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Author: Aneta Spyra

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Environmental factors influencing the occurrence of freshwater snails in woodland water bodies

Aneta Spyra

Department of Hydrobiology, Faculty of Biology and Environmental Protection University of Silesia, Bankowa 9, 40-007 Katowice, Poland; e-mail: aneta.spyra@us.edu.pl

Abstract: Studies were carried out in eight woodland water bodies that are situated in an urbanised area of Southern Poland (Upper Silesia). The aim of this study was to determine the influence of auto- and allochthonous plant detritus and exposure to sunlight on the structure of snail communities in woodland ponds. Among some physico-chemical water parameters, pH influenced the occurrence of snails, whereas sunlight caused an increase in diversity of the snail communities. In the total snail collection, 72.1% of specimens were gathered in sun-exposed sites. By the same degree of insolation more preferred by snails were the sites with allochthonic detritus. The snail fauna of subsidence ponds located inside a forest area differs from those occurring in urban agglomerations. The most conspicuous difference is the high numbers in three woodland ponds of *Hippeutis complanatus* (L.), which is rare in this area.

Key words: subsidence ponds; leaf litter; plant detritus

Introduction

Woodland ponds constitute very valuable freshwater ecosystems, particularly in heavily industrialised regions where they sometimes provide the only refuges for various plant and animal species. For this reason they are often protected by law. Malacological investigations are rare in such ponds, although they form specific habitats for freshwater snails because of their bottom being covered with the litter of leaves (Gasith & Ławacz 1976). After bacterial and fungal processing they transform into allochthonous detritus (Banfield 2006), which together with autochthonous detritus, derived from decayed water plants, forms a valuable food source for many snail species. Moreover, both kinds of detritus are substratum for periphyton, another important food for these animals.

The accumulation of plant detritus on the bottom provide useful shelters for various freshwater animals because of the increase in temperature inside these as a result of decaying processes (Allan 1998). The autochthonous plant detritus forms as a result of water plant decay, particularly of rushes growing along the banks of woodland ponds. Because of the seasonal fluctuation in the physico-chemical water parameters caused by drying in summer and freezing in winter, the woodland ponds are specific habitats for freshwater snails. Freshwater bodies are most frequently settled by snails, when they are grown abundantly by macrophytes, which form pastures or shelters for them (Aho 1966). The same refers to anthropogenic reservoirs as well (Strzelec et al. 2005, 2006; Spyra et al. 2007).

The role of plant detritus in the life of freshwater snails was only rarely discussed in recent literature concerning the water bodies of an anthropogenic origin. These are often subsidence ponds, which originated in consequence of underground coal mining causing depressions in the ground surface. The snail fauna of subsidence ponds in unforested areas has been studied many times (e.g., Strzelec & Serafiński 2004.), but never in relation to the influence of plant detritus nor as to the effect of exposure to sunlight.

Most studies carried out in woodland water bodies (particularly in lakes) (Pope et al. 1999; Salmoiraghi et al. 2001) refer to the zoobenthos in general and snails are discussed in general terms (Bonner et al. 1997; Nicolet et al. 2004). In Poland such studies have been very rare to date. Therefore, the aim of this study was to examine the effects of different kinds of plant detritus and exposure to sunlight on the distribution patterns of snail species and on the structure of snail communities in woodland ponds in a coal mining region.

Study area

The investigations were carried out in eight anthropogenic water bodies (seven of them are subsidence ponds and one is a sand-pit) located in a forested area of the Upper Silesia coal basin (Southern Poland), far from the urban agglomeration (50°22′24″ N, 18°38′4″ E) (Fig. 1).

Underground coal exploitation was, and still is, the cause of earth surface transformations, which results in the appearance of various permanent or temporary water bodies.

