825) metacercariae	1	A±SD						0.06±0.50				
			E(%) (CI95%)						2.1 (0.4–5.2)				
13.	*Ichthyocotylurus variegatus* (Creplin, 1825) metacercariae	3	A±SD						0.03±0.24				
			E(%) (CI95%)						1.4 (0.1–4.0)				
14.	*Ichthyocotylurus* sp. metacercariae	1	A±SD										
			E(%) (CI95%)										
15.	*Diplostomum* sp. metacercariae	16	A±SD	0.3±0.7	0.4±1.2	5.6±7.9	3.0±6.7	5.2±8.2	4.8±11.4		0.4±1.4	3.7±6.4	16.1±11.5
			E(%) (CI95%)	20.0 (2.2–49.4)	20.2 (14.9–26.1)	72.4 (66.2–78.1)	46.3 (31.5–61.5)	61.9 (46.9–75.8)	62.1 (54.0–70.0)		14.3 (4.0–29.4)	33.3 (0.2–85.6)	94.6 (85.1–99.5)
16.	*Posthodiplostomum cuticola* (Nordmann, 1832) metacercariae	11	A±SD		3.3±7.4	1.5±5.2	0.12±0.78	4.0±10.7	2.5±7.9	3.2±2.2	0.2±0.9		1.4±2.3
			E(%) (CI95%)		21.8 (16.2–27.8)	30.4 (24.5–36.7)	2.4 (0.0–9.3)	31.0 (18.0–45.6)	25.0 (18.2–32.5)	80.0 (38.9–99.9)	3.6 (0.0–13.4)		32.4 (18.5–48.2)
17.	*Tylodelphys clavata* (Nordmann, 1832) metacercariae	12	A±SD		0.02±0.16	0.5±2.3	0.5±1.3		3.0±7.7	1.6±0.9	0.04±0.19		1.5±6.4

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
			E(%)		1.0	10.6	12.2		30.7	100.0	3.6		16.2
			(CI95%)		(0.1–2.9)	(6.9–15.0)	(4.1–23.8)		(23.4–38.6)	(54.9–100.0)	(0.0–13.4)		(6.3–29.6)
Monogenea													
18.	*Dactylogyrus amphibothrium* Wagener, 1857	1	A±SD										
			E(%)										
			(CI95%)										
19.	*Dactylogyrus cornu* Linstow, 1878	1	A±SD										
			E(%)										
			(CI95%)										
20.	*Dactylogyrus crucifer* Wagener, 1857	2	A±SD			0.6±4.0							2.0±10.6
			E(%)			6.0							5.4
			(CI95%)			(3.2–9.5)							(0.5–14.9)
21.	*Dactylogyrus difformis* Wagener, 1857	2	A±SD						0.06±0.33				0.6±1.6
			E(%)						2.9				16.2
			(CI95%)						(0.8–6.2)				(6.3–29.6)
22.	*Dactylogyrus falcatus* (Wedl, 1857)	1	A±SD										
			E(%)										
			(CI95%)										
23.	*Dactylogyrus formosus* Kulwiec, 1927	1	A±SD										
			E(%)										
			(CI95%)										

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
24.	*Dactylogyrus intermedius* Wegener, 1909	1	A±SD										
			E(%) (CI95%)										
25.	*Dactylogyrus sphyrna* Linstow, 1878	4	A±SD			0.08±0.50			0.02±0.15				0.05±0.33
			E(%) (CI95%)			2.8 (1.0–5.4)			2.1 (0.4–5.2)				2.7 (0.0 10.3)
26.	*Dactylogyrus tincae* Gussev, 1965	1	A±SD								0.04±0.19		
			E(%) (CI95%)								3.6 (0.0–13.4)		
27.	*Dactylogyrus tuba* Linstow, 1878	1	A±SD					0.1±0.6					
			E(%) (CI95%)					4.8 (0.5–13.2)					
28.	*Dactylogyrus wegeneri* Kulwiec, 1927	1	A±SD										
			E(%) (CI95%)										
29.	*Dactylogyrus* sp.	1	A±SD										
			E(%) (CI95%)										
30.	*Ancyrocephalus percae* Ergens, 1966	1	A±SD										
			E(%) (CI95%)										

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
31.	*Tetraonchus monenteron* (Wagener, 1857)	1	A±SD		0.6±2.6								
			E(%) (CI95%)		16.1 (11.2–21.6)								
32.	*Tetraonchus* sp.	1	A±SD	0.1±0.1									
			E(%) (CI95%)	10.0 (0.0–35.5									
33.	*Gyrodactylus carassii* Malmberg, 1957	1	A±SD										
			E(%) (CI95%)										
34.	*Gyrodactylus cernuae* Malmberg, 1957	1	A±SD										
			E(%) (CI95%)										
35.	*Gyrodactylus gasterostei* Gläser, 1974	1	A±SD										
			E(%) (CI95%)										
36.	*Gyrodactylus lotae* Gussev, 1953	1	A±SD										
			E(%) (CI95%)										
37.	*Gyrodactylus lucii* Kulakowskaja, 1952	1	A±SD		0.4±1.4								
			E(%) (CI95%)		21.2 (15.8–27.3)								

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius eryth-rophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
38.	*Gyrodactylus prostae* Ergens, 1963	2	A±SD			0.03±0.18		0.02±0.15					
			E(%) (CI95%)			3.2 (1.3–6.0)		2.4 (0.0–9.1)					
39.	*Gyrodactylus tincae* Malmberg, 1957	1	A±SD								0.2±0.5		
			E(%) (CI95%)								10.7 (2.2–24.6)		
40.	*Gyrodactylus truttae* Glaser, 1974	1	A±SD	0.1±0.1									
			E(%) (CI95%)	10.0 (0.0–35.5									
41.	*Gyrodactylus vimbi* Shulman, 1954	1	A±SD						0.007±0.085				
			E(%) (CI95%)						0.7 (0.0–2.8)				
42.	*Diplozoon paradox-um* von Nordmann, 1832	4	A±SD						0.007±0.085				0.2±0.9
			E(%) (CI95%)						0.7 (0.0–2.8)				8.1 (1.6–18.9)
43.	*Paradiplozoon bliccae* (Reichenbach–Klinke, 1961)	2	A±SD						0.2±1.4				0.1±0.5
			E(%) (CI95%)						5.0 (2.0–9.2)				5.4 (0.5–14.9)
44.	*Paradiplozoon homoion* subsp. *homoion* (Bychowsky & Nagibina, 1959)	2	A±SD			0.2±0.9		0.02±0.15					

