

Short communication: An overview of the trematodes fauna of pool frog *Pelophylax lessonae* (Camerano, 1882) in the Volga Basin, Russia: 2. Larval stages

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Abstract. Chikhlyayev IV, Ruchin AB, Fayzulin AI. 2019. Short communication: An overview of the trematodes fauna of the pool frog *Pelophylax lessonae* (Camerano, 1882) in the Volga Basin, Russia: 2. Larval stages. *Nusantara Bioscience* 11: 106-111. This paper presents data on the trematodes fauna of the pool frog *Pelophylax lessonae* (Camerano, 1882) from 13 regions of the Volga Basin. It consolidates data from different authors over the past 30 years, supplemented by our own research results. There are authentically known findings of 10 trematodes species at the larval stage of development. The species *Codonocephalus urniger* (Rudolphi, 1819), mtc., *Neodiplostomum spathoides* Dubois, 1937, mtc. and *Pharyngostomum cordatum* (Diesing, 1850), mtc. have been observed for the first time in the given host on the territory of Russia and Volga basin. For each species of trematodes, there is the following information included: taxonomic position, localization, area of detection, biology, definitive hosts, geographic distribution and degree of host-specificity.

Keywords: Larval stages, *Pelophylax lessonae*, pool frog, trematodes, Volga Basin

INTRODUCTION

Amphibians play a significant role in the coastal (near-water) biocoenosis. Being a common small predator and also a food object at the same time, they serve as an important intermediary element in the process of transferring substance and energy from the invertebrates of lower trophic level to the predatory vertebrates of the higher trophic levels. In parallel with this, as an intercalary, additional and/or reservoir host, the amphibians circulate through the trophic relations of different helminth species, including those that are pathogenic in animals and humans. Being parasitic on frogs, the larval stages of helminths indicate the presence/absence of particular predator species in a given biocoenosis, and may serve as bioindicators of the degree of anthropogenic environmental transformation, in both rural and urban ecosystems. The pool frog *Pelophylax lessonae* (Camerano, 1882) is one of the most commonly occurring and numerous forest amphibians. It lives in shallow, standing and overgrown pools in the lowland broadleaved and mixed forests of Europe, where it is one of the main components of the diet of snakes, mustelids and large amphibians (cannibalism). In addition, it is has been noted in the diet of pikes, European pond turtles, various near-water inhabitants, storks, diurnal birds of prey and owls, rodents, insectivorous and canine mammals (Kuzmin 2012; Sainsbury et al. 2017; Korzikov and Aleksanov 2018).

The wide range of predators that consuming the pool frog are also consuming the larval stages of parasitic the

helminths (trematodes), which then develop through a change in hosts. The trematode has been studied in the territory of the pool frog's habitat in a narrow range of countries: Poland (Grabda-Kazubska 1972; Popiolek et al. 2011), the former Czechoslovakia (Vojtkova 1974; Vojtkova and Vojtek 1975), modern Serbia (Bjelic-Cabrilo et al. 2009), Belarus (Shimalov 2002, 2008, 2009) and Ukraine (Volgar-Pastukhova 1959; Mazurmovich 1965; Maguza 1973). Data from the last century is reflected in a consolidated work on the trematodes in frogs and toads of the European countries (Vojtkova and Roca 1994). It should be noted that the discovery of hybrid speciation within the population system of the *Pelophylax esculentus* complex and the difficulties associated with the species diagnostics of green frogs have complicated the study of their helminths (Cavlovic et al. 2018; Fayzulin et al. 2018). In Russia, the combined information on the trematodes fauna of the pool frog was presented in a single general summary (Ryzhikov et al. 1980) and later in two regional ones (Chikhlyayev et al. 2012a, b).

This article is part of a series included into a cycle of publications on the modern character of a helminth fauna from amphibians of the Volga Basin (Ruchin et al. 2009, 2016; Reshetnikov et al. 2013; Chikhlyayev and Ruchin 2014; Chikhlyayev et al. 2016b). The aim of the study was to present a review of the fauna of the larval stages of trematodes of pool frogs from Volga Basin populations on the basis an analysis of literature sources analysis and our own research.