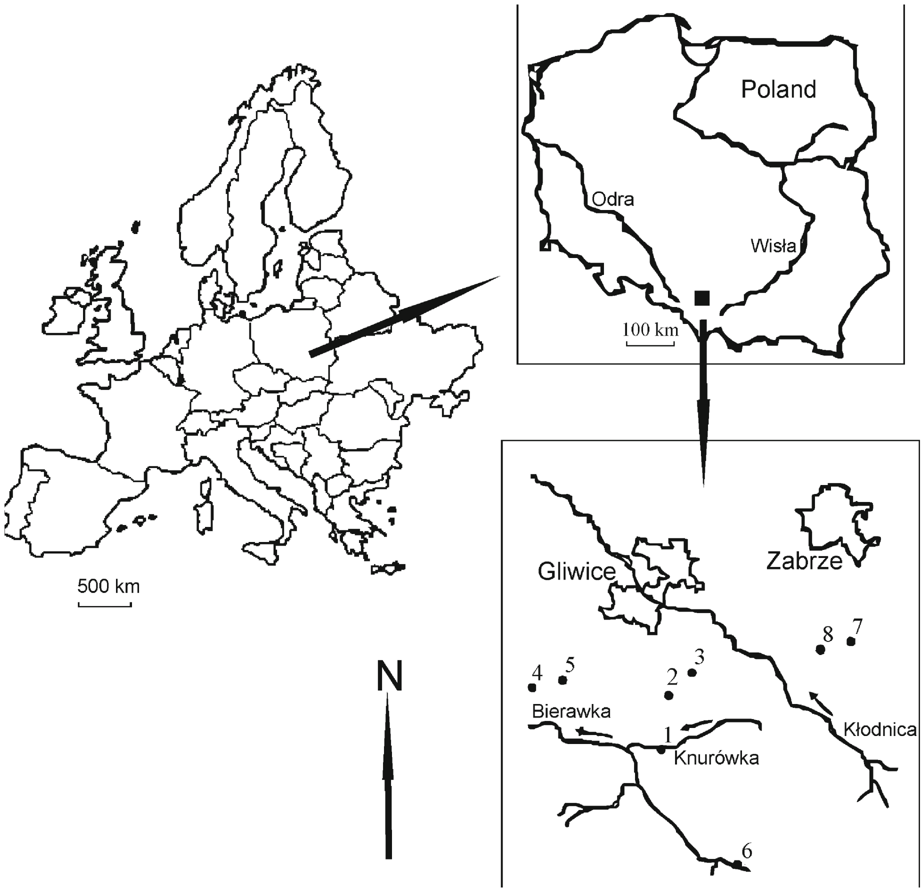

Fig. 1. Location of the study area on the territory of Poland. Numeration of water bodies according to the Table 2. Arrows indicate the directions of river flow.

Table 1. The characteristics of the woodland ponds investigated.

Number of the water-body	Geographic co-ordinates	Year of origin	Surface area in ha	Max. depth in m	Bottom sediment	Persistence	Macrophytes
1	N:50°12′1″, E:18°38′50″	1979	14	3	sand-mud	permanent	1, 2, 4, 6, 7, 15, 16, 23, 28, 31, 32, 34
2	N:50°12′37″, E:18°38′59″	1982	10.4	2	mud	permanent	2, 8, 10, 11, 12, 15, 17, 19, 24, 27, 30, 32, 33, 34, 35
3	N:50°12′36″, E:18°39′25″	1974	67	3	sand-mud	permanent	1, 2, 4, 5, 8, 11, 12, 13, 15, 16, 17, 19, 21, 24, 27, 28, 34, 35
4	N:50°12′35″, E:18°37′53″	1993	12.35	1.9	sand-mud	permanent	2, 3, 4, 5, 6, 8, 11, 17, 19, 21, 22, 24, 27, 29, 30, 32, 33, 34
5	N:50°12′33″, E:18°37′58″	1993	1.2	1.6	sand-mud	temporary	3, 4, 5, 8, 14, 17, 21, 22, 24, 28, 29, 33, 34
6	N:50°11′20″, E:18°39′46″	1970	30.5	4	sand-mud	permanent	1, 4, 5, 6, 8, 11, 14, 17, 19, 21, 22, 29, 30, 34
7	N:50°15′27″, E:18°46′37″	1991	22.3	3	sand-mud	temporary	1, 2, 4, 5, 12, 14, 15, 17, 18, 21, 22, 24, 27, 28, 29, 30, 34, 35
8	N:50°15′20″, E:18°45′57″	1945	12.25	2	sand	temporary	2, 5, 6, 9, 11, 12, 20, 24, 25, 26, 28, 32, 34