Table 2. **(Continued)**

			1	2	3	4	5	6	7	8	9	10
	Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
		E(%) (CI95%)			8.3 (5.0–12.3)		2.4 (0.0–9.1)					
Cestoda												
45. *Caryophyllaeus laticeps* (Pallas, 1781)	1	A±SD										
		E(%) (CI95%)										
46. *Caryophyllaeus fimbriceps* Annenkova-Chlopina, 1919	1	A±SD						0.01±0.17				
		E(%) (CI95%)						0.7 (0.0–2.8)				
47. *Triaenophorus nodulosus* (Pallas, 1781) adults	2	A±SD		0.4±1.3								
		E(%) (CI95%)		11.4 (7.3–16.3)								
T. nodulosus plerocercoides	1	A±SD		0.2±0.7								
		E(%) (CI95%)		6.7 (3.6–10.7)								
48. *Ligula intestinalis* (Linnaeus, 1758)	2	A±SD			0.009±0.096							0.05±0.23
		E(%) (CI95%)			0.9 (0.1–2.6)							5.4 (0.5–14.9)
49. *Proteocephalus cernuae* (Gmelin, 1790)	1	A±SD										
		E(%) (CI95%)										

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
50.	*Proteocephalus esocis* (Schneider, 1905)	1	A±SD		0.6±2.7								
			E(%) (CI95%)		10.4 (6.5–15.0)								
51.	*Proteocephalus percae* (Müller, 1780)	2	A±SD		0.6±2.7								
			E(%) (CI95%)		10.4 (6.5–15.0)								
52.	*Proteocephalus sagittus* (Grimm, 1872)	1	A±SD										
			E(%) (CI95%)										
53.	*Proteocephalus torulosus* (Batsch, 1786)	3	A±SD						0.09±0.71			0.7±1.2	
			E(%) (CI95%)						2.1 (0.4–5.2)			33.3 (0.2–85.6)	
54.	*Neogryporhynchus cheilancristrotus* (Wedl, 1855)	5	A±SD						0.07±0.62		0.04±0.19		
			E(%) (CI95%)						2.1 (0.4–5.2)		3.6 (0.0–13.4		
55.	*Valipora campylancristrota* (Wedl, 1855)	1	A±SD		0.1±1.0								
			E(%) (CI95%)		2.1 (0.5–4.6)								
56.	*Valipora* sp.	1	A±SD		0.01±0.14								
			E(%) (CI95%)		0.5 (0.0–2.0)								
NEMATODA													

Table 2. **(Continued)**

				1	2	3	4	5	6	7	8	9	10
		Number of host species		*Salmo trutta morpha fario*	*Esox lucius*	*Rutilus rutilus*	*Squalius cephalus*	*Leuciscus leuciscus*	*Scardinius erythrophthalmus*	*Leucaspius delineatus*	*Tinca tinca*	*Alburnus alburnus*	*Blicca bjoerkna*
57.	*Raphidascaris acus* (Bloch, 1779)	1	A±SD		0.1±0.8								
			E(%) (CI95%)		3.1 (1.1–6.0)								
58.	*Desmidocercella* sp.	3	A±SD			0.4±2.4			0.2±2.8				
			E(%) (CI95%)			6.0 (3.2–9.5)			0.7 (0.0–2.8)				
59.	*Camallanus lacustris* (Zoega, 1776)	3	A±SD		0.03±0.24				0.1±1.3				
			E(%) (CI95%)		1.6 (0.3–3.8)				0.7 (0.0–2.1)				
60.	*Skrjabillanus scardinii* Molnár, 1966	1	A±SD						0.02±0.25				
			E(%) (CI95%)						0.7 (0.0–2.8)				
61.	*Nematoda* spp.	7	A±SD	0.1±0.1	0.02±0.12	0.02±0.18							
			E(%) (CI95%)	10.0 (0.0–35.5	1.6 (0.3–3.8)	1.8 (0.5–4.1)							
ACANTHOCEPHALES													
62.	*Neoechinorhynchus rutili* (Müller, 1780)	1	A±SD						0.007±0.085				
			E(%) (CI95%)						0.7 (0.0–2.8)				
63.	*Acanthocephalus lucii* (Müller, 1776)	5	A±SD		0.1±0.9								
			E(%) (CI95%)		1.6 (0.3–3.8)								
				1.	2.	3.	4.	5.	6.	7.	8.	9.	10.

Table 2. **(Continuation)**

		11.	12.	13.	14.	15.	16.	17.	18.	19.
		Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
Number of host examined		16	4	12	10	4	5	29	132	6
Number of helminths taxons in host species		11	4	4	4	3	3	10	18	2
PLATHYHELMINTES										
Trematoda										
1. *Bucephalus polymorphus* Baer, 1827	A±SD								0.8±5.2	
	E(%) (CI95%)								2.3 (0.4–5.5)	
2. *Rhipidocotyle campanula* (Dujardin, 1845)	A±SD									
	E(%) (CI95%)									
3. *Phyllodistomum folium* (Olfers, 1816)	A±SD								0.008±0.087	
	E(%) (CI95%)								0.8 (0.0–2.9)	
4. *Asymphylodora imitans* (Mühling, 1898)	A±SD	0.06±0.25								
	E(%) (CI95%)	6.3 (0.0–22.8)								
5. *Asymphylodora tincae* (Modeer, 1790)	A±SD									
	E(%) (CI95%)									

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
6.	*Palaeorchis incognitus* Szidat, 1943	A±SD									
		E(%) (CI95%)									
7.	*Bunodera luciopercae* (Müller, 1776)	A±SD								0.2±0.7	
		E(%) (CI95%)								5.3 (2.1–9.8)	
8.	*Plagioporus* sp.	A±SD									4.5±7.1
		E(%) (CI95%)									33.3 (4.6–72.2)
9.	*Sphaerostomum bramae* (Müller, 1776)	A±SD									
		E(%) (CI95%)									
10.	*Azygia lucii* (Müller, 1776)	A±SD								0.03±0.21	
		E(%) (CI95%)								2.3 (0.4–5.5)	
11.	*Ichthyocotylurus pileatus* (Rudolphi, 1802) metacercariae	A±SD								0.2±2.3	
		E(%) (CI95%)								2.3 (0.4–5.5)	
12.	*Ichthyocotylurus platycephalus* (Creplin, 1825) metacercariae	A±SD									
		E(%) (CI95%)									
13.	*Ichthyocotylurus variegatus* (Creplin, 1825) metacercariae	A±SD							5.6±25.7	1.1±9.2	

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
		E(%) (CI95%)							17.2 (5.9–32.8)	9.1 (4.8–14.6)	
14.	*Ichthyocotylurus* sp. metacercariae	A±SD								0.1±1.1	
		E(%) (CI95%)								0.8 (0.0–2.9)	
15.	*Diplostomum* sp. metacercariae	A±SD	13.3±12.8	5.3±7.5	1.3±1.5	0.7±1.2		7.2±7.6	2.5±3.9	0.4±1.4	
		E(%) (CI95%)	81.3 (59.2–95.9)	50.0 (8.5–91.5)	58.3 (30.6–83.5)	30.0 (7.1–60.3)		60.0 (18.7–94.0)	62.1 (44.0–78.6)	15.2 (9.6–21.7)	
16.	*Posthodiplostomum cuticola* (Nordmann, 1832) metacercariae	A±SD	4.9±10.1						3.8±7.8	2.9±9.6	
		E(%) (CI95%)	43.8 (21.1–67.8)						24.1 (10.6–41.1)	17.4 (11.5–24.3)	
17.	*Tylodelphys clavata* (Nordmann, 1832) metacercariae	A±SD	4.2±13.2	1.3±1.9			2.3±1.5		1.7±7.0	3.4±15.7	
		E(%) (CI95%)	25.0 (7.6–48.3)	50.0 (8.5–91.5)			75.0 (28.0–99.9)		6.9 (0.7–18.7)	18.9 (12.7–26.0)	
Monogenea											
18.	*Dactylogyrus amphibothrium* Wagener, 1857	A±SD							1.2±2.4		
		E(%) (CI95%)							27.6 (13.1–45.0)		
19.	*Dactylogyrus cornu* Linstow, 1878	A±SD		11.8±16.5							

