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MOLLUSCS OF THE LIWIEC RIVER (SOUTH PODLASIE AND MIDDLE MAZOVIAN LOWLANDS)

MAŁGORZATA KORYCIŃSKA

Department Ecology and Environment Protection, University of Podlasie,
Prusa 12, 08-110 Siedlce, phone +48 25 6431215 (e-mail: gosia_k@ap.siedlce.pl)

ABSTRACT: Spatial distribution and seasonal dynamics of molluscs in the Liwiec River (South Podlasie Lowland) were studied: nineteen gastropod species were found, with members of Planorbidae (7 species) and Lymnaeidae (5 species) dominating, and other families being represented by single species. Of bivalves three unionid species, and 2 genera of Spheriidae were represented. The species diversity varied along the river: the malacocenosis of its upper section was the most diverse (14 species), while fewer species (10) were found in the river mouth region. The mid section was the least diverse (5 species). The mollusc densities varied from 1 to 37 indiv./m^2. They were the highest in the upper section (11–33 indiv./m^2), and at one site in the lower section (37 indiv./m^2); the lowest densities were observed in the mid section (1–7 indiv./m^2); in the river mouth region they ranged from 4 to 16 indiv./m^2. The mollusc abundance was higher in June and September than in April.

KEY WORDS: aquatic molluscs, spatial distribution, seasonal dynamics, Poland

INTRODUCTION

Compared to malacocenoses of lakes (LEWANDOWSKI & STAŃCZYKOWSKA 1975, 1986, STAŃCZYKOWSKA et al. 1983, KOŁODZIEJCZYK 1993) and dam reservoirs (STAŃCZYKOWSKA & JURKIEWICZ-KARNKOWSKA 1983, STAŃCZYKOWSKA et al. 1990, DUSOGE et al. 1990, DUMNICKA 1993, KRZYŻANEK 1994, JURKIEWICZ-KARNKOWSKA 1998), much less is known about mollusc communities of rivers of Poland (PIECHOCKI 1969, 1972, 1992, LEWANDOWSKI 1996). In this respect some regions of the country seem to be particularly neglected, and for some areas including Podlasie, data on aquatic molluscs are lacking (PIECHOCKI & DYDUCH-FALNIOWSKA 1993, PIECHOCKI & RIEDEL 1997). South Podlasie and Middle Mazovian Lowlands are drained mainly by the middle and lower Bug River, of which Liwiec is a left tributary. The aim of this study was an assessment of mollusc spatial distribution, and seasonal dynamics in the Liwiec River.

STUDY AREA AND METHODS

Liwiec is a IV order river, and the longest tributary of the Bug, its total length being 136.3 km. It drains South Podlasie and Middle Mazovian Lowlands. Its catchment area of 2,779.0 km^2 is used mainly as meadows and pastures (RAPORT 1997). The river course is meandering; the river is fed by 10 tributaries, among which Muchawka, Kostrzyń, and Osownica are the largest. The water quality varies along the river, being the best in the upper and lower sections while the mid section, below the Siedlce sewage treatment plant, is the most polluted (RAPORT 1997).

Samples were taken from 12 sites, situated at almost even intervals along the river (Fig. 1). Biological samples were collected three times (in April, June and September) in 1997, using semi-quantitative method, with dredge, from the surface of about 1.5 m^2. They