1 – *Acorus calamus* L., 1753, 2 – *Alisma plantago-aquatica* L., 1753, 3 – *Batrachium aquatile* L. Dumort, 1821, 4 – *Bidens tripartitus* L., 1753, 5 – *Carex* sp., 6 – *Ceratophyllum demersum* L.s.s., 1753, 7 – *Cirsium palustre* L.Scop., 1772, 8 – *Equisetum fluviatile* L., 1753, 9 – *Elodea canadensis* Michx., 10 – *Galium palustre* L., 1753, 11 – *Glyceria maxima* (Hartm.) Holmb., 12 – *Heleocharis palustris* (L.) Roem. and Schult., 13 – *Hottonia palustris* L., 1753, 14 – *Iris pseudoacorus* L., 1753, 15 – *Juncus effusus* L., 1753, 16 – *Lemna minor* L., 1753, 17 – *Lycopus europaeus* L., 1753, 18 – *Lysimachia thyrsiflora* L., 1753, 19 – *Mentha aquatica* L., 1753, 20 – *Myriophyllum spicatum* L., 1753, 21 – *Oenanthe aquatica* (L.), 1753, 22 – *Peucedanum palustre* (L.), 1753, 23 – *Phalaris arudinacea* L., 1753, 24 – *Phragmites australis* (Cav.) Trin. ex. Steud, 1841, 25 – *Polygonum amfibium* L., 1753, 26 – *Potamogeton crispus* L., 1753, 27 – *Potamogeton natans* L., 1753, 28 – *Ranunculus sceleratus* L., 1753, 29 – *Rumex hydrolapathum* Huds., 1778, 30 – *Schoenoplectus lacustris* (L.) Palla., 31 – *Scutellaria galericulata* L., 1753, 32 – *Sparganium erectum* L. em. rchb. s.s., 1753, 33 – *Sphagnum* sp., 34 – *Typha latifolia* L., 1753, 35 – *Utricularia vulgaris* L., 1753.

Table 2. The physico-chemical parameters of the water in woodland ponds studied (range of 10 measures).

Parameter	Pond							
	1	2	3	4	5	6	7	8
Temperature C	4–28	4–27	4–26	4–28	4–30	6–28.5	4–30	4–32
pH	6.2–9	5–6.2	5.9–7.1	4.0–9	2.9–6.5	6.2–8.5	6.0–7	6.3–7
NH_4 mg dm^{-3}	0.05–10	0.05–10	0.05–0.56	0.05–1	0.05–0.42	0.05–1.75	0.05–1	0.05–0.3
NO_2 mg dm^{-3}	0.02–0.3	0.02–0.15	0.02–0.16	0.02–0.15	0.02–0.16	0.05–0.14	0.02–0.11	0.02–0.12
NO_3 mg dm^{-3}	1.1–11.5	1.3–20.9	0–19	0–10.2	0–10	0–10	0–23.9	0.5–29.2
PO_4 mg dm^{-3}	0.04–0.59	0–0.72	0–0.51	0.05–0.47	0–0.26	0.21–0.52	0.1–0.41	0–0.62
P mg dm^{-3}	0.03–0.19	0–0.23	0–0.17	0.06–0.17	0–0.17	0.07–0.19	0.006–0.12	0–0.17
Ca mg dm^{-3}	51–187	18–84	14–42	29–190	0–79	69–314	32–81	26–61
Hardness dH°	11–38	3–19	3–7.3	11–44.2	9–25.9	36.7–139	7–17.8	6–48
Mg mg dm^{-3}	8.09–51.56	0.13–57.96	0.57–19.96	28.78–145.82	18.81–82.51	61.49–469.46	3.71–34.48	0.57–19.43
Conductivity µS cm^{-1}	480–1700	69–832	235–290	530–2460	720–4140	920–6860	380–890	200–296
Total dissolved solids mg dm^{-3}	240–780	60–417	110–144	470–1180	350–2090	198–2250	180–430	120–159

The bottom of most of the water bodies investigated is of sandy-muddy type, overgrown with rich vascular vegetation (Table 1), with *Typha latifolia* L. occurring in all ponds.

