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# Mollusks (*Gastropoda*) as Intermediate Hosts of Cattles' Trematodes (*Trematoda*) in Conditions of Dnipro Basin's Small Ponds (Northern Ukraine)

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## Abstract

The article presents the data on distribution and defeat of gastropod mollusks by parasitic trematodes in biotopes of small reservoirs (rivers, lakes and swamps) of the Dnipro basin of northern regions of Ukraine. During the 2016-2017 years, at the following areas were collected and identified: *Lymnaea* (L.) *stagnalis* (Linnaeus, 1758); *L. truncatula* (Müller, 1774); *Planorbis* (P.) *corneus* (Linnaeus, 1758); *P. planorbis* (Linnaeus, 1758); *Viviparus contectus* (Millet, 1813); *Valvata piscinalis* (Müller, 1774) and *Succinea pfeifferi* (Rossmässler, 1834). The microscopic study of the mollusks' liver allowed us to detect the presence of pathogens of cattle trematodoses inside a certain number of the snails – *Fasciola hepatica* (Linnaeus, 1758) and *Paramphistomum* sp. (Fischoeder, 1901). At biotopes of small rivers, 8.3% of mollusks *L. truncatula* species, 23.5% of *L. stagnalis* and 5.7% of *P. corneus* were affected. At lakes and swamps, the number of affected L. truncatula was 36.3%, and *L. stagnalis* – 13.7%. It was determined the defeat of ruminants with fasciolosis and paramfistomatoses in designated regions. It testifies to the formation of sustainable natural foci of these invasions.

**Keywords:** Cattle, *Fasciola hepatica*, Gastropod mollusks, *Paramphistomum* sp., trematodes

## Introduction

The parasitic system is a special biosystem based on the trophic relationship between the parasite and the host (Beklemishev, 1970). The functioning of parasitic systems, in particular, the regulation of the relationship between their members, is ensured by a whole complex of environmental factors (Antipov et al., 2018; Kennedy, 1978; Krasnoshchekov, 1996).

Trematodes (*Treamentoda: Digenea*) are extremely common in tropical and subtropical climates (including Bolivia, Ecuador, Peru, Cuba, Egypt, Turkey, Iran), as well as in the European Union, Russia and Ukraine. Intermediate hosts of trematodes are freshwater gastropods (Caminade et al., 2015; Cañete et al., 2004; Caron et al., 2014; El-Shazly et al., 2012; Gorokhov et al., 2010; Khoramian et al., 2014; Lopez et al., 2012; Novobilský et al., 2013; Rondelaud et al., 2015; Stadnichenko, 2006).

Trematodes, which parasitize in the organs of the digestive system of cattle (in particular in the duodenum, the liver and the sections of the multi-chamber stomach) are an important epizootic danger to the cattle breeding of these countries (Munguía-Xóchihua et al., 2007). In this context, separate representatives of the following species should be singled out: *Fasciola hepatica* (*F. hepatica*) (Linnaeus, 1758), *Paramphistomum ichikawai* (Fukui, 1922), *Paramphistomum cervi* (Schrank, 1790) and *Liorchis scotiae* (Willmott, 1950).

Gastropods mollusks (*Gastropoda*) the most numerous class in the *Mollusca* type (Linnaeus, 1758), which has about 60.000-75.000 species (Zhadin, 1926). Among the gastropods, there are very few real parasites, for example: *Eulima bilineata* (Alder, 1848), parasite of bottom marine animals (*Ophiuroidea*; Grey, 1840) from the type of echinoderms (*Echinodermata*; Klein, 1734) (Nekhaev, 2011).

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However, many species of gastropods are included to the life cycle of helminths and the epizootic chain of domestic animals' invasive diseases, in particular *Fasciola* and *Paramphistomum* invasion of cattle.

According to their biology, freshwater mollusks are natural inhabitants of large and small ponds involved in water purification and are indicator species for determining the degree of anthropogenic loading of biotopes. The fauna of mollusks depends to a large extent on the propagation of certain types of higher vegetation and depth of water bodies, velocity, temperature and pH of water in the pond (Bennema et al., 2011; Sargison et al., 2016; Zhytova and Kornyushyn, 2017).

In Ukraine, the northern Polissya regions, geographical center of which is in the territory of Kyiv and Zhytomyr regions, are characterized by the largest species diversity of gastropods in the small rivers of the Dnipro basin (Zhytova and Kornyushyn, 2017). It causes a severe enzootic situation with *Trematoda* invasions of large and small ruminants in this zone.