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
		E(%) (CI95%)		50.0 (8.5–91.5)							
20.	*Dactylogyrus crucifer* Wagener, 1857	A±SD									
		E(%) (CI95%)									
21.	*Dactylogyrus difformis* Wagener, 1857	A±SD									
		E(%) (CI95%)									
22.	*Dactylogyrus falcatus* (Wedl, 1857)	A±SD	0.5±1.5								
		E(%) (CI95%)	12.5 (1.3–32.5)								
23.	*Dactylogyrus formosus* Kulwiec, 1927	A±SD				36.2±94.6					
		E(%) (CI95%)				30.0 (7.1–60.3)					
24.	*Dactylogyrus intermedius* Wegener, 1909	A±SD			0.4±0.9						
		E(%) (CI95%)			25.0 (5.7–52.1)						
25.	*Dactylogyrus sphyrna* Linstow, 1878	A±SD	0.9±3.5								
		E(%) (CI95%)	6.3 (0.0–22.8)								
26.	*Dactylogyrus tincae* Gussev, 1965	A±SD									
		E(%) (CI95%)									
27.	*Dactylogyrus tuba* Linstow, 1878	A±SD									

Table 2. **(Continuation)**

			11. *Abramis brama*	12. *Vimba vimba*	13. *Carassius carassius*	14. *Carassius gibelio*	15. *Misgurnus fossilis*	16. *Lota lota*	17. *Gymnocephalus cernua*	18. *Perca fluviatilis*	19. *Cottus gobio*
		E(%) (CI95%)									
28.	*Dactylogyrus wegeneri* Kulwiec, 1927	A±SD				0.2±0.6					
		E(%) (CI95%)				10.0 (0.0–34.9)					
29.	*Dactylogyrus* sp.	A±SD								0.008±0.087	
		E(%) (CI95%)								0.8 (0.0–2.9)	
30.	*Ancyrocephalus percae* Ergens, 1966	A±SD								0.2±1.0	
		E(%) (CI95%)								7.6 (3.7–12.7)	
31.	*Tetraonchus monenteron* (Wagener, 1857)	A±SD									
		E(%) (CI95%)									
32.	*Tetraonchus* sp.	A±SD									
		E(%) (CI95%)									
33.	*Gyrodactylus carassii* Malmberg, 1957	A±SD				0.3±0.7					
		E(%) (CI95%)				20.0 (2.3–48.8)					
34.	*Gyrodactylus cernuae* Malmberg, 1957	A±SD							0.07±0.26		
		E(%) (CI95%)							6.9 (0.7–18.7)		
35.	*Gyrodactylus gasterostei* Gläser, 1974	A±SD								0.008±0.087	
		E(%) (CI95%)								0.8 (0.0–2.9)	

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
36.	*Gyrodactylus lotae* Gussev, 1953	A±SD						0.6±1.3			
		E(%) (CI95%)						20.0 (0.1–61.5)			
37.	*Gyrodactylus lucii* Kulakowskaja, 1952	A±SD									
		E(%) (CI95%)									
38.	*Gyrodactylus prostae* Ergens, 1963	A±SD									
		E(%) (CI95%)									
39.	*Gyrodactylus tincae* Malmberg, 1957	A±SD									
		E(%) (CI95%)									
40.	*Gyrodactylus truttae* Glaser, 1974	A±SD									
		E(%) (CI95%)									
41.	*Gyrodactylus vimbi* Shulman, 1954	A±SD									
		E(%) (CI95%)									
42.	*Diplozoon paradoxum* von Nordmann, 1832	A±SD	0.06±0.25	3.0±4.1							
		E(%) (CI95%)	6.3 (0.0–22.8	75.0 (28.0–99.9)							
43.	*Paradiplozoon bliccae* (Reichenbach-Klinke, 1961)	A±SD									
		E(%) (CI95%)									

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
44.	*Paradiplozoon homoion* subsp. *homoion* (Bychowsky & Nagibina, 1959)	A±SD									
		E(%) (CI95%)									
Cestoda											
45.	*Caryophyllaeus laticeps* (Pallas, 1781)	A±SD	1.3±5.3								
		E(%) (CI95%)	6.3 (0.0–22.8								
46.	*Caryophyllaeus fimbriceps* Annenkova-Chlopina, 1919	A±SD									
		E(%) (CI95%)									
47.	*Triaenophorus nodulosus* (Pallas, 1781) adults	A±SD								0.03±0.35	
		E(%) (CI95%)								0.8 (0.0–2.9)	
	T. nodulosus plerocercoides	A±SD									
		E(%) (CI95%)									
48.	*Ligula intestinalis* (Linnaeus, 1758)	A±SD									
		E(%) (CI95%)									
49.	*Proteocephalus cernuae* (Gmelin, 1790)	A±SD							0.3±0.9		

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
50.		E(%) (CI95%)							13.8 (3.9–28.4)		
	Proteocephalus esocis (Schneider, 1905)	A±SD									
		E(%) (CI95%)									
51.	*Proteocephalus percae* (Müller, 1780)	A±SD								0.4±3.8	
		E(%) (CI95%)								2.3 (0.4–5.5)	
52.	*Proteocephalus sagittus* (Grimm, 1872)	A±SD					0.8±1.0				
		E(%) (CI95%)					50.0 (8.5–91.5)				
53.	*Proteocephalus torulosus* (Batsch, 1786)	A±SD	0.5±2.0								
		E(%) (CI95%)	6.3 (0.0–22.8								
54.	*Neogryporhynchus cheilancristrotus* (Wedl, 1855)	A±SD	0.2±0.8		2.0±6.0				0.4±2.4		
		E(%) (CI95%)	6.3 (0.0–22.8		25.0 (5.7–52.1)				3.4 (0.0–13.0)		
55.	*Valipora campylancristrota* (Wedl, 1855)	A±SD									
		E(%) (CI95%)									
56.	*Valipora* sp.	A±SD									
		E(%) (CI95%)									
NEMATODA											