The surroundings with deciduous forest, results in an accumulation of tree leaves on the bottom, every autumn. The leaves of *Alnus glutinosa* L., *Betula pendula* Roth., *Frangula alnus* Mill., *Quercus robur* L., *Quercus rubra*.L., *Sorbus aucuparia* L. em. Held. and *Salix* sp. mainly occur in the leaf litter.

Material and methods

Snails were sampled from three types of bottom in each of the eight water bodies studied:

Type A – an area shaded by waterside trees, with a layer of leaves in various stages of decay. They are situated in small coves, where the water surface is highly and permanently shaded by the foliage of trees.

Type B – a sun-exposed area with the bottom covered with tree leaves. They are situated in shallow parts of water bodies close to their boundaries and are characterized by the straight border line and a great distance to trees.

Type C – occurred only in sun-exposed areas of the water bodies on a bottom covered with the decayed remains of *Typha latifolia* (L.) inside the wide rushes belt.

Sampling was done every month from June 2003 to May 2004 using a metal frame (25 × 25 cm and 65 cm high) from which all organic material was removed and rinsed. Every month one sample was gathered from each of 24 sampling sites (8–A, 8–B and 8–C). In winter (January and February) all water bodies froze to the bottom. In summer, the pond 5th dried out, and the same occurred in the sites with *Typha latifolia* (C) in ponds 7th and 8th during the period from October to December and this made the sampling impossible. The samples were collected along shoreline at a small distance to the banks.

The snails were then preserved in 75% alcohol and identified according to Glöer (2002). Allochthonous and autochthonous detritus from each frame was dried at 105℃ to a constant dry mass and weighed to the nearest 0.001 g. Because the thickness of the detritus layer at particular sites and in succeeding months differed significantly (from 3.5 cm to 59 cm), which makes comparisons of samples impossible, the density of snails were recounted on the 100 g dry weight of the detritus.

To characterize snail communities the following indices were used:

1. Dominance index (D) in % of total number of individuals in the whole collection: $D = k/K \times 100$, where k is the number of individuals of species "a" and K the total number of individuals in a sample.
2. Frequency (F) in % of the number of samples: $F = n/N \times 100$, where n is the number of samples in which given species occurs and N represents the total number of samples.
3. Commoness index ("ecological value" by some authors) $Q\% = \sqrt{D\% \times F\%}$: where D is Dominance index and F is Frequency index.
4. Habitat preferences (according to Økland 1990): $p\% = (n_1/N_1 - n/N) \times 100$, where: n – number of sites in which a species occurs, N – total number of sites, n_1 – number of sites of given type inhabited by species "a", N_1 – total number of sites of given type.
5. Shannon-Wiener diversity index (H): $H' = -\Sigma(P_i)(\log_2 P_i)$, where $P_i = N_i/N$ is the proportion of individuals belonging to species "i" in the total collection.

In each month water samples (one sample per pond) were analysed for some physical and chemical parameters using standard methods described in Hermanowicz et al. (1999). The results of water analyses are shown in Table 2.

Correlations between water parameters, amounts of detritus and the numbers of snails assessed using Pearson's correlation coefficients. To test the statistically significant differences between the sites, data of snail number and number of snail species were evaluated using nonparametric ANOVA Friedman test. Only the statistically significant ($P < 0.05$) relationships and differences were taken into account. To explict comparisons between the types B and C and between types A and B the Wilcoxon test, a nonparametric alternative to t-test for dependent samples, was used.

The cluster analysis was used to distinguish the three types of sites in respect for the faunistic similarities. The dendrogram of faunistic similarities was based on percentage of particular snail species in studied sites.

Results

Totally, 37,220 specimens belonging to 14 snail species were collected during the study period. The number of species recorded per water body ranged from 2 to 9 (on average 6 species per pond) (Table 3). The number of

Table 3. Total number of snail specimens collected in each water body investigated.

