

Digenea species in chosen populations of freshwater snails in northern and central part of Poland

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ABSTRACT. **Background**. The aim of this work was to determine the biodiversity of digenean larvae in the snail populations from various water bodies. **Material and methods**. Snails under study were collected from 29 reservoirs situated in northern and central part of Poland. During the period 1999-2005 10.581 snails from 6 species (among which two species dominated: *Lymnaea stagnalis* — 9.469, and *Planorbarius corneus* — 737 specimens) were examined for shedding cercariae. The total number of 4.404 molluscs was parasitized by 25 species of Digenea. The dominant species found were: *Diplostomum pseudospathaceum* (Diplostomidae), *Echinoparyphium aconiatum* (Echinostomatidae) *Plagiorchis elegans* and *Opisthioglyphe ranae* (Plagiorhiidae) in Lymnaeidae, while *Rubenstrema exasperatum*/*Neoglyphe locellus* (Omphalometridae) and *Tylodelphys excavata* (Diplostomatidae) in Planorbidae. The adults of the most of Digenea species found in snails were reported from birds.

Key words: cerkariae species, freshwater snails, intermediate host, Lymnaeidae, Planorbidae, Poland.

Introduction

Digenea have a complicated developmental cycle, in which usually three hosts are involved: two intermediate (for some species only one) and final host, sometimes additionally separated by paratenic host (or hosts). Much data concerning flukes invasion in vertebrates has been known since XVIII and XIX century [1], when most of those parasite species were described.

Since the discovery of the key-role of snails in a fluke life-cycles, the occurrence of these parasites and the prevalence of digenean larvae in molluscs was studied in many parts of Europe. Some important publications are known from Ukraine [2, 3], Russia [4–6], Germany [7, 8], Czech Republic [9–12], France [13] and Finland [14,15].

In Poland almost 300 Digenea species were recorded in different host species [16]. Most of Polish papers concern the occurrence of those parasites in vertebrates — hosts of adult forms or metacercariae [17–19]. There are also some papers concerning the first intermediate host of those parasites. Cecariae of nearly 80 species were found in molluscs from different part of Poland. Among articles which should be quoted are some descriptions of fluke life cycles [20, 21], the complex studies of parasitic fauna in Drużno Lake [22] and works conducted in some reservoirs near Wrocław [23]. In the above mentioned publications, apart from some cercariae being identified, the authors mentioned many unidentified ones. Probably the lack of precise morphological characteristics of cercariae of different Digenea species was the main cause of a renunciation of studies on prevalence of larval stages of those parasites. Several publications deal with trematodes causing human and farm animals' parasitic diseases. For example in 50s of XX century, the extensive studies on the *Fasciola hepatica* larvae in *Galba truncatula* populations were carried out in Poland [24]. Nowaday, some fragmentary

Table 1. The characterization of reservoirs under study and infection level of the collected Lymnaeidae and Planorbidae (average prevalence of cercariae were calculted only for *L. stagnalis* and *P. corneus*)