MATERIALS AND METHODS

In the period from 1936 to 2016, many authors had examined 1,460 specimens of pool frog from 13 regions of the Volga basin, among which are: Kaluga, Moscow, Ivanovo, Kostroma, Nizhny Novgorod, Tambov, Ulyanovsk and Samara regions, the Republics of Mordovia, Chuvashia, Mari El, Tatarstan and Bashkortostan. For species determination of trematodes, we used reports of Ryzhikov et al. (1980). At distribution on taxons adhered to the modern data on systematics of trematodes (Tkach et al. 1999, 2000, 2001; Olson et al. 2003; Keys to the Trematoda 2002, 2008) and given the website “Fauna Europaea” (<http://www.fauna-eu.org>).

RESULTS AND DISCUSSION

In the pool frog population of the Volga Basin, there are 10 registered species of trematodes in the larval stage of development, belonging to eight genera, four families and two orders (Table 1). Three species of trematodes are indicated for the first time from this host in this basin: *Codonocephalus urniger* (Rudolphi, 1819), mtc., *Neodiplostomum spathoides* (Dubois, 1937), mtc. and *Pharyngostomum cordatum* (Diesing, 1850), mtc. All 10 species of trematodes were found only in the larval stage, so they are using the amphibians as intercalary (mesocercaria), intermediate (metacercaria) and/or reservoir (parathenic) hosts. Of these, eight species are broadly specific, polyhostal parasites of anurans whilst two (*C. urniger*, mtc., *N. spathoides*, mtc.) are specific, oligohostal for the Family Ranidae.

Below is an annotated list of pool frog trematodes species, including their systematic position, localization, areas of detection, biology and geographic distribution. Also, information on the degree of parasites host-specificity is provided. In addition, for each species of helminths, a list of their definitive hosts within Russia is indicated, corrected according to an analysis of the literature, including Ryzhikov et al. (1980); Sudarikov et al. (2002); Kostyunin (2010); Chikhlyaev et al. (2012a,b); Kirillov et al. (2012, 2018); Kuzmin (2012).

Class: Trematoda (Rudolphi, 1808)
Order: Plagiorchiida (La Rue, 1957)
Family: Leptophallidae (Dayal, 1938)

Paralepoderma cloacicola (Luhe, 1909), mtc.

Localization: Kidneys.

Areas of detection: The region of Nizhny Novgorod, Tambov and Samara regions, the Republics of Chuvashia and Tatarstan.

Biology: Metacercariae of this species: widely specific parasites of amphibians. Trixenic life cycle. Intermediate hosts: gastropod mollusks genera *Planorbis* and *Planorbarius* (Dobrovolsky 1969; Grabda-Kazubska 1975), definitive hosts: grass and dice snakes.

Definitive hosts: Serpentes (*Natrix natrix* (Linnaeus, 1758), *Natrix tessellata* (Laurenti, 1768), *Vipera renardi* (Christoph, 1861) (rarely)).

Distribution: Palearctic.

Order: Strigeida (La Rue, 1926)

Family: Strigeidae (Railliet, 1919)

Strigea falconis (Szidat, 1928), mtc.

Localisation: Musculature.

Areas of detection: Samara region and the Republic of Tatarstan.

Biology: Meso- and metacercariae stage it is a specific parasite of anurans Family Ranidae. Tetraxenic life cycle. Intermediate host is a gastropod mollusks genus *Planorbis*. Adult stages complete development in the intestine of diurnal birds of prey (Odening 1967).

Definitive hosts: Falconiformes (*Pandion haliaetus* (Linnaeus, 1758), *Haliaeetus albicilla* (Linnaeus, 1758), *Falco subbuteo* (Linnaeus, 1758), *Falco tinnunculus* (Linnaeus, 1758), *Accipiter nisus* (Linnaeus, 1758), *Accipiter gentilis* (Linnaeus, 1758), *Accipiter brevipes* (Severtzov, 1850), *Aquila chrysaetos* (Linnaeus, 1758), *Aquila clanga* (Pallas, 1811), *Buteo buteo* (Linnaeus, 1758), *Buteo lagopus* (Pontoppidan, 1763), *Circus aeruginosus* (Linnaeus, 1758), *Milvus migrans* (Boddaert, 1783)).

Distribution: Cosmopolitan.