Table 2. **(Continuation)**

			11.	12.	13.	14.	15.	16.	17.	18.	19.
			Abramis brama	*Vimba vimba*	*Carassius carassius*	*Carassius gibelio*	*Misgurnus fossilis*	*Lota lota*	*Gymnocephalus cernua*	*Perca fluviatilis*	*Cottus gobio*
57.	*Raphidascaris acus* (Bloch, 1779)	A±SD									
		E(%) (CI95%)									
58.	*Desmidocercella* sp.	A±SD								0.5±1.7	
		E(%) (CI95%)								7.6 (3.7–12.7)	
59.	*Camallanus lacustris* (Zoega, 1776)	A±SD								0.2±1.0	
		E(%) (CI95%)								4.5 (1.7–8.7)	
60.	*Skrjabillanus scardinii* Molnár, 1966	A±SD									
		E(%) (CI95%)									
61.	*Nematoda* spp.	A±SD			0.4±1.2		0.3±0.5		0.1±0.6		0.2±0.4
		E(%) (CI95%)			16.7 (1.9–41.8)		25.0 (0.1–72.0)		6.9 (0.7–18.7)		16.7 (0.0–53.5)
ACANTHOCEPHALES											
62.	*Neoechinorhynchus rutili* (Müller, 1780)	A±SD									
		E(%) (CI95%)									
63.	*Acanthocephalus lucii* (Müller, 1776)	A±SD	0.5±1.2					7.6±17.0	0.1±0.6	0.2±0.9	
		E(%) (CI95%)	18.8 (4.1–40.8)					20.0 (0.1–61.5)	3.4 (0.0–13.0)	6.1 (2.6–10.7)	
			11.	12.	13.	14.	15.	16.	17.	18.	19.

Two species of the genus *Asymphylodora* were found. Fluke *Asymphylodora imitans* (Mühling, 1898) was found in the intestines of *A. brama*. *Asymphylodora tincae* (Modeer, 1790) was found in the intestines of *R. rutilus* and *T. tinca*. Intermediate hosts of flukes of the genus *Asymphylodora* are molluscs of *Bithynia, Radix* and other genera (Rauckis, 1988). The metacercarial stage is absent in the life cycle of *A. tincae* and the definitive host becomes directly infected after the ingestion of snails harbouring rediae with mature cercariae (Našincová & Scholz 1994). The distribution of *A. tincae* coincides with the distribution of *T. tinca*, yet this parasite is also found in others host species (Bykhovskaya-Pavlovskaya, Kulakova, 1987). *A. imitans* is found in basins of the Baltic, Black, Azov and Caspian seas (Bykhovskaya-Pavlovskaya, Kulakova, 1987).

Palaeorchis incognitus Szidat, 1943 was found in two species of fish, *R. rutilus* and *S. cephalus*. Intermediate hosts of flukes of the genus *Palaeorchis* are molluscs of *Bithynia* genus. These flukes parasitise mainly cyprinids. *P. incognitus* is distributed in the basins of the Baltic, Black, and Azov seas (Rauckis, 1988; Bykhovskaya-Pavlovskaya, Kulakova, 1987). Snails *Bithynia* are the intermediate hosts of the genus *Palaeorchis* (Rauckis 1988).

Bunodera luciopercae (Müller, 1776) was found in *E. lucius* and *P. fluviatilis*. It is a widespread parasite in Eurasia and North America. Nuclear ribosomal DNA studies revealed possible existence of a cryptic species complex within the nominal species *B. luciopercae* (Petkevičiūtė et al., 2010). The first intermediate hosts of this fluke are clams of the genera *Sphaerium* and *Pisidium*, the second intermediate hosts are *Bosmina*, *Chydorus*, *Daphnia*, *Simocephalus*, *Eurycercus*, *Notodroma*, and others (Bykhovskaya-Pavlovskaya, Kulakova, 1987; Ieshko, 1988; Rauckis, 1988). Planktivorous fish are infected by eating the second intermediate hosts. Predatory fish can be infected by eating planktivorous fish. Because of cannibalism, in *P. fluviatilis* population fluke *B. luciopercae* is transferred from one size-age group to another (Ieshko, 1988). In Lithuania, two subspecies of the fluke are found: *B. luciopercae luciopercae* (Müller, 1776) and *B. luciopercae acerinae* Rojtman et Sokolov, 1999 (Sokolov et al., 2006).

Plagioporus sp. was found in two of the six studied specimens of *C. gobio*. According to Rauckis (1988), two species of this genus are found in Lithuania: *Plagioporus angusticolle* (Hausmamm, 1899) and *Plagioporus occidentalis* Szidat, 1944. For some species of the *Plagioporus* genus, e.g. *P. sinitsini* Mueller, 1934, there are three potential pathways: a three-host life cycle involving molluscan, arthropod, and piscine hosts, a two-host life cycle involving only molluscan and piscine hosts, and a one-host life cycle involving only the snail host (Barger, Esch, 2000).

Fluke *Sphaerostomum bramae* (Müller, 1776) was found in *R. rutilus*. The definitive hosts of the flukes of the genus *Sphaerostomum* are cyprinids, but they are also found in fishes of other families (Zhokhov, 2002). The first intermediate host of *S. bramae* is mollusc *Bithynia tentaculata* and the second is leech *Herpobdella* (Bykhovskaya-Pavlovskaya, Kulakova, 1987). The range of *S. bramae* covers Europe (except for Scandinavia) and Western Siberia to the River Ob basin inclusive. Its northern boundary extends from the Ob Bay to lakes Onega and Ladoga. The southern boundary in Europe lies between the Greater and Lesser Caucasus. In Asia, it extends along the Emba and Irgiz rivers to Lake Zaisan and then ascends to the Verkhne-Chulymskie lakes in the Altai piedmonts (Zhokhov, 2002).

Fluke *Azygia lucii* (Müller, 1776) was found in predatory fish, *E. lucius* and *P. fluviatilis*. The main definitive host of this fluke is *E. lucius*, but it is also found in other fish. The range of the fluke coincides with the range of *E. lucius* (Bykhovskaya-Pavlovskaya, Kulakova, 1987). Intermediate hosts of fluke *A. lucii* are molluscs *Anisus vortex*, *Radix ovata*, *Galba palustris*, *Planorbis planorbis*, *Gyraulus acronicus* (Barskaya et al., 2008; Shultz, Gvozdev, 1972). Cercariae of this fluke are similar to larvae of Culicidae and are eaten by fry. In *E. lucius*, they develop into adult flukes; in fish that are not definitive hosts, they develop to metacercariae and reach maturity when these fish are eaten by *E. lucius* (Shultz, Gvozdev, 1972).

Metacercariae of three species of the genus *Ichthyocotylurus* were found. *Ichthyocotylurus pileatus* (Rudolphi, 1802) metacercariae were found in *E. lucius*, *Ichthyocotylurus platycephalus* (Creplin, 1825) metacercariae were found in *S. erythrophthalmus*, and *Ichthyocotylurus variegatus* (Creplin, 1825) metacercariae were found in fish of three species: *S. erythrophthalmus*, *G. cernua* and *P. fluviatilis*. Metacercariae of the genus *Ichthyocotylurus* not identified to the species level were found in *P. fluviatilis*. The first intermediate hosts of flukes of the genus *Ichthyocotylurus* are molluscs of Valvatidae (Rauckis, 1988). Metacercariae are found in fish. The definitive hosts of these flukes are piscivorous birds (Rauckis, 1988; Niewiadomska, 2001b).