Species	Pond 1	2	3	4	5	6	7	8
Potamopyrgus antipodarum (Gray, 1843)	588	–	–	48	–	292	–	–
Lymnaea stagnalis (L., 1758)	–	–	–	–	–	–	16	1152
Stagnicola palustris (O.F.Müller, 1774)	4	–	–	48	28	–	–	32
Radix auricularia (L., 1758)	-	–	–	–	–	–	–	3552
Radix balthica (L., 1758)	3940	48	256	1600	368	4964	272	–
Anisus spirorbis (L., 1758)	–	–	16	92	544	–	–	–
Bathyomphalus contortus (L., 1758)	–	–	–	–	–	–	1024	80
Gyraulus albus (O.F.Müller, 1774)	1492	16	452	104	–	–	256	528
Gyraulus crista (L., 1758)	8	–	–	468	16	16	16	–
Hippeutis complanatus (L., 1758)	–	–	696	–	–	–	11136	224
Planorbarius corneus (L., 1758)	–	–	80	128	240	–	128	1312
Ferrissia wautieri (Mirolli, 1960)	–	–	52	–	–	–	704	64
Physa fontinalis (L., 1758)	–	–	–	–	–	–	32	–
Aplexa hypnorum (L., 1758)	16	–	–	32	40	–	–	–
Total	6048	64	1552	2520	1236	5272	13584	6944

Table 4. Dominance (D), frequency (F) and commoness (Q) of snail communities in studied habitats.

Habitat / Species	Allochthonic detritus on shaded sites (A) N	D%	F%	Q	Allochthonic detritus on sun-exposed sites (B) N	D%	F%	Q	Autochthonic detritus (C) N	D%	F%	Q	Total collection N	D%	F%	Q
Potamopyrgus antipodarum	260	8.1	25.0	14.2	456	1.7	25.0	6.6	212	3	37.5	10.6	928	2.6	29.2	8.7
Lymnaea stagnalis	80	2.5	25.0	7.9	832	3.1	12.5	6.2	256	3.6	12.5	6.7	1168	3.1	16.7	7.2
Stagnicola palustris	16	0.6	12.5	2.7	72	0.3	50.0	3.9	24	0.3	25.0	2.7	112	0.3	29.2	2.5
Radix auricularia	624	19.4	12.5	15.6	2192	8.2	12.5	10.1	736	10.3	12.5	11.3	3552	9.5	12.5	10.9
Radix balthica	644	20	37.5	27.4	9124	34	87.5	54.5	1680	23.5	66.7	42	11448	30.7	66.7	45.2
Anisus spirorbis	208	6.5	25.0	12.7	184	0.7	25.0	4.2	260	3.6	37.5	11.6	652	1.7	29.2	7.0
Bathyomphalus contortus	80	2.5	25.0	7.9	736	2.7	25,0	8.2	288	4	12.5	7.1	1104	3	20.8	7.9
Gyraulus albus	496	15.4	50.0	27.7	1672	6.2	75.0	21.6	680	9.5	62.5	24.4	2848	7.6	62.5	21.8
Gyraulus crista	88	2.7	50.0	11.6	164	0.6	25.0	3.9	272	3.8	12.5	6.9	524	1.4	29.2	6.4
Hippeutis complanatus	400	12.4	25.0	17.6	9800	36.5	25.0	30.2	1856	25.9	25.0	25.4	12056	32.4	25.0	28.5
Planorbarius corneus	268	8.3	25.0	14.4	1028	3.8	62.5	15.4	592	8.3	50.0	20.4	1888	5.2	45.8	15.4
Ferrissia wautieri	32	1	12.5	3.5	516	1.9	37.5	8.4	272	3.8	12.5	6.9	820	2.2	20.8	6.8
Physa fontinalis	0	0	–	0	16	0.1	12.5	1.1	16	0.2	12.5	1.3	32	0.1	8.3	0.9
Aplexa hypnorum	20	0.6	25.0	3.9	52	0.2	25.0	2.2	16	0.2	12.5	1.6	88	0.2	20.8	2.0
Number of collected specimens	3216				26844				7160				37220			
Shannon-Wiener's index (H)		3.12				2.44				3.02						

species was greater at sun-exposed than in shaded sites, but generally the species composition of assemblages is roughly similar in three site types, and the differences relate to the density of particular species.

