DOI 10.2478/s11687-014-0244-5

VERSITA

HELMINTHOLOGIA, 51, 4: 293– 300, 2014

Larval trematodes in bithyniid snails (Gastropoda: Bithyniidae) in the lake-rivers systems from the steppe zone (The West Siberian Plain, Russia)

E. A. SERBINA

Institute of Systematics and Ecology of Animals Institute of Systematics and Ecology of Animals Siberian Branch Russian Academy of Sciences, Frunze, St. 11, Novosibirsk, 630091, Russia, E-mail: *serbina_elena_an@mail.ru*

Summary

A survey of cercariae and metacercariae (Trematoda, Digenea) from bithyniid snails (Gastropoda: Bithyniidae) in lake-river systems in Northern Kulunda (of the steppe zone of the West Siberia Plain) is presented. The role of *Bithynia tentaculata* (Linne, 1758) and *Bithynia troscheli* (Paasch, 1842) as the first intermediate hosts and as the second intermediate hosts of trematodes in the study area was accomplished for the first time. Twelve species of cercariae (8 families) and 12 species of metacercariae (6 families) were found in bithyniid snails. Altogether, bithyniid snails were infected with 23 trematode species including 16 genera in 11 families. New Cercariae *Holostephanus* sp. and five original species of trematode metacercariae, were discovered in bithyniid snails of the steppe zone of the West Siberia Plain. The dominant cercariae were those of the families Prosthogonimidae and Lecithodendriidae. The most prevalent metacercariae were *Echinoparyphium aconiatum* Dietz, 1909 and *E. recurvatum* Linstow, 1873 (both family Echinostomatidae) and *Cyathocotyle bithyniae* Sudarikov, 1974 (Cyathocotylidae). *B. troscheli* infected by trematode parthenitae of *Holostephanus* sp. was detected in the Russia for the first time.

Keywords: ecosystems; steppe zone; *Bithynia tentaculata*; *Bithynia troscheli*; Prosthogonimidae; Lecithodendriidae; Cyathocotylidae; Echinostomatidae

Introduction

Molluscs are the obligatory first intermediate hosts for virtually all trematodes. They are followed by one or two invertebrate or vertebrate intermediate hosts and an obligatory definitive host. The adult stages of trematodes are parasites of domestic animals including commercially important species and occasionally, humans. For example, *Opisthorchis felineus* Rivolta, 1884 is widely spread in Russia and causes very dangerous disease, opisthorchiasis. It is estimated that 1.5 million people in Russia carry this parasite acquiring infection by consuming raw, slightly salted and frozen fish. Snails of the Bithyniidae family are first intermediate hosts in the life cycle of *O. felineus.* They are ordinary inhabitants in Palaearctic fresh water reservoirs. Bithyniid snails are commonly prevalent in the Ob and Irtysh Rivers and their tributaries and lakes in western Siberia (Karpenko *et al.* 2008; Serbina, 2010*a,* 2012, 2013a; Serbina & Bonina, 2011). Previous studies (Serbina, 2010b) showed that 36 species of trematodes in stages of parthenitae and cercariae, 20 species in the metacercarial stage and two species in the marita stage are associated with bithyniid snails in the ecosystems of West Siberia.

Earlier studies Filimonova & Shalyapina (1979, 1980) demonstrated that *Bithynia inflata* (Hansen, 1845) may serve as both,the first and the second intermediate hosts for trematodes in the study area.In this investigation the species distribution of the larval trematodes associated with bithyniid snails in the lake-river systems in Northern Kulunda (steppe zone ecosystem in the West - Siberian Plain) is presented.

Materials and methods

The role of bithyniid snails as trematode hosts was assessed in samples that were obtained in July of 1994 – 1995, in June of 2006 – 2007, and in August of 2009 – 2010. Samples were collected in different parts of the Karasuk River upstream (54°26′53.2″ N; 80°55′50.5″ E and 54°09′53.2″ N; 80°02′54.2″ E) and downstream (53°45′19.4″ N; 78°20′15.1″ E and 53°43′19.7″ N; 77°56′29.5″ E), in the Kur'ya River (53°50"N; 78°22' E), in the Burla River (53°20′ N; 78°20′ E) and in Krotovo Lake (Krotovaya Lyaga) (53°43′30″ N; 77°51′31″ E). Bithyniid snails were collected and analyzed in the fol-

Table1. Prevalence (%) of trematode parthenitae different species in *Bithynia tentaculata* and *Bithynia troscheli* from Northern Kulunda

Species	*Bithynia tentaculata*	*Bithynia troscheli*
Notocotylus imbricatus	0.92 ± 0.65	0
Psilotrema tuberculata	0	1.24 ± 0.87
Echinochasmidae gen. sp.	0.46 ± 0.46	0
Sphaerostomum globiporum	3.21 ± 1.19	0
Schistogonimus rarus	5.96 ± 1.60	1.24 ± 0.87
Prosthogonimus cuneatus	2.75 ± 1.11	0.62 ± 0.62
Prosthogonimus ovatus	4.13 ± 1.35	0.62 ± 0.62
Cercaria papiliogona	2.29 ± 1.01	0.62 ± 0.62
Xiphidiocercaria sp.1	3.21 ± 1.19	1.24 ± 0.87
Cyathocotyle bithyniae	2.75 ± 1.11	0.62 ± 0.62
Holostephanus sp.	0.46 ± 0.46	0
Pleurogenoides medians	4.13 ± 1.35	0