Figure 1. Points of mollusks' collecting at nothern regions of Ukraine (Dnipro basin)


Figure 2. Shells of *Lymnaea truncatula* (Muller, 1774)

So, the study of the epizootology of ruminant animals' trematodoses and freshwater fauna is closely interrelated and the provision of quality products and profitability of cattle breeding in endemic areas is impossible without comprehensive knowledge about ecology of the gastropods.

## Materials and Methods

The research protocol of the current study was approved by the Ethic Committee of the Zhytomyr National Agroecological University (Approval number: 2016/07).

Freshwater mollusks were collected during 2016-2017 from river basins and their tributaries-rivers Teteriv and Sluch (Zhytomyr region), Bucha, Ros, Skvira (Kiev region). Particular attention was paid to the study of the malakofauna of lakes and swamps, which are located on the territory of these regions. Points of mollusks' collecting are shown on the map (Figure 1).

In general, more than one thousand specimens of molluscs from the family *Lymnaeidae* (2 species), *Valvatidae* (1 species), *Planorbidae* (2 species), *Viviparidae* (1 species) and *Succineidae* (1 species) were investigated. Cameral processing of materials was carried out in accordance with the recommendations of Zdun (1961). The molluscs were harvested using common methods (Stadnichenko, 2006). Identification of the species of mollusks was carried out according to external conchological features (Stadnichenko, 2004).

For histological study of the most common species of mollusks – *Lymnaea stagnalis* (*L. stagnalis*) (Linné, 1758), *Planorbarius corneus* (*P. corneus*) (Linné, 1758), hepatopancreas was taken from which were made preparations for parasitological microscopic examination. The presence of partenites (rediae) and larvae (cercariae) in the body of mollusks was determined using a microscope "XS-6320 (MICROmed, Poltava, Ukraine)". The intensity of the invasion was assessed visually according to the following criteria: weak-larvae defeat less than 1/10 volume of hepatopancreas; average-from 1/10 to 1/2; and strong – more than 1/2.

## Results and Discussion

From the biotopes of groundwater ponds of the Dnipro basin in Kiev and Zhytomyr regions, we collected and identified 6 species of freshwater mollusks: *L. stagnalis* (Linnaeus, 1758); *L. truncatula* (Müller, 1774); *P. corneus* (Linnaeus, 1758); *P. planorbis* (Linnaeus, 1758); *Viviparus contectus* (Millet, 1813); *Valvata* (*V.*) *piscinalis* (Müller, 1774), and 1 terrestrial species – *Succinea* (*S.*) *pfeifferi* (Rossmässler, 1834).

Dominant species were *L. truncatula, L. stagnalis,* and *P. corneus* with a population density of 4-9 specimens/m$^2$ in the spring, in the summer of 14-20 specimens/m$^2$, and in the autumn, 1-3 specimens/m$^2$. Other species occurred singly, 1-3 specimens/m$^2$. For trematodes (*Trematoda: Digenea*) of ruminants, as intermediate hosts can serve: *L. truncatula* – for *Fasciola hepatica*

(Figure 2); *L. stagnalis* (Figure 3), *L. truncatula* and *P. corneus* (Figure 4) – for pathogens *Paramphistomidae* sp.; *S. pfeifferi* (Figure 5), sometimes may be an intermediate host of the dicrocoeliosis' pathogen (*Dicrocoelium lanceatum*) (Charlier et al., 2016; Dreyfuss et al., 1999; Faltýnková et al., 2008; Hodasi, 1972; Vignoles et al., 2016; Zhytova and Kornyushyn 2012).

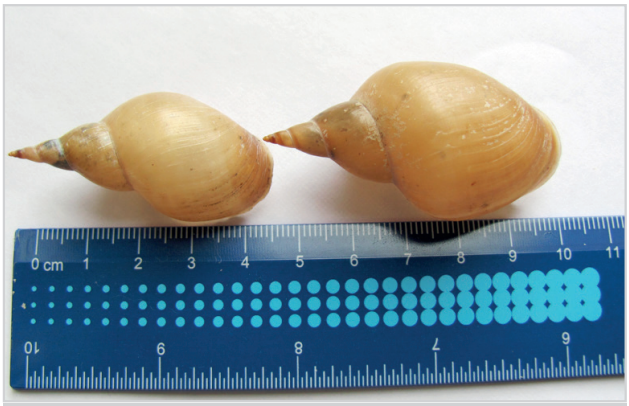


Figure 3. Shells of *Lymnaea stagnalis* (Linnaeus, 1758)