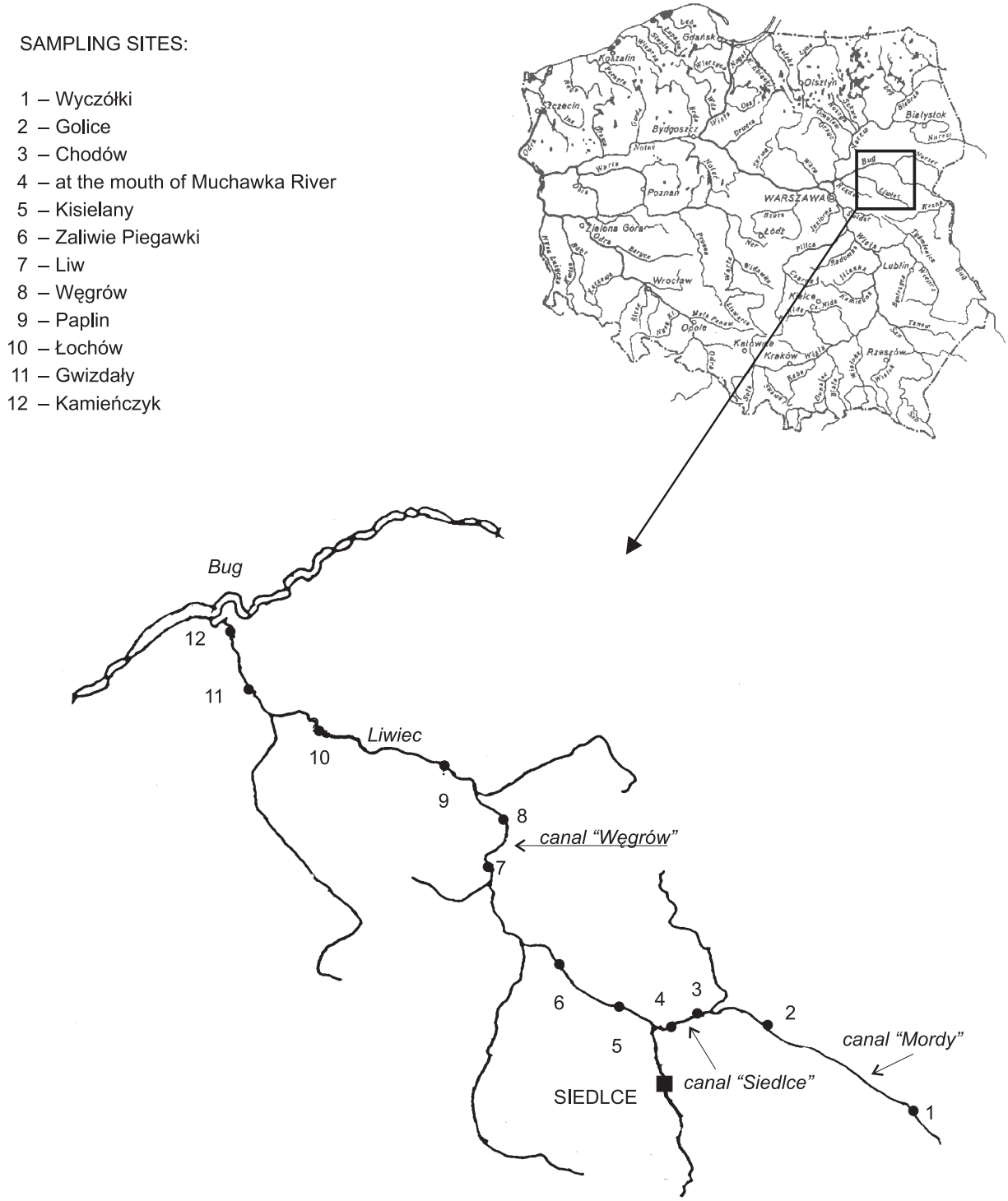

Fig. 1. Location of the sampling sites in the Liwiec River

were washed on a sieve of 1 mm mesh, sorted, and fixed with 75% ethanol. The molluscs were identified according to PIECHOCKI (1979), and PIECHOCKI & DYDUCH-FALNIOWSKA (1993). Snails and unionids were identified to species, and sphaeriid bivalves – to the generic level.

Water samples for chemical analyses were taken on the same dates as mollusc samples. The following water parameters were determined: DO content, BOD_5, and phosphate concentration.

LIST OF STUDY SITES (see: Fig. 1)