The number of snails was greater in sun-exposed than in shaded sites: in habitats of B type 72.1% of the whole collection have been gathered, while in C type 19.3% and in A type only 8.6% (Table 4). However, in this respect some preferences of particular species were observed. For example, *Gyraulus crista* preferred the sites of C type, whereas the remaining species were most numerous in collection of B type habitats. (e.g., *Radix balthica* and *Hippeutis complanatus* 80% and 81% of all individuals, respectively, collected of given species in this type of sites).

By similar insolation the sites with autochthonic detritus on the bottom were preferred by *Anisus spirorbis* and *Gyraulus crista*. For *Physa fontinalis* both types were of the same value. From among 34,004 specimens collected in sun-exposed sites 79% have been found in allochthonic detritus.

The Friedman test showed statistically significant differences in snail species and number of snails individuals between the collections from each type of sites (χ^2 ANOVA 31.988, df 2, $P < 0.000001$, χ^2 ANOVA 36.101, df 2, $P < 0.000001$, respectively).

Type of detritus (B and C) and exposure to sunlight (A and B) significantly influenced the number of snail specimens in woodland ponds ($Z = 6.281$, $P < 0.00001$ and $Z = 5.915$, $P < 0.00001$, respectively). The cluster analysis shows that snail fauna is similar in sites B and C type, and differs from A types (Fig. 2).

Because of the various thicknesses of detritus covering the bottom of the particular sites (both auto-

Table 5. The values of the dried weight of allochthonous and autochthonous detritus (g/m^2) covering the bottom of the woodland ponds investigated.

Sites		Pond 1	2	3	4	5	6	7	8
A	$\bar{X}$	132.7	167.4	191.3	157.4	217.2	222.8	251.5	190.3
	(min–max)	(59.3–320.3)	(60.5–294.7)	(80.72–299.6)	(99.1–279.8)	(154.5–311.1)	(110.6–536.2)	(109.3–584.4)	(103.9–311.7)
B	$\bar{X}$	155.6	152.9	219.8	164.2	249.2	191.4	304.3	179.1
	(min–max)	(51.0–377.9)	(69.2–344.1)	(79.2–313.3)	(83.9–302.2)	(153.2–330.3)	(29.8–313.2)	(120.3–502.6)	(99.8–238.8)
C	$\bar{X}$	124.6	130.9	139.4	162.5	1369	127.3	111.1	190.6
	(min–max)	(84.7–185.1)	(85.0–271.9)	(55.4–205.5)	(87.8–249.8)	(115.0–188.2)	(52.3–171.9)	(68.8–217.5)	(100.3–518.4)

Table 6. Density of snails (per 100 g d.w.) in particular sites during the study period.

Month	Pond 1			2			3			4			5			6			7			8		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
June	185	1669	23	0	0	0	0	163	0	0	64	153	114	53	56	0	15233	23	24	930	72	239	621	851
July	674	588	484	0	17	0	0	148	83	97	815	164	62	136	373	14	110	71	128	111	2789	498	577	287
August	35	729	77	0	23	0	0	323	57	32	127	28	–	–	–	0	20	30	59	733	297	154	269	129
September	117	668	148	0	8	19	16	25	0	18	274	143	–	–	–	0	15	0	76	1525	52	20	250	31
October	111	594	17	0	0	0	0	34	102	0	93	0	–	–	–	0	0	9	0	312	–	205	449	–
November	98	106	15	0	0	0	12	18	0	0	24	0	–	–	–	5	74	0	0	220	–	0	61	–
December	67	8	94	0	0	0	0	0	0	0	22	21	0	25	0	0	0	0	10	0	–	0	0	–
March	0	0	0	0	0	0	0	0	0	6	5	0	5	0	0	0	0	0	0	10	0	0	17	0
April	10	100	0	0	0	0	0	0	0	0	9	0	0	0	0	7	0	11	0	28	0	0	0	10
May	5	7	110	0	0	0	0	29	13	0	18	0	0	0	0	0	0	22	0	47	0	11	184	22
$\overline{X}$	130	447	97	0	5	2	3	74	25	15	145	51	30	36	72	3	1545	17	30	391	459	113	243	190

Explanations: –: lack of samples, 0: snails absent in the sample.