lowing years: Krotovo Lake 1994 – 1995, 2006 – 2007 and 2009, Kur'ya River (2007), Karasuk River (2009), and Burla River (2010). The hydrological and hydrochemical characteristics of the rivers and lakes in steppe zone in the West - Siberian Plain are presented in the study by Savchenko (2010). The study was based at the Karasuk Field Station (Institute of Systematics and Ecology of Animals Russian Academy of Sciences; Karasukskii district, Novosibirsk region). For the quantitative analysis all snails, in the lake-river systems, were collected by hand from sites of 0.25 m2 (50x50 cm). The control sites were in open parts and in macrophyte stands at a depth of 0.1 – 1.1 m. All work with trematodes was performed by traditional methods (Ginetsinskaya, 1968; Sudarikov *et al.*, 2002). In the laboratory each snail was isolated into a single Petri dish, filled with filtered river water. Shedding of cercariae was stimulated by light and heat for 4 to 6 h and live cercariae were stained by a vital dye (0.01 % solution of neutral red and Nile blue). Fifteen days later, the bithyniid snails were dissected to determine earlier larval stages (trematode parthenitae) and to detect infection with metacercariae. Trematode invasion was assessed by the compression method (Sudarikov *et al.*, 2002 p. 9 – 10) where the diameter and thickness of the metacercariae cyst was measured. The cysts were removed mechanically or dissolved in antiforminum (Sudarikov *et al.*, 2002 p. 14). The temporary slides were brightened with glycerine. Cercaria and metacercaria (without cysts) were measured after fixation with Schneider's carmine (acetocarmine).

Identification of parthenitae trematode was based on observation when mature cercariae were capable of leaving the shell of the host snail on their own. Trematodes at earlier stages of the development were identified according to family (and, at times, by genus). The trematode species were defined under a number of taxonomic keys cited in previous publication (see the complete list in Serbina 2013b,c). The identification of metacercariae was based on keys by Filimonova & Shalyapina (1979) and Sudarikov *et al.* (2002). The definitions of prevalence and mean abundance corresponded to those given by Beklemishev (1970) and Bush *et al.* (1997). The Bithyniidae family in the areas of research is represented by two species: *Bithynia tentaculata* (Linne, 1758) and *Bithynia troscheli* (Paasch, 1842). In total, 218 *B. tentaculata* and 161 *B. troscheli* were examined. Statistical analyses were carried out using STATISTICA 6.0 and Excel 2003.

Results

Trematode infections in B. troscheli and B. tentaculata

Both, *B. troscheli* and *B. tentaculata* were confirmed as the first and the second intermediate hosts of trematodes in the lake-river systems of Northern Kulunda. *B. troscheli* (7.45 ± 1.8 %) was significantly less infected by trematode parthenitae than *B. tentaculata* (30.28 ± 3.1 %; $\chi 2 = 20.19$, $p < 0.001$). *B. troscheli* and *B. tentaculata* infected by trematode metacercariae did not show significant differences (48.6 ± 3.9 % and 48.4 ± 3.9 %, respectively).

Cercariae of trematodes found in bithyniid snails

In bithyniid snails, we found parthenitae of 12 species of trematodes belonging to 8 families. Among these, 4 species from 4 families had sporocyst and redia stages in parthenogenetic generations: *Notocotylus imbricatus* (Looss, 1893), Szidat, 1935 [Notocotylidae Lühe, 1909]; *Psilotrema tuberculata* Filippi, 1857 [Psilostomidae (Looss 1900) Odhner 1913]; Echinochasmidae gen. sp. (subfamily Echinochasminae[1] Odhner 1910) [Echinostomatidae (Looss 1899) Dietz, 1909], and *Sphaerostomum globiporum* (Rudolphi, 1802) (Opecoelidae Ozaki, 1925).

The remaining 8 species from 4 families were sporocyst stages ('mothers' and 'daughters') in parthenogenetic generations: *Schistogonimus rarus* Braun, 1901; *Prosthogonimus cuneatus* Rudolphi, 1809; *Prosthogonimus ovatus* Rudolphi, 1803 [Prosthogonimidae Lühe, 1909]; *Xiphidiocercaria* sp.1 Odening, 1962; *Cercaria papiliogona* Hall, 1963 [Lecithodendriidae Odhner, 1911], (*Cyathocotyle bithyniae* Sudarikov, 1974; *Holostephanus* sp.

[1]Odening (1963) and Sudarikov& Karmanova (1977) elevated the subfamily Echinochasminae to full family rank

Table 2. Indicators of infection of *Bithynia troscheli* and *Bithynia tentaculata* of trematode metacercariae in the ecosystems steppe zone in the West – Siberian Plain (Northern Kulunda)

Species	*Bithynia tentaculata*		*Bithynia troscheli*		Intensity of infection
	Prevalence (%)	Abundance	Prevalence (%)	Abundance	
	Min – max	Min – max	Min – max	Min – max	Max
Asymphylodora tincae	0.68*	0.02*	6.87 – 17.19	0.95 – 2.23	45
Parasymphylodora sp.	0.003 – 0.01	2.78 – 2.86	0		5
Echinoparyphium aconiatum	17.01 – 44.44	0.13 – 4.42	0.98 – 4.53	21.88 – 50.0	70
Echinoparyphium recurvatum	2.78 – 25.85	0.17 – 0.64	4.69 – 14.29	0.09 – 7.00	84
Echinoparyphium clerci	0		1.56*	0.13*	8
Echinostoma revolutum	0		3.33	2.1*	63
Echinostoma uralensis	2.78*	0.003*	0		1
Cyathocotyle bushiensis	1.36*	0.12*	3.13 – 25.0	0.05 – 1.25	35
Cyathocotyle bithyniae	1.36 – 11.43	0.03 – 1.86	14.29 – 39.06	0.4 – 3.06	51
Lecithodendriidae gen. sp.	4.76*	0.03*	0		36
Cotylurus cornutus	2.86 – 19.44	0.03 – 1.17	0.02 – 2.5	1.56 – 25.0	153
Cyclocoliidae gen. sp.	0.68 – 2.78	0.02 – 0.06	3.33 – 25.0	0.03 – 0.06	16