Strigea sphaerula (Rudolphi, 1803), mtc.

Syn.: *Tetracotyle crystallina* (Rudolphi, 1819), mtc.

Syn.: *Tetracotyle sphaerula* (Rudolphi, 1803), mtc.

Localization: Serous coat of inner organs, pericardium, musculature.

Areas of detection: Regions of Nizhny Novgorod and Samara regions, the Republic of Mordovia.

Biology: Meso- and metacercariae of this species: widely specific parasite of anurans. Tetraxenic life cycle. Intermediate hosts: gastropod mollusks genera *Planorbis*, *Anisus*, and *Segmentina*. Definitive hosts: corvids (Odening 1966a, 1967).

Definitive hosts: Corvidae (*Corvus cornix* (Linnaeus, 1758), *Pica pica* (Linnaeus, 1758), *Corvus monedula* (Linnaeus, 1758), *Corvus frugilegus* (Linnaeus, 1758); *Columba livia* (Gmelin, 1789), *Anas platyrhynchos* (Linnaeus, 1758), *Buteo buteo* (sporadically)).

Distribution: Europe.

Strigea strigis (Schrank, 1788), mtc.

Syn.: *Tetracotyle strigis* (Schrank, 1788), mtc.

Syn.: *Tetracotyle colubri* (Linstow, 1877), mtc.

Localization: Serous coat of inner organs, mesentery, musculature.

Areas of detection: Regions of Kaluga, Nizhny Novgorod and Samara regions, the Republics of Mordovia, Chuvashia, and Tatarstan.

Biology: Meso- and metacercariae stage it is a widely specific parasite of anurans. Tetraxenic life cycle. Intermediate host is a gastropod mollusks genus *Planorbis*. Definitive hosts: owls (Odening 1966b, 1967).

Definitive hosts: Strigidae (*Bubo bubo* (Linnaeus, 1758), *Asio otus* (Linnaeus, 1758), *Asio flammeus* (Pontoppidan, 1763), *Strix aluco* (Linnaeus, 1758), *Strix uralensis* (Pallas, 1771), *Athene noctua* (Scopoli, 1769), *Tyto alba* (Scopoli, 1769)); and rarely Falconiformes
Distribution: Palearctic.

Family: Diplostomidae (Poirier, 1886)

Codonocephalus urniger (Rudolphi, 1819), mtc.

Localization: Body cavity, serous coat of internal organs, adipose bodies, musculature.

Area of detection: Samara region. First discovered in the pool frog of the fauna of Russia and the Volga Basin.

Biology: Metacercariae of this species it is a specific parasite of green frogs (gen. *Pelophylax*). Trixenic life cycle. Intermediate hosts are gastropod mollusks genus *Lymnaea*. Adult stages parasitize in the intestine of long-legged wading birds (Niewiadomska 1964).

Definitive hosts: Ciconiiformes (*Botaurus stellaris* (Linnaeus, 1758), *Ixobrychus minutus* (Linnaeus, 1766), *Ardea cinerea* (Linnaeus, 1758)).

Distribution: Palearctic.

Neodiplostomum spathoides (Dubois, 1937), mtc.

Syn.: *Neodiplostomulum minor* (Dubinina, 1950), mtc.

Syn.: *Neodiplostomulum cochleare* (Krause, 1914), mtc.

Localization: Musculature, body cavity, subcutaneous tissue.

Area of detection: Samara region. First discovered in the pool frog of the fauna of Russia and the Volga Basin.

Biology: At this stage it is a specific parasite in green frogs. Trixenic life cycle. Intermediate hosts are a gastropod mollusks genera *Planorbis* and *Planorbarius*. Definitive hosts are diurnal birds of prey (Sudarikov 1960a; Odening 1965a, b).

Definitive hosts: Falconiformes (*Pernis apivorus* (Linnaeus, 1758), *A. clanga*, *B. buteo*, *C. aeruginosus*, *M. migrans*, *Falco vespertinus* (Linnaeus, 1766), *F. tinnunculus*, *P. haliaetus*, *H. albicilla*).

Distribution: Palearctic.

Tylodelphys excavata (Rudolphi, 1803), mtc.

Syn.: *Tylodelphys rhachiaea* (Henle, 1895), mtc.

Localisation: spinal cord canal.