Diplostomum sp. metacercariae were found in eye lens of 16 fish species: *S. trutta* morpha *fario*, *E. lucius*, *R. rutilus*, *S. cephalus*, *L. leuciscus*, *S. erythrophthalmus*, *T. tinca*, *A. alburnus*, *B. bjoerkna*, *A. brama*, *V. vimba*, *C. carassius*, *C. gibelio*, *L. lota*, *G. cernua* and *P. fluviatilis*. Systematics of the genus *Diplostomum* is still debated; species identification based only on morphology is complicated and molecular studies revealed a high level of species diversity (Niewiadomska, Laskowski, 2002; Galazzo et al., 2002; Locke et al., 2010a, b; Haarder et al., 2013). Because of this, we did not identify these metacercariae to the species level. Eyeflukes of the genus *Diplostoma* have three host life cycles. Definitive hosts are piscivorous birds. The first intermediate hosts are freshwater snails. In the case of *Diplostomum spaethaceum*, one of the species in which metacercariae are found in fish eye lens, the first intermediate hosts are limneids. Fish are the second intermediate hosts (Shultz, Gvozdev, 1972). Eyeflukes can be pathogenic to the fish host and cause poor growth, blindness, and, in certain situations, mass mortality in aquaculture of salmonids and cyprinids (Chappell et al., 1994).

The GLMM shows that six cyprinid species – *R. rutilus*, *S. erythrophthalmus*, *L. leuciscus*, *S. cephalus*, *B. bjoerkna*, and *A. brama* – have greater probability of infection with *Diplostomum* sp. metacercariae (or have a positive statistical significant impact ($p < 0.05$) on the parasite appearance) (Table 3). In these cyprinids, high infection prevalence and mean abundance values were identified; the highest values were registered in *B. bjoerkna* (Table 2). In order to determine the homogeneity of infection prevalence in the six selected fish species (*R. rutilus*, *S. erythrophthalmus*, *L. leuciscus*, *S. cephalus*, *B. bjoerkna* and *A. brama*), a non-parametric χ^2 test was performed. The obtained results ($\chi^2 = 37.106$, $p = 0.00$) showed that there were statistically significant infection prevalence differences.

In addition, the GLMM shows that the random effect (the type of Lithuanian inner water) is also statistically significant at 0.05 level

Table 3. **GLMM parameters for *Diplostomum* sp. metacercariae**

Model term	Coefficient	SE	*t*	*p*	95% confidence interval	
					Lower	Upper
Intercept	–0.881	1.011	–0.872	0.384	–2.867	1.105
Rutilus rutilus	2.327	0.842	2.763	0.006	0.672	3.981
Scardinius erythrophthalmus	2.143	0.843	2.543	0.011	0.487	3.799
Leuciscus leuciscus	2.474	0.848	2.917	0.004	0.808	4.140
Squalius cephalus	1.818	0.825	2.205	0.028	0.198	3.439
Blicca bjoerkna	3.435	0.884	3.884	0.000	1.697	5.172
Abramis brama	3.397	0.951	3.573	0.000	1.529	5.264
Salmo trutta morpha *fario*	0.000a					
Negative Binomial	2.110					

[a] This coefficient is set to be zero because it is redundant.

(Table 4). Different water body types differ in the structure of fish community, and infection parameters of some species are different in different water body types. Based on the data in Table 1, the homogeneity of the distribution of the six selected fish species (*R. rutilus*, *S. erythrophthalmus*, *L. leuciscus*, *S. cephalus*, *B. bjoerkna* and *A. brama*) in types of water bodies was evaluated using a non-parametric χ^2 test. The obtained results (χ^2 = 189.173, p = 0.000) showed that there was a statistically significant difference between fish distribution in Lithuanian inner water body types. This can be related with various habitat preferences of different fish species (Virbickas, 2000).

Differences of the prevalence of infection with *Diplostomum* sp. metacercariae in different types of water bodies were assessed using χ^2 test. For some fish, species prevalence differences are significant, e.g., *S. erythrophthalmus* and *B. bjoerkna* (Table 5). Higher prevalence of infection in *S. erythrophthalmus* in rivers compared to lakes was ascertained. Prevalence in *B. bjoerkna* was higher in lakes.

P. cuticola metacercariae were found in skin and fins of 11 fish species: *E. lucius*, *R. rutilus*,

Table 4. **GLMM random effect for *Diplostomum* sp. metacercariae**

Random Effect	Estimate	SE	Z	*p*	95% confidence interval	
					Lower	Upper
Intercept	0.321[a]					
Type of inner water	0.500	0.198	2.520	0.012	1.697	5.172

[a] This parameter is redundant.

Table 5. **Infection with *Diplostomum* sp. metacercariae in fish in different types of water bodies in Lithuania in 2005. N – number of fish studied; P(%) – prevalence, *p* – asymptotic significance level (2-sided)**

	Fish species	Lakes		Rivers		Curonian Lagoon		Total		*p*
		N	P (%)	N	P (%)	N	P (%)	N	P (%)	
1.	*Salmo trutta* morpha *fario*	0	–	10	20.0	0	–	10	20.0	–
2.	*Esox lucius*	15	20.0	178	20.2	0	–	193	20.2	0.983
3.	*Rutilus rutilus*	44	79.5	168	70.8	5	60.0	217	72.4	0.425
4.	*Squalius cephalus*	0	–	41	46.3	0	–	41	46.3	–
5.	*Leuciscus leuciscus*	0	–	42	61.9	0	–	42	61.9	–
6.	*Scardinius erythrophthalmus*	85	55.3	55	72.7	0	–	140	62.1	0.038
7.	*Tinca tinca*	21	14.3	7	14.3	0	–	28	14.3	1.000
8.	*Alburnus alburnus*	0	–	3	33.3	0	–	3	33.3	–
9.	*Blicca bjoerkna*	32	100.0	5	60.0	0	–	37	94.6	0.000
10.	*Abramis brama*	16	81.3	0	–	0	–	16	81.3	–
11.	*Vimba vimba*	0	–	4	50.0	0	–	4	50.0	–
12.	*Carassius carassius*	7	57.1	5	60.0	0	–	12	58.3	0.921
13.	*Carassius gibelio*	1	100.0	9	22.2	0	–	10	30.0	0.107
14.	*Lota lota*	1	0.0	4	75.0	0	–	5	60.0	0.171
15.	*Gymnocephalus cernua*	21	71.4	8	37.5	0	–	29	62.0	0.092
16.	*Perca fluviatilis*	60	15.0	61	18.0	11	0.0	132	15.2	0.307

S. cephalus, *L. leuciscus*, *S. erythrophthalmus*, *L. delineatus*, *T. tinca*, *B. bjoerkna*, *A. brama*, *G. cernua*, and *P. fluviatilis*. Flukes of the genus *Posthodiplostomum* have three-host life cycles (Shultz, Gvozdev, 1972). Definitive hosts are Ciconiiformes, metacercariae are found in cyprinids and other fish species, the genus is distributed universally (Niewiadomska 2001a; Bykhovskaya-Pavlovskaya, Kulakova, 1987).