Figure 4. Shells of *Planorbis corneus* (Linnaeus, 1758)


Figure 5. Shells of *Succinea pfeifferi* (Rossmässler, 1834)

Mollusk *V. piscinalis* can be the first intermediate host for trematodes *Ichthyocotylurus pileatus* (Rudolphi, 1802) and *Diplostomum baeri* (Dubois, 1937), the additional hosts of which are freshwater fish, and the definitive – gulls. According to the fact that there is no literature data about the distribution of ruminant trematodes' larvae in *V. piscinalis*, microscopic examination of these mollusks' hepatopancreas was not carried out. Our studies have confirmed that the ratio of species of molluscs in a certain area and the level of their invasion by partenites and larvae of the trematodes depend on the biotope's characteristics.

Thus, the malakofauna of small flowing (rivers, their tributaries and floodplains) and standing reservoirs (lakes, swamps) of the Dnipro basin of northern Ukraine differed considerably.

The data obtained is illustrated in Table 1, from which it is evident that part of the representatives of the species *L. truncatula* (up to 36.3%) was affected by rediae and cercariae of *F. hepatica* (Figure 6); up to 23.5% of *L. stagnalis* mollusks contained parthenogenetic genera of both *F. hepatica* and *Paramphistomum* sp. in hepatopancreas; some specimens of gastropods of the

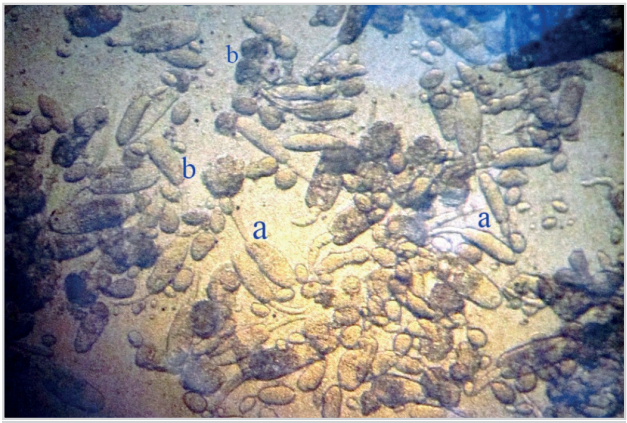


Figure 6. a, b. Parasitic trematode larvae (Trematoda: Digenea) in the liver of mollusk *Lymnaea truncatula* (Muller, 1774): a) mature cerkarias; b) young cerkarias

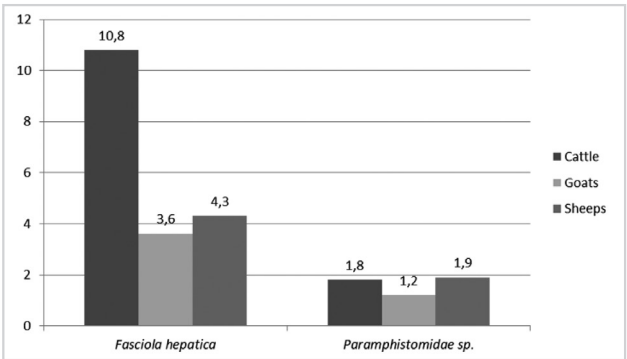


Figure 7. Average extensiveness of the invasion of large and small cattle by trematodes in the territory of Kyiv and Zhytomyr regions during 2016-2017, %

**Table 1.** Parasitologic study of mollusks' hepatopancreas (selected from ponds, Dnipro basin, Northern Ukraine)

| Species of Mollusks | Extensiveness of the Invasion, % | | Level of the Invasion | |
|---|---|---|---|---|
| | Biotopes of Lakes and Swamps | Biotopes of Rivers | Biotopes of Lakes and Swamps | Biotopes of Rivers |
| *L. truncatula* (Müller, 1774) | *F. hepatica* | | | |
| | 36.3 | 8.3 | Average | Weak |
| *L. stagnalis* (Linnaeus, 1758) | *F. hepatica* and *Paramphistomidae* sp. | | | |
| | 13.7 | 23.5 | Weak | Strong |
| *P. corneus* (Linnaeus, 1758) | *Paramphistomidae* sp. | | | |
| | 0 | 5.7 | 0 | Weak |
| *P. planorbis* (Linnaeus, 1758) | *Paramphistomidae* sp. | | | |
| | 0 | 0 | 0 | 0 |
| *S. pfeifferi* (Rossmässler, 1834) | *Dicrocoelium lanceatum* | | | |
| | 0 | 0 | 0 | 0 |

species *P. corneus* (5.7%) were invasive solely by *Paramphistomum* sp. trematodes.