No. and name of reservoir	Stretch [ha]	Province/district	Lymnaeidae coll/inf/ (%)	Planorbidae (%) coll/inf/ (%)
		Field and meadow reservoirs		
1. Jabłonka P.	0.5	W/Konin	325/159 (49)^{LS}	—
2. Kwatery P.	3.0	M/Gostynin	262/140 (53)^{LS}	33/15 (45)^{PC}
3. Czarne L.	9.0	M/Gostynin	474/170 (36)^{LS}	—
4. Głuchowskie L.	13.7	K-P/Toruń	396/176 (44)^{LS}	—
5.Starogrodzkie L.	18.5	K-P/Chełmno	408/169 (41)^{LS}	—
6. Tynwałdzkie L.	29.9	W-M/Iława	324/210 (65)^{LS}	—
7. Stempa L.	36.1	W/Konin	325/137 (42)^{LS}	—
8.Koziegłowskie L.	38.5	W/Konin	318/71 (23)^{LS}	—
9. Jeleniec L.	30.4-56.4	K-P/Chełmno	405/179 (44)^{LS}	—
10. Wąsoskie L.	58.0	K-P/Nakło	310/83 (27)^{LS}	—
11 Zaleskie L.	65.0	K-P/Tuchola	314/104 (33)^{LS}	—
12. Druzno L.	1200-2980	W-M/Elbląg	630/156 (25)^{LS} 12/1RA	149/30 (20)^{PC} 59/14^{PP}; 3/1^{SN}
		Agricultural — forest reservoirs		
13. Deczno L.	43.0	K-P/Świecie	311/90 (29)^{LS}	—
14. Górskie L.	43.1	M/Płock	294/108 (37)^{LS} 92/2RA	55/23 (42)^{PC}
15. Sobiejuskie L.	118.0	K-P/Żnin	288/99 (34)^{LS}	—
16. Borówno L.	207.7	K-P/Bydgoszcz	280/86 (31)^{LS}	—
		Forest reservoirs		
17. Piechota D.	4.0	M/Gostynin	730/419 (57)^{LS}	135/93 (69)^{PC}
18. Pod Zamkiem L	5.0	M/Gostynin	417/181(43)^{LS}	—
19. Brzozówka D.	5.0	M/Gostynin	201/85 (42)^{LS}	122/82 (67)^{PC}
20. Sendeń L.	14.2	M/Płock	298/136 (46)^{LS} 5/1 ^{RA}; 1/1^{SP}	75/47 (63)^{PC} 4/1^{SN}
21. Czarże L.	15.0	K-P/Bydgoszcz	394/176 (45)^{LS}	—
22. Zielone L.	20.2	W-M/Iława	302/112 (37)^{LS}	—
23. Soczewka L.	35.5	M/Płock	308/152 (49)^{LS} 56/32RA; 19/2^{SP}	61/34 (56)^{PC}
24. Lubodzież L.	44.0	K-P/Świecie	299/76 (26)^{LS}	—
		Urban and parc reservoirs		
25. Aleksandrów P.	0.2	K-P/Aleks. Kuj.	144/81 (56)^{LS}	—
26. Osiny P.	1.0	Ł/Kutno	223/143 (64)^{LS}	107/61 (57)^{PC}
27. Jeziorak L.	3460	W-M/Iława	492/260 (53)^{LS}	—
28. Bytyń Wielki L	881	Z-P/Wałcz	30/1^{LS}; 70/3RA	—
29. Kolbudzkie L.	86	P/Gdańsk	20/3^{LS}	—
RAZEM				10,581/4,404

coll — collected, inf — infected, % — proportion of infected snails
Snails: LS — *Lymnaea stagnalis*, PC — *Planorbarius corneus*, RA — *Radix auricularia*, SP — *Stagnicola palustris*, PP — *Planorbis planorbis*, SN — *Segmentina nitida*
Province: W — wielkopolskie, M — mazowieckie, K-P — kujawsko-pomorskie, W-M — warmińsko-mazurskie, Ł — łódzkie, Z-P — zachodnio-pomorskie, P — pomorskie. Reservoirs: L. — lake, P. — pond, D. — dam

data concerning the *Alaria alata* occurrence in Planorbidae [25], and bird schistosomes in Lymnaeidae [26] were published.

Considering a scarcity of information on trematode occurrence in a first intermediate host populations in Polish lakes, the main aim of this work was to study the Digenea biodiversity in common snail species living in some reservoirs in northern and central part of Poland. The snails collected represented 6 species, with the great prevalence of *L. stagnalis*, resulted from the inclusion the great num-

Table 2. The trematode species in regularly studied populations of *L. stagnalis* and *P. corneus*