The GLMM did not reveal any statistically significant dependencies for *P. cuticola* metacercariae.

Using χ^2 test, significant differences of prevalence of infection with *P. cuticola* metacercariae in various water body types were established for *E. lucius*, *G. cernua* and *P. fluviatilis* (Table 6). In fish of these species *P. cuticola* metacercariae were found only in rivers.

T. clavata metacercariae were found in vitreous humour of 12 fish species: *E. lucius*, *R. rutilus*, *S. cephalus*, *S. erythrophthalmus*, *L. delineatus*, *T. tinca*, *B. bjoerkna*, *A. brama*, *V. vimba*, *M. fossilis*, *G. cernua* and *P. fluviatilis*. The definitive hosts of *T. clavata* are grebes, the first intermediate hosts are snails *Radix ovata* and others. Metacercariae are found in cyprinids and other fish (Shultz, Gvozdev, 1972; Bykhovskaya-Pavlovskaya, Kulakova, 1987).

The GLMM did not prove any statistically significant dependencies for *T. clavata* metacercariae.

Using χ^2 test, significant differences in the prevalence of infection with *T. clavata* metacercariae in various water body types were established for *R. rutilus*, *S. erythrophthalmus* and *P. fluviatilis* (Table 7). In fish of these species, higher prevalence meanings were established in lakes or the Curonian Lagoon. Higher prevalence of infection in *R. rutilus* with *T. clavata* metacercariae in lakes compared to rivers has been already mentioned by Rakauskas and Blaževičius (2009) and explained by the lower numbers of Grebes in rivers compared with those in lakes.

Twenty-seven monogeneans were found, each on 1–4 host species. This is in agreement with the known fact that monogeneans are highly host specific, so that a given parasite species infects a single host species or a restricted number of host species (Šimková and Morand, 2008). The life cycles of monogeneans are direct without involvement of intermediate hosts. They are viviparous (*Gyrodactylus*) or oviparous (all other genera) (Shultz, Gvozdev, 1972). All monogenean species, except *G. truttae*, have already been found in Lithuania and are mentioned by Rauckis (1988). Monogenea *G. truttae* was found on the skin of *S. trutta*

Table 6. **Infection with *Posthodiplostomum cuticola* metacercariae in fish in different types of water bodies in Lithuania in 2005. N – number of fish studied; P(%) – prevalence, *p* – asymptotic significance level (2-sided)**

	Fish species	Lakes		Rivers		Curonian Lagoon		Total		*p*
		N	P (%)	N	P (%)	N	P (%)	N	P (%)	
1.	*Esox lucius*	15	0.0	178	23.6	0	–	193	21.8	0.033
2.	*Rutilus rutilus*	44	38.6	168	27.4	5	60.0	217	30.4	0.122
3.	*Squalius cephalus*	0	–	41	2.4	0	–	41	2.4	–
4.	*Leuciscus leuciscus*	0	–	42	31.0	0	–	42	31.0	–
5.	*Scardinius erythrophthalmus*	85	24.7	55	25.5	0	–	140	25.0	0.920
6.	*Leucaspius delineatus*	0	–	5	80.0	0	–	5	80.0	–
7.	*Tinca tinca*	21	0.0	7	14.3	0	–	28	3.6	0.078
8.	*Blicca bjoerkna*	32	34.4	5	20.0	0	–	37	32.4	0.523
9.	*Abramis brama*	16	43.8	0	–	0	–	16	43.8	–
10.	*Gymnocephalus cernua*	21	0.0	8	87.5	0	–	29	24.1	0.000
11.	*Perca fluviatilis*	60	0.0	61	37.7	11	0.0	132	17.4	0.000

Table 7. **Infection with *Tylodelphys clavata* metacercariae in freshwater fish in different types of water bodies in Lithuania in 2005. N – number of fish studied; P(%) – prevalence, *p* – asymptotic significance level (2-sided)**

	Fish species	Lakes		Rivers		Curonian Lagoon		Total		*p*
		N	P (%)	N	P (%)	N	P (%)	N	P (%)	
1.	*Esox lucius*	15	0.0	178	1.1	0	–	193	1.0	0.680
2.	*Rutilus rutilus*	44	9.1	168	9.5	5	60.0	217	10.6	0.001
3.	*Squalius cephalus*	0	–	41	12.2	0	–	41	12.2	–
4.	*Scardinius erythrophthalmus*	85	40.0	55	16.4	0	–	140	30.7	0.003
5.	*Leucaspius delineatus*	0	–	5	100.0	0	–	5	100.0	–
6.	*Tinca tinca*	21	4.8	7	0.0	0	–	28	3.6	0.557
7.	*Blicca bjoerkna*	32	18.8	5	0.0	0	–	37	16.2	0.290
8.	*Abramis brama*	16	25.0	0	–	0	–	16	25.0	–
9.	*Vimba vimba*	0	–	4	50.0	0	–	4	50.0	–
10.	*Misgurnus fossilis*	0	–	4	75.0	0	–	4	75.0	–
11.	*Gymnocephalus cernua*	21	9.5	8	0.0	0	–	29	6.9	0.366
12.	*Perca fluviatilis*	60	36.7	61	3.3	11	9.1	132	18.9	0.000

morpha *fario*. The species is a widespread parasite in *S. trutta* morpha *fario* and rainbow trout *Oncorhynchus mykiss* (Walbaum, 1792) (Ergens, 1985).

Two species of the genus *Caryophyllaeus* were found: tapeworm *Caryophyllaeus laticeps* (Pallas, 1781) was found in *A. brama* and tapeworm *Caryophyllaeus fimbriceps* Annenkova-Chlopina, 1919 was found in *S. erythrophthalmus*. Tapeworms of the *Caryophyllaeus* genus have two-host life cycles. The main definitive hosts of *C. laticeps* are *A. brama*, *B. bjoerkna*, white-eye bream *Ballerus sapa* (Pallas, 1814), *V. vimba*, and *R. rutilus*; it also parasitises *S. cephalus*, ide *Leuciscus idus* (L., 1758), *S. erythrophthalmus*, asp *Leuciscus aspius* (L., 1758), barbel *Barbus barbus* (L., 1758), and other cyprinids; intermediate hosts of the species are annelids *Tubifex tubifex*, *T. barbatus*, and *Limnodrilus claperedeanus* (Shultz, Gvozdev, 1972; Dubinina, 1987). The definitive hosts of tapeworm *C. fimbriceps* are wild and domesticated common carps *Cyprinus carpio* L., 1758, more rarely *A. brama*, but this parasite also parasitises *T. tinca*, *S. cephalus*, and *R. rutilus*. Intermediate hosts of tapeworm *C. fimbriceps* are annelids *T. tubifex*, *T. barbatus*, *Psammoryctes albicola*, and *Limnodrilus udekemianus* (Shultz, Gvozdev, 1972; Dubinina, 1987).