Areas of detection: Moscow, Nizhny Novgorod and Samara regions, the Republics of Mordovia and Tatarstan.

Biology: Metacercariae of a trematode it is a specific parasite of anurans family Ranidae. Trixenic life cycle. Intermediate hosts are gastropod mollusks genera *Planorbis* and *Coretus*. Adult stages complete their development in the intestines of long-legged wading birds (Sudarikov 1960a).

Definitive hosts: Ciconiiformes (*A. cinerea*, *Nycticorax nycticorax* (Linnaeus, 1758), *B. stellaris*, *I. minutus*).

Distribution: Palearctic.

Alaria alata (Goeze, 1782), msc.

Localisation: Musculature, mesentery, serous coat of the internal organs.

Areas of detection: Region of Nizhny Novgorod, Tambov, Ulyanovsk and Samara regions, the Republics of Mordovia, Chuvashia and Tatarstan.

Biology: Mesocercariae stage: widely specific parasite of anurans. Trixenic life cycle. Intermediate hosts: gastropod mollusks of genera *Planorbis* and *Anisus*. Definitive hosts: canids (Sudarikov 1959, 1960b).

Definitive hosts: Canidae (*Nyctereutes procyonoides* (Grey, 1834), *Canis lupus* (Linnaeus, 1758), *Vulpes vulpes* (Linnaeus, 1758)).

Distribution: Cosmopolitan.

Pharyngostomum cordatum (Diesing, 1850), mtc.

Syn.: *Neodiplostomulum major* (Dubinina, 1950), mtc.

Syn.: *Neodiplostomulum spathoides* (Dubois, 1937), mtc.

Localization: Musculature, mesentery, pericardium, body cavity, stomach and intestinal walls.

Area of detection: Samara region. First discovered in the pool frog of the fauna of Russia and the Volga Basin.

Biology: Metacercariae of this species it is a specific parasite of green frogs. Trixenic life cycle. Intermediate host is a gastropod mollusks genus *Planorbis*. Adult stages - intestines of wild and domesticated carnivores (Sudarikov 1960b; Sudarikov et al. 1991).

Definitive hosts: Canidae (*N. procyonoides*, *V. vulpes*, *C. lupus*), Felidae (*Felis silvestris* (Schreber, 1775)).

Distribution: Palearctic.

Incertae sedis group

Family: Encyclometridae (Mehra, 1931)

Encyclometra colubrimurorum (Rudolphi, 1819), mtc.

Syn.: *Encyclometra natrix* (Baylis and Cannon, 1924), mtc.

Localization: Body cavity, serous coat of internal organs (liver, spleen, ovaries), mesentery.

Areas of detection: Region of Tambov, Ulyanovsk and Samara regions, the Republic of Tatarstan.

Biology: Metacercariae stage it is a specific parasite of anurans families Ranidae and Pelobatidae. Life cycle not completely studied. Intermediate hosts: are unknown. Adult stages parasitize in the gullets and stomachs of grass and dice snakes, and rarely in vipers (Sharpilo 1976).

Definitive hosts: Serpentes (*N. natrix*, *N. tessellata*, *Vipera berus* (Linnaeus, 1758), and rarely *V. renardi* (rarely)).

Distribution: Palearctic.

The largest number of quantity species of trematodes (10) was registered in pool frogs in the Samara (10 species) region. Average numbers were recorded in the Republics of Tatarstan (six) and Mordovia (four), and the Nizhny Novgorod region (five). The least numbers were found in the Tambov region and the Republic of Chuvashia (both three), and the Ulyanovsk (two), Moscow and Kaluga (one each) regions. The larval stages of trematodes in pool frogs

in the Ivanovo and Kostroma regions, and the Republics of Mari El and Bashkortostan, were not registered (Table 1).

These differences are of a biotopic nature, depending on the conditions of the habitat and the diversity of the amphibians in a particular biotope, each of which is characterized by its own historically-related complex of abiotic and biotic factors. On the other hand, the distributions could also be due to geographical location, level of anthropogenic impact and the difference in size of the amphibian samplings.