Parasite species	Snail species	% of infected snails*
Diplostomum pseudospathaceum Niewiadomska, 1984	*L. stagnalis*	24%
Echinoparyphium aconiatum Dietz, 1909	*L. stagnalis*	23%
Plagiorchis elegans (Rudolphi, 1802)	*L. stagnalis*	21%
Opisthioglyphe ranae (Frölich, 1791)	*L. stagnalis*	10%
Echinostoma revolutum (Frölich, 1802)	*L. stagnalis*	3%
Sanguinicola inermis Plehn, 1905	*L. stagnalis*	2%
Plagiorchis maculosus (Rudolphi, 1802)	*L. stagnalis*	2%
Hypoderaeum conoideum (Bloch, 1782)	*L. stagnalis*	1%
Notocotylus attenuatus Luhe, 1909	*L. stagnalis*	1%
Tyleodelphys clavata (Nordmann, 1832)	*L. stagnalis*	1%
Trichobilharzia szidati (Odening, 1996)	*L. stagnalis*	< 1%
Apatemon burti (Miller, 1923)	*L. stagnalis*	< 1%
Neoglyphe sobolevi Shaldybin, 1953	*L. stagnalis*	< 1%
Unidentified: metacerkariae, sporocysts and/ or rediae	*L. stagnalis*	9%
Rubenstrema exasperatum (Rudolphi, 1819) / *Neoglyphe locellus* (Kossak, 1910)	*P. corneus*	7%
Tyleodelphys excavata (Rudolphi, 1819)	*P. corneus*	6%
Bilharziella polonica (Kowalewski, 1895)	*P. corneus*	2%
Notocotylus ephemera (Nitzsch, 1807)	*P. corneus*	2%
Echinostoma spiniferum (La Valette, 1855)	*P. corneus*	2%
Haematoloechus asper (Looss, 1899)	*P. corneus*	1%
Rubenstrema opisthovitellinum Sołtys, 1954	*P. corneus*	1%
Unidentified: metacerkariae, sporocysts and/ or rediae	*P. corneus*	79%

*the total number of infected *Lymnaea stagnalis* Σ = 3956, *Planorbarius corneus* Σ = 385

ber of these snails, collected prior to this study for investigations of snail-trematode interactions [27].

Material and methods

Snails were sampled during 1999–2005 period in the near-shore zone of 29 reservoirs (Table 1). The individuals of *Lymnaea stagnalis* (L.) were sampled regularly (once a month from April to October during two vegetation periods) from 27 reserviors, and occasionally (single samples) from 2 other ones. In the eight reservoirs, during one vegetation period, specimens of *Planorbarius corneus* (L.) were also regularly collected. The collection of all other snail species was restrained to single samples. The *Radix auricularia* (L.) were collected in four lakes, *Stagnicola palustris* (O.F. Muller, 1774) and *Segmentina nitida* (O.F. Muller, 1774) — in two, and *Planorbis planorbis* (L.) — only in one lake. In total ten thousand and five hundred eighty-one snails were collected in 29 reservoirs under study: 9.469 *L. stagnalis* individuals, 737 — *P. corneus*, 230 — *R. auricularia*, 59 — *P. planorbis*, 25 — *S. palustris* and 7 — *S. nitida* specimens (Table 1).

The presence of cercariae was checked by placing a snail in a small amount of tap water under a light source for 2–24 h. In such conditions, cercariae left their host. Digenean species were identified on the basis of morphological features, according to Nasincova [9] and Niewiadomska et al. [15]. The individuals which failed to release cercariae were dissected to find other digenean stages (sporocysts, rediae, metacercariae). The average prevalence of infected snails (by all trematode larvae) was calculated.

Results

In regularly examined *L. stagnalis* populations the average prevalence of infected snails was various — from 23% in Koziegłowskie Lake (No. 8), to 65% in Tynwałdzkie Lake (No.6). Similar prevalence was noted in *P. corneus* populations — from 20% in Drużno Lake (No.12), to 69% in Piechota Dam (No. 17). In the smallest reservoirs the percentage of

Table 3. Digenea species in snail populations under study

Snail	Digenea species	Number of reservoir (according to Table 1), number (top) and percentage (bottom) of snails with patent invasion																												
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29
L. stagnalis	*Diplostomum pseudospathaceum*	39 12	32 12	41 9	50 13	52 13	45 14	21 6	24 8	51 13	24 8	39 12		31 10	40 14		20 7	99 14	59 14	19 9	41 14	37 9	38 13	40 13	22 7	30 21		71 14		
	Echinoparyphium aconiatum	35 11	28 11	37 8	22 6	31 8	36 11	22 7	22 7	41 10	25 8	37 12	38 6	33 11	29 10	35 12	32 11	92 13	37 9	30 15	35 12	28 7	34 11	36 12	31 10	37 26	35 16	28 6		
	Plagiorchis elegans	32 10	34 13	29 6	41 10	40 10		20 6	20 6	48 12	23 7	21 7	53 8	20 6	21 7	17 6	22 8	68 9		29 14	48 16	44 11	31 10	35 11	17 6	11 8	42 19	81 16		
	Opisthioglyphe ranae	42 13	31 12	21 4		17 4	12 4	11 3	3 1	21 5	9 3	2 <1		4 1	15 5	15 5	12 4	99 14		4 2	12 4	42 11	7 2	23 7	1 <1		8 4			
	Echinostoma revolutum		10 4	26 5	27 7	22 5				9 2		1 <1	26 4					2 <1	5 1			4 1					1 <1	1 <1		
	Plagiorchis maculosus		1 <1		12 3			11 3	1 <1						1 <1			20 3	14 3	1 1		14 4					4 2			
	Sanguinicola inermis		3 1	13 3	21 5			8 2		4 1		1 <1		2 1				20 3				4 1	1 <1		2 1					
	Notocotylus attenuatus	11 3							1 <1				9 1					8 1	1 <1								10 2		
	Hypoderaeum conoideum									4 1		3 1			2 1			9 1	9 2			3 1	1 <1	9 3					
	Tylodelphys clavata							39 12																						
	Apatemon burti		1 <1					5 2										2 <1												
	Trichobilharzia szidati			3 1									6 1						5 1	1 1								7 1	1 3	3 *
	Neoglyphe sobolevi									1 <1																	1 <1			