Taking into account that *L. truncatula* mollusks are biological hosts exclusively for *F. hepatica*, as well as the fact that they are widely distributed in the ponds of Ukrainian Polissya and the damage by the trematodes' partenites and larvae (especially in biotopes of lakes and swamps), there is a high risk for ruminants about fasciolosis throughout the studied area.

In contrast, the populations of *L. stagnalis* species of mollusks, which are often infected with rediae and cercariae of *F. hepatica* and *Paramphistomidae* sp., are more numerous near rivers than near standing water bodies.

Thus, in the northern regions of Ukraine at ponds of Dnipro basin, the predominant number of cases of cattle contamination by pathogens of paramfistomoses occurs near the rivers, and invasion by fascioles – near any ponds (both flowing and standing).

To establish the scale of the damage by the ruminant animals' trematodes in the investigated area, we have analyzed the official data of the state veterinary service in the Kyiv and Zhytomyr regions for 2016-2017. The analysis results are presented in Figure 7. The high extensiveness of ruminal invasion with *Paramphistomidae* sp. (1.2-1.9% of all examined animals), and especially *F. hepatica* (3.6-10.8%), confirm the obtained data on the widespread distribution of the diseases in the northern regions of Ukraine.

It is known that 25% invasion of malakofauna with helminths in a particular region is quite sufficient for the preservation and spread of the disease among the favorable domestic animals (Beesley et al., 2017). Just in one mollusc can develop at the same time more than 100 trematodes' cercariae. This is confirmed by our own research, according to which, up to 11% of cattle in the territory of Kyiv and Zhytomyr regions are having fasciolosis. It is not a critical indicator, but it is also not a reason to ignore the problem, since the stationary troubles of farms bring not less economic damage than sudden outbreaks of especially dangerous diseases.

To disrupt the stability of the parasitic system (trematodes-mollusks-ruminants), a sharp change in external environmental factors may occur. For example, the subletal for gastropods is the temperature of water above 27°C, depending on the type of mollusk (Afanasyev, 1993), due to the population of mollusks in the waters of Central Europe in the summer, it is sometimes significantly reduced. However, representatives of the subclass *Pulmonata* (Cuvier, 1817), adapted to the sharp fluctuations of temperature, falling into the summer (aestivation period) or winter (hibernation period) lethargy.

In most of the water systems of the Dnipro basin in the north of Ukraine, conditions for the development of freshwater mollusks are quite favorable. The climate of this area is mild, moderately continental. Endemic species of molluscs are evolutionally adapted to possible short-term critical climatic oscillations, as evidenced by the seasonal fluctuations of the number of gastropods in the studied ponds.

Thus, the presence of a permanent population of gastropod mollusks, affected by trematodes' pathogens, in small ponds of the north of Ukraine creates a permanent natural reservoir of fasciolosis and paramfistomatoses. This does not let to allow the cattle to be protected from further invasion without using of complex control measures against helminths.

## Conclusion

In the biotope of natural ponds of the Dnipro basin at the northern regions of Ukraine, there are 7 species of gastropods, which are intermediates of ruminant's trematodes: *L. stagnalis,*

*L. truncatula, P. corneus, P. planorbis, Viviparus contectus, V. piscinalis* and *S. pfeifferi*. The first three species are dominated by numbers: from 4 to 9 specimens/$m^2$ in spring, from 14 to 20 per $m^2$ in summer, and from 1 to 3 per $m^2$ in autumn.

Intraspecies indices of mollusks' invasiveness by partenites and larvae of the trematodes varied depending on the type of ponds. More often (23.5%) and more intensively the *L. stagnalis* population was affected by rediae and cercariae of *F. hepatica* and *Paramphistomum* sp., while in *P. corneus* (5.7%) was found only *Paramphistomum* sp. in rivers' biotopes. Indices of damage to mollusks of the species *L. truncatula* by the *F. hepatica* trematodes increased in lakes and swamps (36.3%).

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