Adult tapeworms *Triaenophorus nodulosus* (Pallas, 1781) were found in the intestines of *E. lucius* and *P. fluviatilis*. Plerocercoides of the species were found in livers of *E. lucius*. This tapeworm has free living coracidium which is swallowed by crustaceans, the first intermediate hosts: *Cyclops strenuus*, *Microcyclops varicans*, *Mesocyclops oithonoides*, *Macrocyclops fuscus*, *Acanthocyclops bicuspidatus*, *Eucyclops serrulatus*, *Eudiaptomus gracilus*, and others. In the body cavity of crustaceans, procercoids are formed. When crustaceans are eaten by fish, the second intermediate host, plerocercoids, form in them. Definitive hosts are infected when they eat the second intermediate hosts. The definitive hosts of *T. nodulosus* are *E. lucius* and other predatory fish. The second intermediate hosts are the same predatory fish and also other fish species (Shultz, Gvozdev, 1972; Dubinina, 1987; Rauckis, 1988).

Plerocercoids of *Ligula intestinalis* (L., 1758) were found in *R. rutilus* and *B. bjoerkna*. The definitive hosts of *L. intestinalis* are gulls and other piscivorious birds. The tapeworm has a free-living stage, coracidium. Procercoids develop in crustaceans, the first intermediate hosts: *Cyclops strenuus*, *Acanthocyclops bicuspidatus*, *A. viridis*, *Mesocyclops oithonoides*, *Eudiaptomus gracilus*, and *E. graciloides*. Fish represent the second intermediate host. Plerocercoids are found in body cavities of *R. rutilus*, *L. leuciscus*, *S. cephalus*, *L. idus*, Eurasian minnow *Phoxinus phoxinus* (L., 1758), *S. erythrophthalmus*, *G. gobio*, *B. barbus*, chirruh snowtrout *Schizothorax esocinus* Heckel, 1838, *A. alburnus*, schneider *Alburnoides bipunctatus* (Bloch, 1782), *B. bjoerkna*, *A. brama*, *B. sapa*, and other species (Shultz, Gvozdev, 1970; Dubinina, 1987).

Five tapeworm species of the genus *Proteocephalus* were found. *Proteocephalus cernue* (Gmelin, 1790) were found in *G. cernua*, *Proteocephalus esocis* (Schneider, 1905) in *E. lucius*, *Proteocephalus percae* (Müller, 1780) in *P. fluviatilis*, *Proteocephalus sagittus* (Grimm, 1872) in *M. fossilis*, and *Proteocephalus torulosus* (Batsch, 1786) were found in *S. erythrophthalmus*, *A. alburnus*, and *A. brama*. These tapeworms are parasites of freshwater fish. There are one or two intermediate hosts and definitive hosts in the life cycle of the genus *Proteocephalus*. Procercoids develop in crustaceans, the first intermediate hosts: *Cyclops*, *Eucyclops*, *Macrocyclops* and others. The development in a piscine host depends on the fish species. If a procercoid occurs in the intestine of a definitive host, it can develop into a plerocercoid and then into an adult tapeworm. If a procercoid occurs in the intestine of a nonspecific host, it develops into a plerocercoid and remains in this stage until its access to the specific definitive host. The life cycle may also include paratenic hosts (Shultz, Gvozdev, 1972; Dubinina, 1987).

Plerocerci of tapeworm *Neogryporhynchus cheilancristrotus* (Wedl, 1855) was found in fish of five species: *S. erythrophthalmus*, *T. tinca*, *A. brama*, *C. carassius*, and *G. cernua*. The definitive hosts of this cestode are herons (Dubinina, 1987). Their life cycle includes two intermediate hosts: cercoscoleci develop in cyclopid copepods *Mesocyclops oithonoides* (Jarecka, 1970) and plerocerci in the intestines of freshwater fish, particularly cyprinids (Dubinina, 1987). In zope *Ballerus ballerus* (L., 1758) from the Oder River, *N. cheilancristrotus* metacestodes are found throughout the year, but the dynamics of infection parameters indicates that there are two main periods of new infections: spring and late autumn-early winter (Pietrock, Scholz, 2000). Unlike the majority of cestodes inhabiting the gut lumen of fish and attaching to the gut epithelium, *N. cheilancristrotus* intrudes into deeper layers of the gut wall. Histological findings show that *N. cheilancristrotus* is a pathogenic species causing degeneration and inflammation in the intestinal wall (Molnár, 2005). According the review by Scholz et al. (2004), the geographic distribution of *N. cheilancristrotus* covers Belarus, Bulgaria, the Czech Republic, Germany, Hungary, Italy, Lithuania, Moldova, Poland, Romania, Russia, Slovakia, and Ukraine in Europe and Azerbaijan, Georgia, Iraq, Japan, Kazakhstan, Tajikistan, Turkmenia, and Uzbekistan in Asia. The morphological descriptions of *N. cheilancristrotus* (e.g., length of rostellar hooks) provided by most authors differ from those provided by Dubinina (1987) and some uncertainty in the taxonomy of gryporhynchid metacestodes exists (Pietrock, Scholz, 2000).

Cestodes *Valipora campylancristrota* (Wedl, 1855) and *Valipora* sp. were found in gall bladders of *E. lucius*. The definitive hosts of this cestode are herons (Dubinina, 1987). Their life cycle includes two intermediate hosts: the first intermediate hosts are crustaceans and the second intermediate hosts are fish. The most common host of the cestode are *T. tinca*, but parasites are found in many cyprinids and predatory fish. According to the review by Scholz et al. (2004), the geographic distribution of *V. campylocristrota* covers: Czech Republic, Germany, Hungary, Italy, Latvia, Lithuania, Moldavia, Poland, Romania, Russia, Slovakia, the Ukraine, former Yugoslavia (Monte Negro) in Europe; Iraq, Japan, Kazakhstan, Mongolia, Tajikistan, Uzbekistan in Asia; Canada and Mexico in North America; and Brazil in South America. In Lithuania, *V. campylocristrota* were registered under the name of *Valipora unilateralis* (Rauckis, 1988). In pond fisheries *V. campylocristrota* cause decrease in the fish mass and growth and if it occurs in high intensities, it may cause fish death (Dubinina, 1987; Ermolenko, 2000).

Nematodes *Raphidascaris acus* (Bloch, 1779) were found in *E. lucius*. *R. acus* is a widely distributed parasite in various predatory fish in the Holarctic; in Europe, the most frequent definitive hosts are *E. lucius* and *S. trutta* morpha *fario* but it also occurs in other fish species (Moravec, 1994). Various invertebrate (oligochaetes, crustaceans and aquatic insects) are preintermediate paratenic hosts of the second stage larvae (Moravec, 1994). There is an opinion that these invertebrates are to be considered as the first intermediate hosts (Vismanis et al., 1987). Various species of fish and cyclostomes, and more rarely, amphibians are intermediate hosts; the third stage larvae in the liver of an intermediate host are infective to a definitive host (Moravec, 1994). Some invertebrate (e.g., *Gammarus fussarum*) may also serve as true intermediate hosts (Moravec, 1996), but most invertebrates play a role as paratenic hosts only (Moravec, 2004). The maturation cycle of *R. acus* is seasonal, but it may be different in different ecological conditions (Moravec, 2004).