R. a.	*Trichobilharzia franki*													2 2								3 5					3 4	
S. p	*Sanguinicola inermis*											1 *																
	Moliniella anceps																		1 *			1 *						
P. corneus	*Echinostoma spiniferum*											2 1													6 6			
	Notocotylus ephemera											5 3					2 2		1 1									
	Bilharziella polonica											2 1					3 2		3 2									
	Tylodelphys excavata											7 5										15 25						
	Haematoloechus asper													4 7														
	Rubenstrema opisthovitellinum											4 3																
	R. exasperatum) / N. locellus																		14 11	9 12		5 1						
P.p	*Echinoparyphium recurvatum*											5 1																
S. n.	*Parastrigea robusta*											1 *								1 *								

* very low number of the examined snails (<20 specimens)
for explanation: *R.a. — Radix auricularia*, *S.p. — Stagnicola palustris*, *P.p — Planorbis planorbis*, *S.n. — Segmentina nitida*

infected snails was rather high (Table 1, No.: 1, 2, 17, 25, 26).

Twenty five parasite species were found, as well as unidentified metacercarie, sporocysts and/or rediae with immature cercariae. The list of identified Digenea species and their prevalence in snail populations are presented in Tables 2 and 3.

In *L. stagnalis* populations four parasite species were noted most frequently: *Echinoparyphium aconiatum* (in 27 from 29 reservoirs), *Plagiorchis elegans* (25/29), *Diplostomum pseudospathaceum* (24/29), and *Opisthioglyphe ranae* (22/29). Those species composed a majority of digeneans (78%) in 27 regularly studied *L. stagnalis* populations (Table 2). The larvae of *Echinostoma revolutum*, *Plagiorchis maculosus* and *Sanguinicola inermis* were observed at least in 10 from 29 water bodies under study. The remaining parasites were rarely found.

In the eight *P. corneus* populations under study 7 or 8 cercariae species were recognized. Among them *Rubenstrema exasperatum /Neoglyphe locellus*, *Bilharziella polonica* and *Notocotylus ephemera* were noted in three reservoirs, *Tyleodelphys excavata* and *Echinostoma spiniferum* — in two, and other species only in one of them. It should be emphasized that only 21% of snails from these populations released cercariae (Table 2).

In four snail species (*R. auricularia*, *P. planorbis*, *S. nitida and S. palustris*) five trematodes were found — *S. inermis*, *Trichobilharzia franki*, *Echinoparyphium recurvatum*, *Moliniella anceps* and *Parastrigea robusta*. (Table 3).

Discussion

The biodiversity of Digenea in snail populations under study was rather high. In the only six snail species (where two of them were regularly collected) 25 Digenea taxa were found. For example Faltynkova and Haas [8] described 29 different cercariae in 26 snail species from 26 localities, and in another study Faltynkova [12] found 27 Digenea taxa in 12 molluscs species. Also Loy and Haas [7] in several *L. stagnalis* populations examined in the period of 20 years observed 7 trematode species, and Finnish authors [14] — 11 parasite species in two lymnaeids.