* - detected only in a single sample (one year)

[Cyathocotilidae (Mühling, 1898) Poche, 1925], and *Pleurogenoides medians* Olsson, 1876 [Pleurogenidae Looss, 1898].

Seven of the 12 trematode species were found in *B. troscheli*; and 11 species were found in *B. tentaculata* (Table 1). The dominant cercariae were those of the families Prosthogonimidae, and Lecithodendriidae.

Metacercariae found in bithyniid snails

The metacercaria were represented by twelve species from six families, *Asymphylodora tincae* Modeer, 1790; *Parasymphylodora* sp. [Monorchiidae Odhner, 1911]; *Echinoparyphium aconiatum* Dietz, 1909; *Echinoparyphium recurvatum* Linstow, 1873; *Echinoparyphium clerci* Skrjabin, 1915; *Echinostoma revolutum* Frohlich, 1808; *Echinostoma uralensis* Skrjabin, 1915 [Echinostomatidae Dietz, 1909]; *Cyathocotyle bithyniae* Sudarikov, 1974; *Cyathocotyle bushiensis* Khan, 1962 [Cyathocotilidae (Mühling, 1898) Poche, 1925]; (Mühling, 1898) Lecithodendriidae gen. sp. [Lecithodendriidae Odhner, 1911]; Cyclocoelidae gen. sp. [Cyclocoelidae Kossack, 1911], and *Cotylurus cornutus* Rudolphi, 1808 [Strigeidae Railliet, 1919]. Nine of the 12 trematode species were found in *B. troscheli*, and ten species were found in *B. tentaculata.* Seven trematode species were found both in *B. troscheli* and *B. tentaculata.* The trematode species *E. cinctum* and *E. revolutum* were found only in *B. troscheli.* The trematode species *Parasymphylodora* sp., *E. uralensis,* and Lecithodendriidae gen. sp. were found only in *B. tentaculata.*

Table 3. The parts of trematode parthenitae and metacercariae different families in infected bithyniid snails from the Lake and Rivers ecosystems in the steppe zone in the West - Siberian Plain

Families	Parthenitae		Metacercariae	
	Lake	Rivers	Lake	Rivers
Echinostomatidae	1.52	0	55.09	27.78
Notocotylidae	3.03	0	-	-
Pleurogenidae	13.64	0	-	-
Psilostomidae	1.52	10	0	0
Lecithodendriidae	22.73	0	3.24	0
Cyathocotylidae	10.61	10	22.22	11.11
Prosthogonimidae	46.97	10	-	-
Opecoelidae	0	70	0	0
Monorchiidae	0	0	6.02	16.67
Strigeidae	-	-	11.11	38.89
Cyclocoelidae	0	0	2.31	5.56

Table 4. The occurrence of cercariae found in bithyniid snails in Northern Kulunda, and Palaearctic

Genus	Valid name	Synonyms	Snail species*	Country [References]**
Sphaerostomum Stiles et Hassal, 1898	*S. globiporum* (Rudolphi 1802)	syn.: *Cercaria micrura* (Filippi, 1857 =*Sphaerostomum sp.*	BL BT BI BT BTr	Russia [4]; Russia [11]; [12]; [15]; Holland [19]. Russia [17]. Russia [22, 32].
Psilotrema Odhner, 1913	*P. tuberculata* Filippi, 1857	syn.: *Cercaria tuberculata* Filippi, 1857= *P. spiculigerum* Muhling, 1898 = *P. oligoon* Linstow, 1887	BT BI BT BTr	Russia [5], [15], [24]; Ukraine [20]; Great Britain [26]. Russia [17]. Russia [25, 29].
Echinostomatidae gen. sp.	Echinochasmidae sp.		BT BI BT BTr	Russia [11]; [14]. Russia [17]. Russia [31].
Notocotylus Diesing, 1839	*N. imbricatus* Looss, 1894, Szidat, 1935	*Cercaria imbricata* Looss. 1893 rom. nud., nee. Looss, 1896; *Cercaria helvetica I* Dubois, 1929; *Cercaria fennica I* Wikgren, 1956; *Notocotylus babai* Bhalerao, 1935; *Hindia babai* (Bhalerao, 1935) Lai, 1935; *N. indicus* Lai, 1935; *Hmdia lucknowensis* Lai, 1935; *N. anatis* Ku, 1937; *Hindolana babai* (Bhalerao, 1935) Strand, 1942; *N. imbricatus imbricatus* (Looss, 1893) Dubois, 1951; *N. solitaria* Singh, 1954; *N. duboisi* Stunkard,1966	BT BL BT BI BT BTr	Russia [1]. Kazakhstan [10]; Holland [19] Russia [24]; Germany [28]. Russia [17]. Russia [23, 25].
Cyathocotyle Muhling 1896	*C. bithyniae* Sudarikov, 1974		BI BT BT, BTr	Russia [17]. Poland [18]. Russia [23, 25].
Holostephanus Szidat, 1936	*Holostephanus sp.*		BT	Russia [9], [13], [24]; Kazakhstan [10]; France [16]; Great Britain [26]
Schistogonimus Luhe, 1909	*S. rarus* Braun, 1901	syn.: *Cercaria rumniensis* Pike, 1967	BT BI BT, BTr	Great Britain [7]; Holland [8] Russia [11], [24]. Russia [17]. Russia [23, 25, 27, 30].
Prosthogonimus Luhe, 1909	*P. cuneatus* Rudolphi, 1809		BT BI BC BT, BTr	Russia [5]. Russia [17]. Middle Asia [21]. Russia [25, 27].
	P. ovatus Rudolphi, 1803		BT BI BT BTr	Holland [3]; Great Britain [26] Russia [17]. Russia [25, 27].
Pleurogenoides Travassos, 1921	*P. medians* (Olsson, 1876) Travassos, 1921	syn.: *Pleurogenes medians* (Olsson, 1876) = *Cercaria helvetica VIII* = *Distomum medians* Olsson, 1876;	BT BI BT BTr	Russia [2], [11]; Czech Republic [6]; Great Britain [7], Ukraine, [20]; Germany [28]. Russia [17]. Russia [25].
Lecithodendriidae gen. sp.	*Cercaria papiliogona* Hall, 1963		BI	Russia [17].
	Xiphidiocercaria sp.1 Odening, 1962		BI BTr	Russia [17]. Russia [25].