Site 1 – near the village Wyczółki, 6.5 km from the river source, regulated, width 2.5 m, depth 0.5 m, sandy bottom, slow current; surrounded by meadows.
Site 2 – near the village of Golice, below the outlet of a channel ca. 10 km long and carrying treated wastewater from the Mordy sewage processing plant, regulated, sandy bottom, slow current, sampling depth 0.5 m; surrounded by meadows and pastures.
Site 3 – village Chodów, clayey and muddy bottom, slow current, depth ca. 1 m, on banks willow shrubs; surrounded by farmland and greenhouses.
Site 4 – Muchawka River mouth, below a channel 2 km long and carrying wastewater from the Siedlce sewage treatment plant, very muddy bottom, slow current, depth ca. 1 m, on banks willows and alders; surrounded by meadows and pastures.
Site 5 – village Kisielany, muddy bottom, depth ca. 1 m, banks covered by willows and alders; surrounded by meadows.
Site 6 – village Zaliwie Piegawki, sandy and muddy bottom, depth ca. 1 m, slow current.
Site 7 – near the village of Liw, sandy and muddy bottom, wide riverbed, fast current, banks covered by willows and alders.
Site 8 – town Węgrów, below the outlet of a channel 3 km long and carrying wastewater from the Węgrów sewage treatment plant, sandy and muddy bottom, wide riverbed, fast current, depth ca. 1.5 m, banks covered by willows and alders; surrounded by pastures.
Site 9 – near the village of Paplin, sandy bottom, fast current, depth ca. 1 m, on banks willow shrubs and alders; surrounded by pastures.
Site 10 – near the village of Łochów, sandy bottom, depth ca. 0.3 m, slow current, on banks willows, alders and reed.
Site 11 – village Gwizdały, sandy and gravelly bottom, depth ca. 0.5 m, riverbed divided by vegetation-covered islands, current diversified, on banks alders.
Site 12 – near the village of Kamieńczyk, at the outlet of Liwiec to the Bug River, riverbed very wide, sandy and gravelly bottom, depth ca. 0.5 m, on banks willows, alders and reed.

RESULTS

Sixteen gastropod species representing 6 families, 3 species of unionid bivalves, and 2 species of sphaeriids (Table 1) were recorded from the Liwiec river. The families Planorbidae (7 species), and Lymnaeidae (5 species) were represented by numerous species, members of other families being fewer.

The species diversity was found to vary along the river. The most numerous gastropod species (8–9) were observed in the upper section of the river, and at one site in its lower section (site 8). The mid section, below the outlet of the channel carrying wastewater from the Siedlce sewage treatment plant, harboured the poorest mollusc community (1 species), followed by one of the lower section sites (site 10) where 2 species were observed. At the remaining sites the number of species was similar (4–6).

B. tentaculata, L. peregra and *L. stagnalis* were the most frequent, and present at least at 8 sites. *Sphaerium* sp. was equally widespread, absent from 2 sites only. On the other hand, *L. corvus, L. truncatula, P. carinatus, P. planorbis, V. contectus, A. contortus, H. complanatus, S. nitida, U. pictorum, U. tumidus,* and *Pisidium* sp. were rare. Other species (*V. piscinalis, P. fontinalis, L. auricularia, A. vortex, P. corneus,* and *U. crassus*) were present at ca. 50% sites.

The composition of the malacocenoses and the occurrence of various mollusc taxa varied seasonally: at 7 sites the number of species was higher in spring, and at 4 sites the highest diversity was observed in autumn. In summer, equal or lower numbers of species, compared to spring and autumn were noted at most sites (Table 1).

U. pictorum and *S. nitida* were most commonly found in summer, and *A. vortex* – in autumn. *L. stagnalis* was frequent in summer and autumn. *B. tentaculata* and *Sphaerium* sp. were present all over the sampling season.

The total density of molluscs was the highest in the upper section of the river (11–33 indiv./m^2), and at one of the lower section sites (8) (Fig. 2); the lowest densities were observed in the mid section of the river – from 1 to 7 indiv. m^{-2}. In the lower reaches the densities ranged from 4 to 6 indiv. m^{-2}. The densities of molluscs in June and September were higher than in

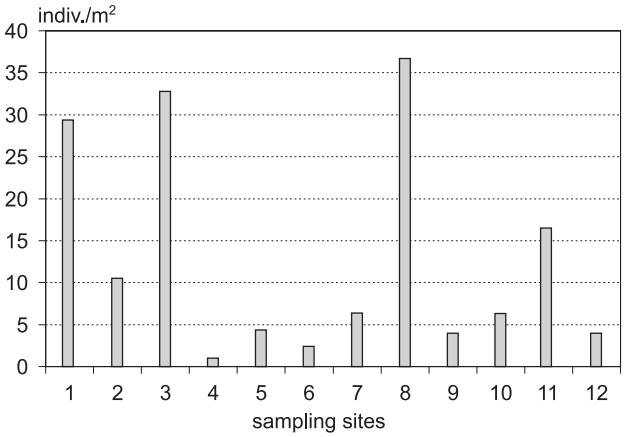

Fig. 2. Average densities of molluscs at the sampling sites in the Liwiec River in 1997