The regular two-year examination of *L. stagnalis* enlarged the probability of finding a majority of trematode species of these snails occurring in water reservoirs under study. Different trematodes can have different maximum of cercariae shedding from snail-host during season [27]. It is worth to emphasize that only mature (emerged) larvae can be identified, therefore regular sampling snail populations in this kind of study is very important. Moreover, long lasting maintenance of cercariae non-shedding snails in the laboratory is very helpful, as after some time at least some of them could shed cercariae.

It is difficult to compare the presented data with those of Wiśniewski [22] and Bertman and Wojciechowska [23], because the authors placed among identified, also many unidentified cercariae. The taxa which were found both by the cited authors, and nowadays belong to: *E. recurvatum* in *Planorbis planorbis*, *Cercaria echinata* (*E. aconiatum*), *E. revolutum* and *T. clavata* in *L. stagnalis*, *B. polonica* and *T. excavata* in *Planorbarius corneus*. Nevertheless, the long list of both identified and unidentified cercariae species in snails under study supported the opinion about high biodiversity of trematodes in Polish freshwater molluscs.

A comparatively high number of Digenea species in *L. stagnalis* and *P. corneus* supports the data of the authors who maintain that big-size snails are very useful in life cycle of those parasites [28]. On the other hand, low trematode frequency in the examined *P. planorbis* or *S. nitida* does not result from small body size of snails but probably from low snail sampling.

In Poland, bird parasites constitute nearly 50% of known parasitic platyhelminthes [16]. Also in molluscs under study bird flukes dominated. Probably the low specificity to final host species and high mobility of birds created very useful conditions for the parasite spreading in the environment.

The domination of *D. pseudospathaceum*, *E.*

aconiatum and *P. elegans* in *L. stagnalis* verified the data of different researchers of European snail populations. In twenty-year study of German reservoirs Loy and Haas [7] observed high prevalence of *Diplostomum spathaceum* (synonym: *D. pseudospathaceum*) and *Pseudoechinoparyphium echinatum* (synonym: *E. aconiatum*) in *L. stagnalis*, and Vayrynen et al. [14] noted high percentage of snails infected with *P. elegans* larvae.

In the eight *P. corneus* populations, only 21% snails shed cercariae. This fact constitutes very serious obstacle in comparing different trematode species contribution in the parasite communities in snails.

The studies of trematode prevalence in snail populations will be continued. Other mollusc species will be examined. The regular snail sampling in environment and maintenance of cercariae non-shedding individuals for a long time in a laboratory will make the list of Digenea species in snails living in our country longer.

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References

[1] Stefański W. 1968. Parazytologia Weterynaryjna tom I: Protozoologia i Helmintologia. PWRiL Warszawa.

[2] Cernogorenko-Bidulina M.I. 1958. Fauna liczinkovych form trematod v moljuskach Dnipra. VAN UCCR, Kijów.

[3] Zdun W.I. 1961. Licinki trematod v prisnowodnich moljuskach Ukrainy. VAN UCCR, Kijów.

[4] Ginecinskaja T.A., Dobrovol'skij A.A. 1962. K faunie licinok trematod presnovodnych molljuskov delty Volgi. I. Furkocerkarii (sem. Strigeidae i Diplostomidae). *Trudy Astrachanskogo Zapovednika* 6: 45–89.

[5] Ginecinskaja T.A., Dobrovol'skij A.A. 1964. K faunie licinok trematod presnovodnych molljuskov delty Volgi. II. Echinostomatidnyje cerkarii (sem. Echinostomatidae). *Trudy Astrachanskogo Zapovednika* 9: 64–104.

[6] Ginecinskaja T.A., Dobrovol'skij A.A. 1964. K faunie licinok trematod presnovodnych molljuskov delty Volgi. III. Furkocerkarii (sem. Cyathocotylidae) i stiletnyje cerkarii (Xiphidiocercariae). *Trudy Astrachanskogo Zapovednika* 11: 29–95.

[7] Loy C., Haas W. 2001. Prevalence of cercariae from *Lymnaea stagnalis* snails in a pond system in Southern Germany. *Parasitology Research* 87: 878–882.

[8] Faltynkova A., Hass W. 2006. Larval trematodes in freshwater molluscs from the Elbe to Danube (Southeast Germany): before and today. *Parasitology Research* 99: 572–582.

[9] Nasincova V. 1992. Vyvojove stadia motolic v nasich vodnich plzich a vyvojove cykly vybranych druhu celedi Omphalometridae and Echinostomatidae. Ph.D. Thesis, UCAV Ceske Budejovice.