* BT – *Bithynia tentaculata*; BTr – *Bithynia troscheli*; BL – *Bithynia leachi*; BI – *Bithynia inflata*; BC – *Bithynia caerulans*

** [1] – Erkina 1953; [2] – Ginetsinskaya, 1959; [3] – Boddeke, 1960; [4] – Pestushko, 1960;
[5] – Kupriyanova-Shachmatova, 1962; [6] – Zdárská, 1963; [7] – Pike, 1967; [8] – Borgsteede *et al*., 1969;
[9] – Vojtek, Vojtkova, 1968; [10] – Belyakova-Butenko, 1971; [11] – Bykhovskaya-Pavlovskaya, Kulakova 1971; [12] – Razmashkin , 1972;
[13] – Sudarikov, 1974; [14] – Karmanova, 1975; [15] – Frolova 1975; [16] – Combes, *et al*., 1980; [17] – Filimonova, Shalyapina, 1979;
[18] – Niewiadomska, 1980; [19] – Keulen, 1981;
[20] – Chernogorenko, 1983; [21] – Aristanov, 1986; [22] – Serbina, 1998a; [23] – Serbina, 1998b; [24] – Ataev *et al*., 2002; [25] – Serbina, 2004;
[26] – Morley *et al*., 2004; [27] – Serbina, 2005; [28] – Faltýnková, Haas 2006; [29] – Serbina, 2006; [30] – Serbina, 2008; [31] – Serbina, 2009;
[32] – Serbina, Tolstenkov, Terenina, 2012;

Among 12 trematode species found in the bithyniid snails sampled in the lake-river systems of Northern Kulunda, the 8 species were regarded as common (>25 % occurrence), whereas the other 4 species were rare (*E. clerci*; *E. revolutum, E. uralensis* and Lecithodendriidae gen. sp.).

In *B. tentaculata,* the dominant metacercariae were those of *E. aconiatum* and *E. recurvatum.* In *B. troscheli* the dominant metacercariae were those of *E. aconiatum* and *C. bithyniae.* The invasion rates of metacercariae in bithyniid snails are shown in Table 2.

Infection of bithyniid snails of trematodes from the Lake and River ecosystems

In the river ecosystems, four cercarial species were found (*Psilotrema tuberculata, Holostephanus* sp.*, Sphaerostomum globiporum,* and *Schistogonimus rarus*) and 6 species of metacercariae (*A. tincae, Parasymphylodora* sp., *E. aconiatum, Cyathocotyle bithyniae, Cyclocoelidae gen.* sp., *C. cornutus*). Ten cercarial species (except *Sphaerostomum globiporum* and *Holostephanus* sp.) and 11 species of metacercariae (except *Parasymphylodora* sp.) were found in the bithyniid snails from the lake. Bithyniid snails infected by trematode parthenitae in the lake and river ecosystems (21.5 % and 13.9 %, respectively) did not show significant differences ($\chi2 = 1.45$, $p = 0.22$). The prevalence of metacercariae in bithyniid snails in the lake (61.2 %) was significantly higher than in bithyniid snails in the rivers (15.3 %; $\chi2 = 48.23$, $p < 0.001$).

The dominant cercariae were those of the families Prosthogonimidae and Opecoelidae, in the lake and river ecosystems, respectively (Table 3). In the bithyniid snails from the lake dominant metacercariae were those of *E. aconiatum* and *E. recurvatum.* In the rivers ecosystems, the dominant metacercariae were those of *C. cornutus* and *E. aconiatum*.