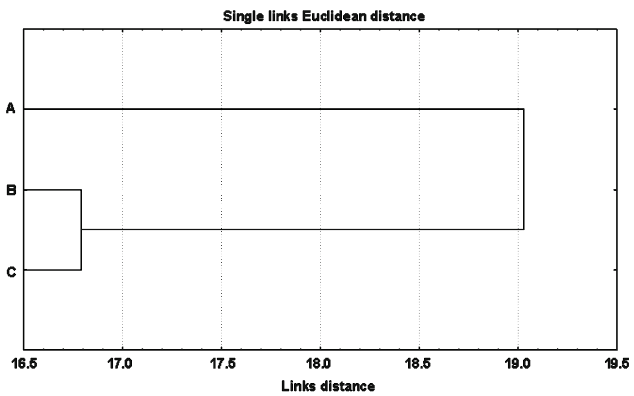

Fig. 2. Faunistic similarities of the three types of sites (A, B, C) in woodland ponds.

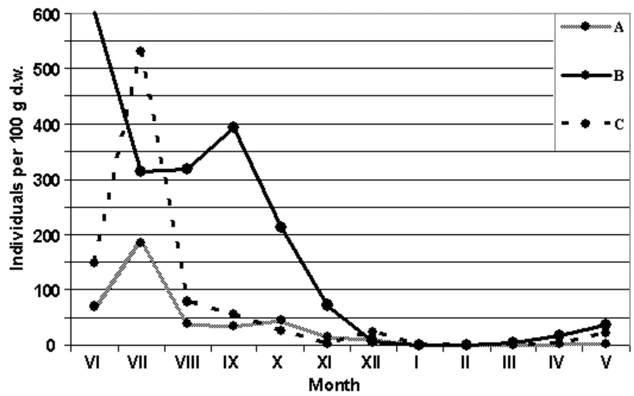

Fig. 3. Mean density of snails (per 100 g d.w.) in particular sites during the study period.

and allochthonous), its different amounts were collected from each (Table 5). The thickness of both kinds of detritus was positively correlated with the number of snail specimens ($r = 0.50$, $n = 24$, $P < 0.01$).

The snail density was the lowest (on average) in sites of A type, and the highest in B types (Table 6, Fig. 3).

Only the contributions of *Radix balthica* and *Hippeutis complanatus* exceeded 10% of total collections, similarly as in particular habitat types (Table 6). Both species were most numerous at sun-exposed sites, whereas *Radix auricularia* and *Gyraulus albus* abundantly occurred at shaded sites.

Hippeutis complanatus preferred sun-exposed habitats where it was sampled in a two or three times greater number than on shaded sites. It was most numerous at low water level, but never on the dried bottom.

Species with the highest commoness index (Q > 20%), *R. balthica, H. complanatus* and *G. albus*, were found on the shaded sites. On sun-exposed sites on both kinds of detritus layer commonly occurred: *R. balthica*, *G. albus* and *H. complanatus* and on *Typha* remains *Planorbarius corneus* as well. In the whole collection, *R. balthica, H. complanatus* and *G. albus* were the most common. In this respect the community in site A differed from that in site B and site C. These data indicate the role of insolation in the distribution of snails in woodland ponds, which is illustrated by almost all the species (except *Lymnaea stagnalis* and *Gyraulus crista*) found there.

The periodicity of some ponds affects the chemical water properties, particularly the total hardness and the calcium content in water (Table 2). The greatest fluctuations were observed in pH values during the partial or total drying out of the water body.

The water acidity is sometimes the cause of the low number and diversity of snails. In this study a very small number of individuals was observed in the 2nd pond, where the pH value was permanently about 5 (except in April, when it amounted to 6.2), however, in the 5th pond where the pH value decreased in December to 2.9 (after a dry period from August to November) and in pond 4 where the pH value decreased to below 4.0 (from March to May) after the freezing period, such reduction in snail numbers was not observed.

Subsidence ponds may be periodically polluted by saline mine waters, which is the cause of very high conductivity of the water, especially in ponds 4, 5 and 6 (Table 2).

The investigations have not found any statistically significant relationship between the numbers and diversity of snails to the physico-chemical parameters, except for the pH value, which was positively correlated with the numbers of individuals ($r = 0.25$, $P < 0.05$).