Desmidocercella sp. larvae were found in fish of three species: *R. rutilus*, *S. erythrophthalmus* and *P. fluviatilis*. Larvae parasitise in ocular vitreous of Cyprinidae and Percidae in the lakes of Lithuania and Belarus (Vismanis et al., 1987; Rauckis, 1988). Adults of the *Desmidocercella* genus parasitise in air sacks of herons, bitterns and cormorants (Vismanis et al., 1987).

Nematodes *Camalanus lacustris* (Zoega, 1776) were found in the intestines of fish of three species: *E. lucius*, *S. erythrophthalmus* and *P. fluviatilis*. The definitive hosts of this nematode are fish of the *Percidae* and *Esocidae* families and also many other fish (Vismanis et al., 1987; Rauckis 1988). Females of the nematode are viviparous, larvae with faeces of fish get into the water and are swallowed by intermediate hosts – copepods, in the body cavity of which *C. lacustris* develop; larvae moult two times and become infective for definitive hosts (Vismanis et al., 1987).

Nematodes *Skrjabillanus scardinii* Molnár, 1966 (syn. *Agrachanus scardinii*) were found in kidneys of *S. erythrophthalmus*. Adults of this nematode parasitise on the serosa of swimbladder, kidneys, and intestine and on the mesentery of *S. erythrophthalmus* (Vismanis et al., 1987; Anderson, 2000). The first-stage larvae are carried in blood to the skin, where small accumulations from five to 50 individuals could be found. Intermediate hosts – the ectoparasitic brachiurans, *Argulus coregoni* and *A. foliaceus* – ingest larvae while feeding. Larvae move to haemocoel of crustaceans and later resettle to the legs, where two moults take place. The third-stage larvae leave the mouth parts of brachiurans while the latter are feeding. Larvae invade the fish, migrate to the serous membranes and mature (Tikhomirova 1971, 1975, 1980 cited according Anderson 2000; Vismanis et al., 1987).

Acanthocephalan *Neoechinorhynchus rutili* (Müller, 1780) was found in *S. erythrophthalmus*. The species is a wide spread parasite of many species of fish, mostly cyprinids in Eurasia and North America (Bauer, Skryabina, 1987) also found in Africa e.g. Nigeria (Olurin, Somorin, 2006). Intermediate hosts are alderflies *Sialis* sp. (possibly paratenic host) and ostracods, *Candona* spp. and *Cypria* spp. (Bauer, Skryabina, 1987).

Acantacephalus lucii (Müller, 1776) was found in fish of five species: *E. lucius*, *A. brama*, *L. lota*, *G. cernua* and *P. fluviatilis*. The species parasitises a wide range of carnivorous and benthofagous fish. The intermediate host is *Asellus aquaticus* (Bauer, Skryabina, 1987).

CONCLUSIONS

Sixty-three species or higher taxa of helminths were identified in fish of 23 species. Fifty-six taxa of Plathyhelminthes, five Nematoda, and two Acanthocephales were found. Monogenea *Gyrodactylus truttae* were registered in Lithuania for the first time. For the identified helminths, fish are the only hosts (monogeneans), definitive hosts (part of trematodes, some cestodes, some nematodes and all acanthocephalans), intermediate and definitive hosts (some trematodes, some cestodes and some nematodes), and intermediate hosts (part of trematodes, some cestodes and some nematodes); where fish are intermediate hosts, piscivorous birds are the definitive hosts.

The highest number of helminth taxa was found in predatory fish: *E. lucius* and *P. fluviatilis*, 20 and 18, respectively. A relatively large number of helminth taxa were also found in cyprinids: *R. rutilus* and *S. erythrophthalmus*, 15 and 17, respectively. In fish of other species, from two to 11 helminth taxa were found.

Metacercariae of flukes *Diplostomum* sp., *Posthodiplostomum cuticola* and *Tylodelphys clavata* were found in the biggest number of host species; 16, 11, and 12, respectively. All other helminths were found in hosts of 1–7 species.

The GLMM shows that six cyprinid species – *R. rutilus*, *S. erythrophthalmus*, *L. leuciscus*, *S. cephalus*, *B. bjoerkna* and *A. brama* – have a greater probability of infection with *Diplostomum* sp. metacercariae. In addition, the GLMM shows that the random effect (the type of Lithuanian inner water) is also statistically significant. There is a statistically significant difference between the fish distribution in Lithuanian inner water body types. The differences in the prevalence of infection in different water body types are significant for some fish species, e.g., for *S. erythrophthalmus* and *B. bjoerkna*. Higher prevalence of infection in *S. erythrophthalmus* with *Diplostomum* sp. metacercariae was established in rivers compared to lakes. The prevalence in *B. bjoerkna* was higher in lakes.

Significant differences of prevalence of infection with *P. cuticola* metacercariae in different water body types were established for *E. lucius*, *G. cernua* and *P. fluviatilis*. In these hosts, *P. cuticola* metacercariae were found only in rivers.

Significant differences of prevalence of infection with *T. clavata* metacercariae in various water body types were established for *R. rutilus*, *S. erythrophthalmus*, and *P. fluviatilis*. In fish of these species, higher prevalence values were established in lakes or the Curonian Lagoon. This can be explained by the fact that definitive hosts of the parasite (grebes) live in standing waters.

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ŽUVŲ HELMINTAI LIETUVOS VIDINIUOSE VANDENYSE

Santrauka

Tirti Lietuvos vidaus vandenų 23 žuvų rūšių helmintai. Nustatyti 63 helmintų taksonai: 56 plokščiųjų kirmėlių, 5 nematodų ir 2 akantocefalų. Monogenėja *Gyrodactylus truttae* Lietuvoje registruota pirmą kartą. *Diplostomum* sp., *Posthodiplostomum cuticola* ir *Tylodelphys clavata* metacerkarijų aptikta daugiausia šeimininkų rūšių – atitinkamai 16, 11 ir 12. Bendrasis tiesinis mišrus modelis (GLMM) rodo, kad 6 karpinių žuvų rūšys – *Rutilus rutilus*, *Scardinius erythrophthalmus*, *Leuciscus leuciscus*, *Squalius cephalus*, *Blicca bjoerkna* ir *Abramis brama* – turi didesnę tikimybę užsikrėsti *Diplostomum* sp. metacerkarijomis. GLMM taip pat patvirtina statistiškai reikšmingą atsitiktinį efektą (Lietuvos vidaus vandenų tipas). Įvairiuose vandens telkinių tipuose nustatyti žuvų užsikrėtimo *Diplostomum* sp., *P. cuticola* ir *T. clavata* metacerkarijomis ekstensyvumo skirtumai.

Raktažodžiai: helmintai, žuvis, vidiniai vandenys, Lietuva