Discussion

Our results were obtained from naturally infected snails from lake-river systems of the Northern Kulunda. In bithyniid snails, area we found 12 species of cercariae (8 families) and 12 species of metacercariae (6 families). All these species of trematodes were found previously in bithyniid snails in Palaearctic (Table 4; Sudarikov *et al.*, 2002; Serbina, 2013b, c). However, cercariae of *Holostephanus* sp. and five species of trematode metacercariae (*A. tincae, E. revolutum, E. uralensis*, Cyclocoeliidae gen. sp., and *C. bushiensis*), were recorded in bithyniid snails in Northern Kulunda for the first time. The species composition of trematodes in bithyniid snails of the ecosystems of steppe zone of the Northern Kulunda includes 33.3 % cercarial species and 60 % metacercarial species from the total species list (Serbina, 2010b).

The dominant cercariae were those of Prosthogonimidae and Lecithodendriidae. The cercariae of Prosthogonimidae, Lecithodendriidae, and Pleurogenidae were of the «stylet group». These species are widely distributed in bithyniid snails in Palaearctic: Great Britain (Pike, 1967; Morley *et al.,* 2004), Holland (Boddeke, 1960; Borgsteede *et al.,* 1969), Czech Republic (Žďárská, 1963), Ukraine (Chernogorenko, 1983), Germany (Faltýnková & Haas, 2006), Middle Asia (Aristanov, 1986), Kazakhstan (Belyakova-Butenko, 1971), and Russia (Ginetsinskaya, 1959; Kupriyanova-Shachmatova, 1962; Bykhovskaya-Pavlovskaya & Kulakova, 1971; Ataev *et al.,* 2002; Serbina, 2005, 2008). They were found as the most frequent in all countries where samples were collected. For example, Belyakova-Butenko (1971) showed that bithyniid snails from some ecosystems of the steppe zone of Kazakhstan were 100 % infected by trematode parthenitae of the «stylet group». Altogether, 8 species of cercariae (7 families) were recorded in bithyniid snails of the steppe zone of Kazakhstan (Belyakova-Butenko, 1971).

In previous studies Vojtek and Vojtkova (1968), Belyakova-Butenko (1971), Sudarikov (1974), Combes *et al.* (1980), Ataev *et al.* (2002), and Morley *et al.* (2004) showed that *B. tentaculata* is first intermediate host of *Holostephanus. B. troscheli* infected by trematode parthenitae from *Holostephanus* sp. was observed in Russia for the first time.

The most prevalent metacercariae were those of *E. aconiatum* and *E. recurvatum* (both family Echinostomatidae) and *C. bithyniae* (Cyathocotylidae). In previous studies Yurlova *et al*. (2006), and Serbina, (2014) showed that, metacercariae of *E. aconiatum*, were recorded in more than 70 % of samples of *Lymnaea stagnalis* and samples of *B. troscheli* in Chany Lake (South-West Siberia, Russia). Metacercariae of *E. recurvatum*, were recorded in more than 65 % of samples of *L. stagnalis* and in more than 40 % samples of *B. troscheli*. Three rare species of the family Echinostomatidae were recorded in more than 40 %, 10 % and 5 % of samples of *L. stagnalis* (*E. revolutum, E. uralensis* and *E. clerci,* respectively), and in more than 20 % and 10 % of samples of *B. troscheli* (*E. revolutum,* and *E. uralensis,* respectively). The second most common were metacercariae of the family Cyathocotylidae. However, they were rare species in pulmonates (Yurlova & Serbina, 2004).

The species composition of trematodes that infect bithyniid snails of the steppe zone of Northern Kulunda comprises twenty three species from eleven families, i.e. Monorchiidae (2 species), Opecoelidae (1), Echinostomatidae (6), Psilostomidae (1), Cyclocoelidae (1), Notocotylidae (1), Cyathocotylidae (3), Strigeidae (1), Prosthogonimidae (3), Lecithodendriidae (3), and Pleurogenidae (1). Most of the larval trematodes (16 species) found in bithyniid snails had previously been recorded in birds from West Siberia (Bykhovskaya-Pavlovskaya, 1962; Filimonova & Shalyapina, 1975; Serbina, 2002). Opecoelidae species may reach maturity in fish (Razmashkin, 1972) or even in the first intermediate hosts (Chernogorenko-Bidulina & Bliznyuk, 1960; Serbina, 1998b; Serbina *et al.* 2012). Three trematode species (from Monorchiidae and Opecoelidae) finish their life cycles in fish, one trematode species of Pleurogenidae in amphibians. The second intermediate hosts are snails (for 12 trematode species), leeches (3), insects (9), crustaceans (3), and fish (1). Life cycles of trematode species of the family Lecithodendriidae are unknown.

The present study shows that the richness of species and prevalence of larval trematodes associated with bithyniid snails in the lakes was higher than in the rivers. The high richness of trematode species in bithyniid snails from the lake ecosystem may be linked to the period of studies that were performed in different summer months and different years. In addition, favorable conditions for nesting of aquatic birds (definitive hosts for trematodes) exist in the lake ecosystems. According to the data of ornithologists, the aquatic birds concentrate in the lake areas (Mikhantyev & Selivanova, 2010). A total of 182 bird species were recorded in the North Kulunda. Among these, 112 (61.5 %) were breeding species, 44 species (24.1 %) were detected only as flyovers (transient migratory birds), 14 (7.6 %) were nomadic in summer and autumn, and 12 (6.8 %) were wintering species (Danilov & Mikhantyev, 1976). In previous studies, Bykhovskaya-Pavlovskaya and Kulakova (1971), and Serbina (2004) showed that high richness of trematode species in bithyniid snails occurs in ecosystems with favorable conditions for aquatic birds. The richness of aquatic bird species and the high population density of birds, as well as the absence of currents and large areas of shallow water, increases the probability of snail infection. Shallow water warms up rapidly and the trematodes have a good chance to finish their life cycle successfully even during the short Siberian summer. This was shown previously for prosthogonimid species (Serbina, 2005, 2008), and for opisthorchiid species (Serbina, 2012). In the river ecosystems the conditions are less favorable for trematode development. The water stream impacts the water temperature regime and decreases the probability of the invasion of snails by trematode free-living larvae, miracidia and cercariae.