The trematodes faunas of the pool frog vary significantly in the Volga Basin. Of the registered 10 species, not all were noted in all regions. The trematode of *A. alata*, msc. found in seven regions of 13 locations examined, was the most often found. One species (*S. strigis*, mtc.) was detected in six regions, two species (*P. cloacicola*, mtc., *T. excavata*, mtc.) in five and one (*E. colubrimurorum*, mtc.) in four regions. The other species are seldom seen in this host. In particular, *S. falconis*, mtc., *C. urniger*, mtc. *N. spathoides*, mtc. and *Ph. cordatum*, mtc. were found locally and they were observed in one or two regions (Table 1).

The helminth faunas in the amphibians are closely connected to their way of life and are formed depending on biotopic timing, the duration of their stay in the water and the food spectrum. Pool frog helminths composition in the Volga Basin are more than 25% represented by trematode larval stages (10 species). Their development proceeds in five types and two subtypes in two life cycles groups. Most circulates on trixenic (six types); less on tetraaxenic (three), cycles. This indicates a wide array of definitive hosts involved in the circulation of the parasites, including snakes (two species), owls (one), corvids (one), diurnal birds of prey (two) and long-legged wading birds (two), and canids (two). This species of amphibians plays a significant role in the transfer of the mesocercariae and metacercariae of trematodes to their reservoir hosts (common and marsh frogs, common toads, vipers, pond turtles, ducks and gulls, rodents, mustelids and insectivores, wild boars). All this points to the importance of the pool frog as valuable food resources in the ration of predators of a higher trophic level in the natural biocenosis of the Volga basin.

Table 1. Trematode larval stages in the pool frog *Pelophylax lessonae* in the Volga basin regions

Trematodes species	KL	MS	IV	KS	NN	TM	UL	SM	RM	CH	ME	TT	BS
Class Trematoda (Rudolphi, 1808)													
Order Plagiorchiida (La Rue, 1957)													
Family Leptophallidae (Dayal, 1938)													
<i>Paralepoderma cloacicola</i> , mtc.					+	+		+		+		+	
Order Strigeida (La Rue, 1926)													
Family Strigeidae (Railliet, 1919)													
<i>Strigea falconis</i> , mtc.								+					+
<i>Strigea sphaerula</i> , mtc.					+			+	+				
<i>Strigea strigis</i> , mtc.	+				+			+	+	+			+
Family Diplostomidae (Poirier, 1886)													
<i>Codonocephalus urnigerus</i> , mtc.								+					
<i>Neodiplostomum spathoides</i> , mtc.								+					
<i>Tylodelphys excavata</i> , mtc.		+			+			+	+				+
<i>Alaria alata</i> , msc.					+	+	+	+	+	+			+
<i>Pharyngostomum cordatum</i> , mtc.								+					
Incertae sedis group													
Family Encyclometridae (Mehra, 1931)													
<i>Encyclometra colubrimurorum</i> , mtc.							+	+	+				+
Total number of species	1	1	-	-	5	3	2	10	4	3	-	6	-
Number of specimens examined	22	121	132	134	418	40	17	203	53	38	8	257	17

Note: KL: Kaluga region (Chikhlyayev et al. 2016a); MS: Moscow region (Kotova 1936); IV: Ivanovo region (Kirillova 2002; Kirillova and Egorov 2002); KS: Kostroma region (Radchenko and Budalova 1980); NN: Nizhny Novgorod region (Borisova 1988; Nosova 1983, 1985, 1990, 1993; our data); TM: Tambov region (Rezvantseva and Chikhlyayev 2005; Kolodina et al. 2016); UL: Ulyanovsk region (Indiryakova et al. 2008); SM: Samara region (Evlanov et al. 2001, 2002; Chikhlyayev 2004, 2009, 2017; Fayzulin et al. 2013; Kirillov et al. 2018; our data); RM: Republic of Mordovia (Chikhlyayev et al. 2015; Ruchin et al. 2016; our data); CH: Republic of Chuvashia (Chikhlyayev and Fayzulin 2015; our data); ME: Republic of Mari El (our data); TT: Republic of Tatarstan (Smirnova 1968, 1970; Smirnova and Sizova 1978; Smirnova et al. 1987; Shaldybin 1974, 1977; our data); BS: Republic of Bashkortostan (Ayupov et al. 1974; Bayanov 1992; Yumagulova 2000).

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