Table 1. Composition of mollusc communities at the sampling sites in the Liwiec River in 1997: a – April, b – June, c – September

Family and species	sites																																		
	1			2			3			4			5			6			7			8			9			10			11			12		
	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c	a	b	c
Prosobranchia:																																				
Viviparidae																																				
Viviparus contectus (Mill.)	+																																			+
Valvatidae																																				
Valvata piscinalis (O. F. Müll.)					+																	+	+	+	+				+				+			
Bithyniidae																																				
Bithynia tentaculata (L.)	+	+	+		+		+	+	+										+		+	+	+	+	+		+	+	+		+	+	+			+
Pulmonata:																																				
Physidae																																				
Physa fontinalis (L.)	+	+	+		+	+			+							+			+		+	+														
Lymnaeidae																																				
Lymnaea auricularia (L.)									+					+	+			+	+		+	+		+												
L. corvus (Gmel.)					+																															
L. peregra (O. F. Müll.)	+					+	+	+		+							+						+		+						+					+
L. stagnalis (L.)	+		+			+									+	+			+			+									+			+		+
L. truncatula (O. F. Müll.)																								+												
Planorbidae																																				
Planorbis carinatus O. F. Müll.	+	+																																		
P. planorbis (L.)					+																															
Anisus contortus (L.)	+								+																											
A. vortex (L.)			+			+			+						+							+														
Hippeutis complanatus (L.)																							+			+										
Segmentina nitida (O. F. Müll.)								+									+																			
Planorbarius corneus (L.)	+		+			+			+					+	+	+		+																		
Number of gastropod species	8	4	5	0	5	5	2	3	6	1	0	0	0	2	4	3	2	2	4	0	3	6	4	4	3	1	1	1	2	0	3	1	2	1	0	4
Number of gastropod species in site	9			9			8			1			4			6			4			9			4			2			4			4		
Sphaeriidae																																				
Sphaerium sp.	+	+		+	+	+						+		+					+	+			+	+		+		+	+			+	+		+	+
Pisidium sp.								+	+												+												+			
Unionidae																																				
Unio crassus Philips.	+				+															+												+			+	
U. pictorum (L.)																							+													
U. tumidus Philips.																							+													

April. In spring, the highest densities, ranging from 19 to 20 indiv. m^{-2} (Fig. 3a), were observed in the upper part of Liwiec (site 1), and near Węgrów (site 8). The lowest densities, of ca. 1 indiv. m^{-2}, were noted in spring at the following sites: Golice (site 2), below the outlet of the Siedlce sewage treatment plant (site 4), and at the Liwiec outlet to Bug (site 12). At site 5 in Kisielany no molluscs were observed.

In April, Lymnaeidae were most abundant at 6 sites, and their highest density – about 14 indiv. m^{-2} was noted at site 8, in Węgrów. Bithyniidae were slightly less numerous at that time (up to 7 indiv. m^{-2}). Compared to other sites, the upper part of Liwiec was the richest in Physidae (ca. 5 indiv. m^{-2}), Planorbidae, and Sphaeriidae (ca. 4 indiv. m^{-2}), as well as Unionidae (ca. 1 indiv. m^{-2}).

In summer, Sphaeriidae were very abundant at 8 sites (Fig. 3b). Their highest density (36 indiv. m^{-2}) was found at site 8, in Węgrów. Moreover, the densities of Valvatidae were higher than in spring, while