Conclusions

The presented data suggest the significant role of bithyniid snails as trematode hosts in the steppe zone in the West - Siberian Plain. The species composition of trematodes that infect bithyniid snails of the steppe zone of Northern Kulunda comprises twenty three species belonging to eleven families. In the examined area one cercaria and five metacercariae species were detected in bithyniid snails for the first time. The richness of species and prevalence of larval trematodes associated with bithyniid snails in the lake was higher than in the rivers. The role of *B. tentaculata* and *B. troscheli* as first intermediate hosts and as second intermediate hosts of trematodes in the lake-river system of Northern Kulunda is proposed. *B. troscheli* infected by trematode parthenitae from *Holostephanus* sp. is the first original observation in the Russian territory

Acknowledgements

The author is grateful to M. A. Sedykh for help in snail sampling, to N. I. Yurlova, L. M. Kipriyanova, and to the staff of Karasuk Scientific Station (Institute of Systematics and Ecology of Animals, Novosibirsk) for their help in organizing and supporting the field work, and two anonymous reviewers for useful comments on an earlier draft.
The study was supported by The Federal Fundamental Scientific Research Programme for 2013–2020 (#VI.51.1.9.).

References

ARISTANOV, E. A. (1986): *Fauna of trematode parthenites and larvae of molluscs in delta of Amu Darya and the south of Aral sea*. Tashkent, 160 pp. (In Russian)

ATAEV, G. L, KOZMINSKY, E. V., DOBROVOLSKIY, A. A. (2002): Dynamics of infection of *Bithynia tentaculata* (Gastropoda: Prosobranchia) with trematodes. *Parazitologiya*, 36: 203 – 218 (In Russian)

BEKLEMISHEV, V. N. (1970): *The Biocenological Foundations of Comparative Parasitology*. Moscow Nauka 502 pp. (In Russian)

BELYAKOVA-BUTENKO, YU. V. (1971): Trematode larvae in freshwater snails of Irgis-Turgay. *Tr. Inst. Zool. AN Kas. SSR*, 31, 74 – 87 (In Russian)

BODDEKE, R. (1960): The life history of *Prosthogonimus ovatus*. II. The intermediate hosts. *Trop. Geogr. Med*., 12, (4): 363 – 377

BORGSTEEDE F. H. M., DAVIDS C., DUFFELS J. P. (1969): The life history of *Schistogonimus rarus* (Braun, 1901) Lühe, 1909 (Trematoda: Prosthogonimidae). *Koninkl. Nederl. Akad. Wetenchappen, Amsterdam. Ser. Zoology* 72, (1): 28 – 32

BUSH, A. O., LAFFERTY, K. D., LOTZ, J. M., SHOSTAK, A. W. (1997): Parasitology meets ecology on its own terms: Margolis *et al.* revisited. *J. Parasitol*., 83: 575 – 583. DOI: 10.2307/3284227

BYKHOVSKAYA-PAVLOVSKAYA, I. E. (1962): *Trematodes of birds in the fauna of the USSR*. Akademii Nauk SSSR, Moscow and Leningrad, 407 pp. (In Russian)

BYKHOVSKAYA-PAVLOVSKAYA, I. E., KULAKOVA, A. P. (1971): Cercariae from Bithynia (*Bithynia tentaculata* and *B. leachi*) in Curonian Lagoon. *Parazitologiya*, 5 (3): 222 – 232 (In Russian).

CHERNOGORENKO-BIDULINA, M. I., BLIZNYUK I. D. (1960): The life-cycle of *Sphaerostoma bramae* Müller, 1776. *Dokl. Akad. Nauk SSSR*, 134 (1): 237 – 240 (In Russian)

CHERNOGORENKO, M. I. (1983): *Larvae of trematodes in snails in Dnepr River and its reservoirs (fauna, biology, and peculiarities of formation)*. Naukova Dumka, Kiev 212 pp. (In Russian)

COMBES, C., ALBARET, J. L, ARVY, L., BARTOLI, P., BAYSSADE-DUFOUR, C., DEBLOM, S., DURETTE-DESSET,

M. C., GABRION, C., JOURDANE, J., LAMBERT, A., LEGER, N., MAILLERD, C., MATRICON, M., NASSI H., PREVOST, G., RICHARD, J., THERON, A. (1980): *Atlas Mondiale des Cercaires*. Museum National d'Histoire Naturelle, Paris 235pp.