Discussion

It is widely believed that the distribution of freshwater snails depends on many different factors, e.g., physico-chemical water properties, the type of reservoir, its area and depth, bottom sediments and richness of macrophytes (Dussart 1976). According to Dillon (2000) the type of bottom is most important in this respect. My studies have shown that in addition to the above-mentioned factors the covering of the bottom with plant detritus and exposure to sunlight play a significant role.

Lodge (1985) found that on fallen leaves in small shallow water body in England, the snail fauna was scanty and poorly diversified in comparison with the snail fauna inhabiting live macrophytes. In the woodland ponds investigated great numbers of snails were found in the detritus layer, among them some snail species rarely observed either in these types of water bodies or in the whole area studied (Lewin & Smoliński 2006). Likewise France (1995) found a greater abundance of freshwater snails in a layer of dead fallen leaves than on living water plants.

The study shows a significant positive correlation of the number of snails and the amount of allochthonic and autochthonic detritus.

Some of these woodland ponds had very low snail densities; probably due to the acidic water (pH about 5). Batzer et al. (2005) observed such a situation in natural woodland ponds in England.

France (1995) recorded an increase in zoobenthos richness simultaneously with the enlargement of the mass of allochthonous detritus, and the impoverishment of the invertebrate fauna as a result of the reduction of the detritus amount, which was caused by the felling of trees. A significant positive correlation between the amount of allochthonous detritus and the number of snails was found in my study whereas Lodge (1985, 1986) observing the snail occurrence on various bottom types, found that they avoided places covered with tree leaves.

The snail communities occurring in woodland anthropogenic water bodies differ from those, localised in urban agglomerations. From among 28 freshwater snail species known to date from the subsidence ponds of Upper Silesia (Strzelec & Serafiński 2004) in the woodland subsidence ponds studied 14 species were found. The absent species were: *Viviparus contectus*, *Physella acuta*, *Stagnicola corvus*, *Galba truncatula, Planorbis planorbis, Anisus leucostomus, Anisus vortex, Segmentina nitida* and *Acroloxus lacustris*, all species known from subsidence ponds located in open areas. However, five species previously unknown in such ponds were found during present studies. These are *Physa fontinalis, Radix auricularia, Stagnicola palustris, Hippeutis complanatus* and *Ferrissia wautieri.* Species such as *Anisus spirorbis, Bathyomphalus contortus* and *Gyraulus crista*, which had been determined as rare in this type of water body, occurred commonly and numerously in the woodland ponds studied.

The observed great abundance and high frequency of species considered to be rare in Upper Silesia, namely: *Aplexa hypnorum, Hippeutis complanatus, Anisus spirorbis* and *Radix auricularia* is very interesting fact.

Of special interest is the case of *H. complanatus*, known to date only from several sites in Upper Silesia. Its common occurrence in three of the ponds studied (a species very rarely found in the anthropogenic water bodies of Upper Silesia, except in fish ponds and never in subsidence ponds) is very interesting. Its frequency in all kinds of anthropogenic water bodies investigated in Southern Poland amounted to 8.2% only (Strzelec & Serafiński 2004). According to Hubendick (1947) and Kerney (1999) it is intolerant to desiccation and rarely occurs in temporary water bodies. Because it is the calciphilous species that prefers water of pH above 7.4 (Økland 1990), its mass occurrence in three of eight studied ponds is noteworthy. It has never been found in periodically drying sites, whereas it occurred abundantly in the shallow but permanently flooded places and was most numerous in waters with a low content of Ca (32–81 mg dm^{-3}). Perhaps this is a result of the greater thickness of the detritus layer on the bottom of these ponds, since food richness is one of the principal factors attracting the majority of snail species (Økland 1990).

From among three alien snail species known from the anthropogenic water bodies of Upper Silesia, *Potamopyrgus antipodarum* and *Ferrissia wautieri* were found in the woodland ponds studied, the last with a developed septum which is very rarely observed in natural conditions (Spyra 2008).

It seems that further studies on anthropogenic woodland ponds as a whole, and on the role of the detritus covering the bottom will further explain some seemingly incomprehensible observations concerning the distribution of freshwater snails in various water bodies.

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