[10] Kolarova L., Horak P., Fajfrlik K. 1992. Cercariae of *Trichobilharzia szidati* Neuhaus, 1952 (Trematoda: Schistosomatidae): The causative agent of cercarial dermatitis in Bohemia and Moravia. *Folia Parasitologica* 36: 399–400.

[11] Horak P., Kolarova L., Dvorak J. 1998. *Trichobilharzia regenti* n.sp. (Schistosomatidae, Bilharziellinae), a new nasal schistosome from Europe. *Parasite* 5: 349–357.

[12] Faltynkova A. 2005. Larval trematodes (Digenea) in molluscs from small water bodies near Ceske Budejovice, Czech Republic. *Acta Parasitologica* 50: 49–55.

[13] Ferte H., Depaquit J., Carre S., Villena I., Leger N. 2005. Presence of *Trichobilharzia szidati* in *Lymnaea stagnalis* and *T. franki* in *Radix auricularia* in northeastern France: molecular evidence. *Parasitology Research* 95: 150–154.

[14] Vayrynen T., Siddall R., Valtonen E.T., Taskinen J. 2000. Patterns of trematode parasitism in lymnaeid snails from northern and central Finland. *Annales Zoolgici Fennici* 37: 189–199.

[15] Niewiadomska K., Valtonen E.T., Siddal R. 1997. Cercariae from *Lymnaea stagnalis* in Lake Kuuhankavesi (central Finland). *Acta Parasitologica* 42: 132–137.

[16] Pojmańska T., Niewiadomska K. 2003. Czy fauna pasożytnicza Polski jest dobrze poznana? *Wiadomości Parazytologiczne* 49: 333–345.

[17] Grabda–Kazubska B. 1972. Katalog Fauny Pasozytniczej Polski. Cz. III Pasożyty płazów i gadów. PWN Warszawa — Wrocław.

[18] Sulgostowska T., Czaplińska D. 1987. Katalog Fauny Pasożytniczej Polski. Cz. IV Pasożyty ptaków. Zeszyt 1 Pierwotniaki i przywry. PWN Warszawa — Wrocław.

[19] Niewiadomska K. 2003. Pasożyty ryb Polski. Przywry — Digenea. PTP Warszawa.

[20] Sinicyn D.F. 1905. Materialy po estestvennoj istorii trematod'. Distomy ryb' i ljagusek okrestnostej Varsa-

vy. Varsava: 1–210.
[21] Ruszkowski J.S. 1925. Materiały do fauny helmintologicznej Polski. Część I. *Sprawozdanie Komisji Fizjograficznej Kraków* 60: 173–185.
[22] Wiśniewski W.L. 1958. Characterization of the parasitifauna of an eutrophic lake. Parasitifauna of the biocenosis of Drużno Lake — part I. *Acta Parasitologica Polonica* 6: 1–64.
[23] Bertman M., Wojciechowska K. 1974. Fauna cerkarii ślimaków słodkowodnych zbiorników Wrocławia i okolic. *Przegląd Zoologiczny* 18: 354–359.
[24] Drozdowski A. 1958. Wyniki czteroletnich badań nad rozmieszczeniem i stopniem zarażenia błotniarki moczarowej cerkariami motylicy wątrobowej w województwie bydgoskim. *Studia Societatis Scientarum Torunensis* IV: 1–9.
[25] Wójcik A.R., Grygon–Franckiewicz B., Żbikowska E. 2002. Badania nad przywrą *Alaria alata* (Goeze, 1782). *Medycyna Weterynaryjna* 58: 517–520.
[26] Żbikowska E. 2004. Infection of snails with bird schistosomes and the threat of swimmer's itch in selected Polish lakes. *Parasitology Research* 92: 30–35.
[27] Żbikowska E. 2006. Interakcje w układzie żywiciel — pasożyt między błotniarkami *Lymnaea stagnalis* i przywrami z gatunków: *Diplostomum pseudospathaceum*, *Echinoparyphium aconiatum*, *Plagiorchis elegans*. Wydawnictwo Uniwersytetu Mikołaja Kopernika, Toruń.
[28] Brown K.M., Leathers B.K., Minchella D.J. 1988. Trematode prevalence and population dynamics of freshwater pond snails. *The American Midland Naturalist* 120: 289–301.

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