DANILOV, O. N., MIKHANT'EV, A. I. (1976): The Birds of Karasuk Lake Stationer (Northern Kulunda). In *Okhrana ipreobrazovanie prirody lesostepi Zapadnoi Sibiri* (*Protection and Transformation of Forest-Steppe Nature in Western Siberia)*. Novosibirsk: Nauka, pp. 254 – 263

ERKINA, N. G. (1953): *K. I. Skrjabin. Trematodes of animals and man. Suborder Notocotylata Skrjabin et Schulz, 1933*. Moscow 8, 42 – 47. (In Russian)

FALTÝNKOVÁ, A., HAAS, W. (2006): Larval trematodes in freshwater molluscs from the Elbe to Danube rivers (Southeast Germany): before and today. *Parasitol. Res*., 99: 572 – 582. DOI: 10.1007/s00436-006-0197-9

FILIMONOVA, L.V., SHALYAPINA, V. I. (1975): Trematodes of water and marsh birds. In K. M. RYZHIKOV, S. S. FOLITAREK (Eds) *Parasites in natural complexes of North Kulunda*. Trudy Biologicheskogo Instituta, Nauka, Siberian Branch, Novosibirsk, 35 – 52 (In Russian)

FILIMONOVA, L. V., SHALYAPINA, V. I. (1979): Metacercariae in the snails *Bithynia inflata* in Severnaya Kulunda lakes. In *Helminths of animals and plants*. Nauka, Moscow, 29: 157 – 166 (In Russian)

FILIMONOVA, L. V., SHALYAPINA, V. I. (1980): Cercariae of trematodes in the prosobranch mollusc *Bithynia inflata* from lakes of North Kulunda. *Tr. Akad. Nauk SSSR*., 30: 113 – 124 (In Russian)

FROLOVA E, N. (1975): *Trematode larvae in molluscs in South Karelian lakes*. Leningrad: Nauka 184 pp. (In Russian)

GINETSINSKAYA, T. A. (1959): On the fauna of cercariae from molluscs in the Rybinsk water reservoir. Part I. Systematic survey of cercariae. *Ekol. Parazitol*., 1: 96 – 149 (In Russian)

GINECINSKAYA, T. A. (1968): *Trematodes, their life cycles, biology and evolution*. Leningrad: Nauka 412pp. (In Russian)

KARMANOVA, E. M. (1975): Morphological features of the genus Echinochasmus Dietz, 1909 Echinostomatidae, parasitic in fish-eating birds. Research of the systematics, life cycles and biochemistry of the parasitic worms. *Tr. Gel'mintol. Lab*., 25: 52 – 64 (In Russian)

KARPENKO, S. V., CHECHULIN, A. I., YURLOVA, N. I., SERBINA, E. A., VODYANITSKAYA, S. N., KRIVOPALOV, A. V., FEDOROV, K. P. (2008): Characteristic of Opisthorchosis foci in the Southern of West Siberia. *Contemp. Probl. Ecol*., 1 (5): 517 – 521

KEULEN, S. M. A. (1981): Cercariae of the lakes maarsseveen (Netherlandes) infecting *Bithynia* spp. (Gastropoda: Prosobranchia) and *Physa fontinalis* (Gastropoda: Pulmonata). *Bijdr. dierk*, 1 (1): 89 – 104

KUPRIYANOVA-SHACHMATOVA, R. A. (1962): To fauna of trematodes fresh-water molluscs of the Average Volga region. *Tr. Gel'mintol. Lab*., 11: 130 – 143. (In Russian)

MIKHANT'EV, A.I., SELIVANOVA, M. A. (2010): Water and Periowater Birds. In *Biodiversity of the Karasuk-Burla Region (Western Siberia)*. Novosibirsk: Nauka 215 – 233 (In Russian)

MORLEY, N. J, ADAM, M. E. LEWIS, J. W. (2004): The role of *Bithynia tentaculata* in the transmission of larval digeneans from a gravel pit in the Lower Thames Valley. *J. Helminthol*., 78: 129 – 135. DOI: 10.1079/JOH2003223

NIEWIADOMSKA K. (1980): The cercaria of *Cyathocotyle bithyniae* Sudarikov, 1974 Trematoda, Cyathocotylidae. *Acta Parasitol*., 26(12): 137 – 142

PESTUSHKO, E. И. (1960): The species composition of Trematode larvae from molluscs Bithynia leachi and seasonal dynamics of its infection in conditions Dnepropetrovshini. In: *Problems of parasitology*. Naukova Dumka, Kiev USSR, 57 – 59 (In Russian)

PIKE, A. W. (1967): Some stylet cercariae and a microphallid type in British from water molluscs. *Parasitology*, 57: 729 – 754

RAZMASHKIN D. A. (1972): About life cycle *Sphaerostomum globiporum* (Rud. 1802) [Trematoda, Opecoelidae]. Parasites of water unvertebrate animals. Lvov 71 – 72 (In Russian)

SAVCHENKO, N. V. (2010): Landscape-limnological features. In *Biodiversity of the Karasuk-Burla Region (Western Siberia)*. Novosibirsk Nauka, 15 – 52 (In Russian)

SERBINA, E. A. (1998a): Seasonal dynamics of development Sphaerostomum globiporum (Rud.1802) [Trematoda, Opecoelidae]. In: *The Condition Siberia Water ecosystems and prospect of their use*. Tomsk, 266 – 268 (In Russian)

SERBINA, E. A. (1998b): Trematody of family Bithyniidae molluscs (Gastropoda, Prosobranchia) the rivers Obs (a vicinity of a city of Novosibirsk). In: *Unvertebrate animals of Southern Zauralye and adjacent territories*. Kurgan, 281 – 284 (In Russian)

SERBINA, E. A. (2002): *Bithyniidae Snails in Water Bodies in the South of West Siberia and Their Role in the Life Cycle of Trematodes*. PhD thesis, Novosibirsk, 162 pp. (In Russian)

SERBINA, E. A. (2004): Cercariae of trematodes in snails of the family Bithyniidae (Gastropoda: Prosobranchia) from the Malye Chany Lake (south of West Siberia). *Sibirskiy Ekologicheskiy Zh*., 4: 457 – 462 (In Russian)

SERBINA, E. A. (2005): Distribution of trematodes of the family Prosthogonimidae in river and lake ecological systems in the south of the Western Siberia. Parazitologiya 39(1): 50 – 65 (In Russian)

SERBINA, E. A. (2006): Prevalence of Trematodas Family Psilostomatidae Odhner, 1913 in the South of West Siberia. *Sibirskiy Ekologicheskiy Zh*., 13(4): 409 – 418 (In Russian)

SERBINA, E. A. (2008): Characteristics of the seasonal development of *Schistogonimus rarus* (Trematoda: Prosthogonimidae). An essay on quantitative estimation of the trematode in the ecosystem of the Malye Chany lake2 (south of Western Siberia). *Parazitologiya*, 42(1): 53 – 65 (In Russian)

SERBINA, E. A. (2009): Distribution of Trematodas Echi-

nochasmidae Odhner, 1911 Family in ecosystem the south of the Western Siberia. In *III inter-regional scientific conference for parasitologists of Siberia and the Far East. Devoted to the 80 years old of professor KP Fedorova*. Novosibirsk, 264 – 267 (In Russian)
SERBINA, E. A. (2010a): Shell as an Indicator of the Growth Rate of Freshwater Gastropods of the Family Bithyniidae. *Contemp. Probl. Ecol*., 3(1): 19 – 27
SERBINA, E. A. (2010b): Coevolution of the Host - Parasite systems (Bithyniidae-Trematode). In: BE`ER, S. A. (Ed) *Biodiversity and Ecology of Parasites.* Transactions of Center for Parasitology. Nauka, Moscow 46: 239 – 259 (In Russian)
SERBINA, E. A. (2012): Biological value of seasonal cercarial emission of trematodas families Opisthorchidae and Echinochasmidae from ecosystems of south of Western Siberia. *Russ. Parasitol. J*. 3: 28 – 34 (In Russian)
SERBINA, E. A. (2013a): A Quantitative Estimation of the Role of Bithyniidae Snails (Gastropoda: Prosobranchia) in the Ecosystems of the Southern Part of Western Siberia (Russia). *Contemp. Probl. Ecol*., 6 (1): 28 – 33
SERBINA, E. A. (2013b): Versions of trixenic life cycles. trematodes from *Bithynia* (Gastropoda: Prosobranchia Bithyniidae) Palaearctic. *Russ. Parasitol. J.*, 2: 29 – 39
SERBINA, E. A. (2013c): Variety dixenic life cycles of trematode from Bithyniidae snails (Mollusca: Gastropoda: Prosobranchia) Palaearctic. *Russ. Parasitol. J.*, 3: 49 – 57. (In Russian)
SERBINA, E. A. (2014): The influence of trematode metacercariae on the individual fecundity of *Bithynia troscheli* (Gastropoda: Bithyniidae). *Parazitologiya*, 48, (1): 3 – 19
SERBINA, E. A., BONINA, O. M. (2011): Revealing local nidi of opisthorchidoses in flood-lands of river Ob and in Novosibirsk man-made lake. Message 2. Prosobranchia mollusca's number and infection of their by parteniters of trematoda. *Russ. Parasitol. J.*, 4: 55 – 59 (In Russian)
SERBINA, E. A., TOLSTENKOV, O. O., TERENINA, N. B. (2012): Cercariae of Sphaerostomum globiporum (Rudolphi, 1802): Trematoda, Opecoelidae – biology, distribution, morphofunctional characteristic. Morphology, Systematisatics and Ecology of Parasites. *Transactions of Center for Parasitology*. Nauka, Moscow 47, 230 – 238 (In Russian)
SUDARIKOV, V. E. (1974): The biology of some trematode species from the suborder *Cyathocotylata*. In: *Ecology and geography of helminths*. Tr. Geľmintol. Lab., Nauka, Moscow, 24: 182 – 194
SUDARIKOV, V. E., SHIGIN, A. A., KUROCHKIN, YU. V., LOMAKIN, V. V., STENKO, R. P., YURLOVA, N. I. (2002): *Metacercariae of trematodes parasites of freshwater hydrobionts in Central Russia*. Nauka, Moscow 298 pp. (In Russian)
VOJTEK, I., VOJTKOVA, L. (1968): To knowledge of life cycle *Holostephanus dubinini nov.* sp. (Cyathocotylidae, Trematoda). *Tr. Astrakh. Zapov*., 11: 13 – 27
YURLOVA N. I., SERBINA E. A. (2004): New data on *Cyathocotyle bushiensis* (Trematoda: Cyathocotylidae). *Parazitologiya*, 38, 191 – 205 (In Russian)
YURLOVA N. I., VODYANITSKAYA S. N, SERBINA E. A., BISERKOV V. Y., GEORGIEV B. B., CHIPEV N. H. (2006): Temporal Variation in Prevalence and Abundance of Metacercariae in the Pulmonate Snail *Lymnaea stagnalis* in Chany Lake, West Siberia, Russia: Long-Term Patterns and Environmental Covariates. *J. Parasitol*., 92(2): 249 – 259. DOI: 10.1645/GE-544R2.1
ŽĎÁRSKÁ, Z. (1963): Trematode larval stages of aquatic snails in the territory of the CSSR. *Československ. Parasitol*., 10: 207 – 262 (In Czech)

RECEIVED APRIL 04, 2014

ACCEPTED JULY 7, 2014