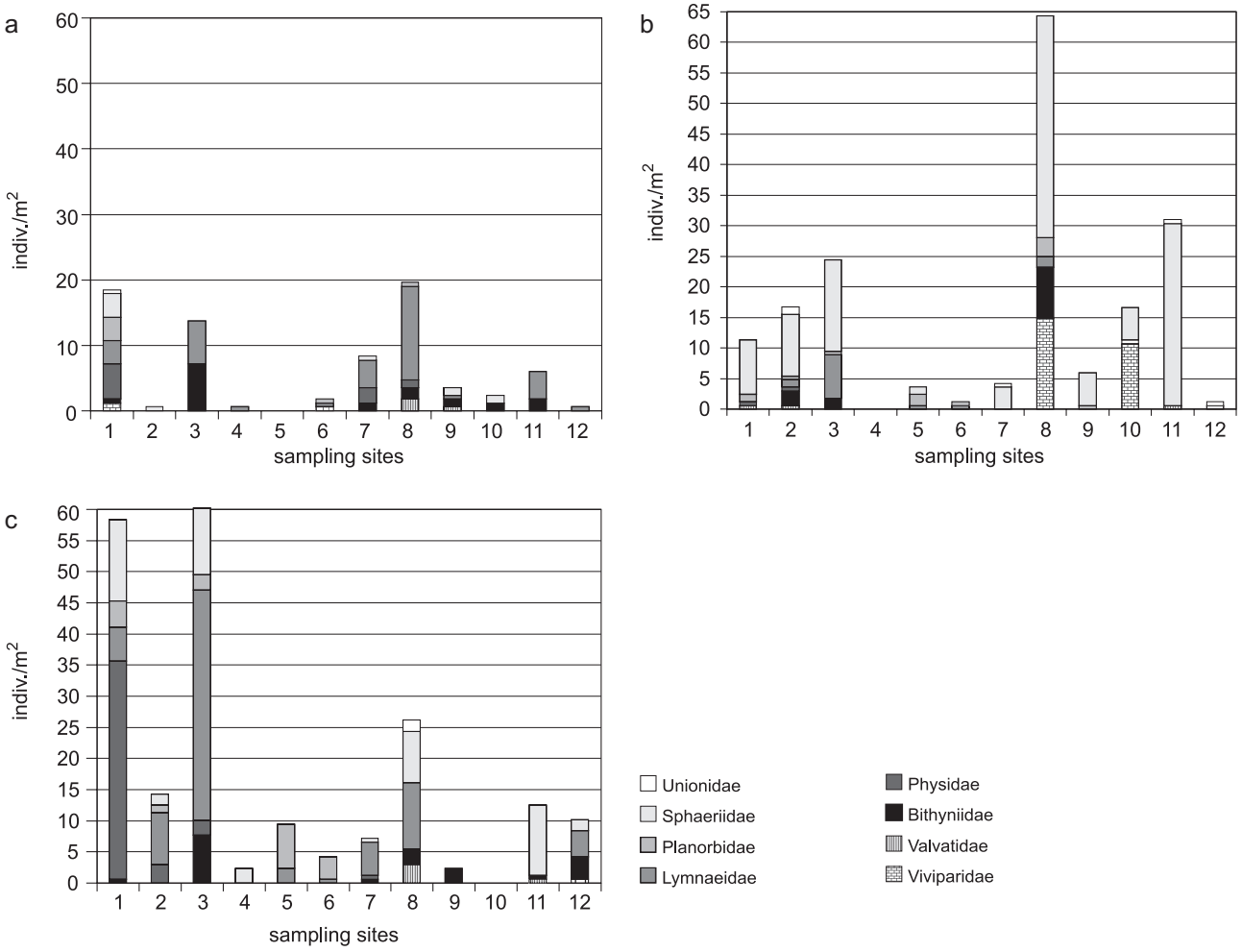

Fig. 3. Densities of molluscs at the sampling sites in the Liwiec River in 1997: a – April, b – June, c – September

numbers of Lymnaeidae and Bithyniidae were reduced. At the same time, the species diversity and density of molluscs at sites 1, 6, and 7 decreased. In September the density increased again (Fig. 3c). Site 1 was particularly abundant with Physidae (ca. 35 indiv. m^{-2}), while Lymnaeidae were very numerous in Chodów (ca. 37 indiv. m^{-2}). The density of these snails increased also at six other sites. A similar situation was observed for Planorbidae, whose density increased in September at five sites. At some sites, however, the density of molluscs dropped in autumn, e.g. at site 8, where the number of molluscs decreased from 65 to 26 indiv. m^{-2}, at site 9 (from 6 to 2.5 indiv. m^{-2}), site 11 (from 31 to 13 indiv. m^{-2}), and at site 10 no molluscs were observed at all.

The chemical parameters of water were measured to assess environmental conditions (Table 2). According to the Polish chemical standards, the water of the upper and lower parts of Liwiec meets requirements of quality class II, but in the mid section of the river the water is off-class. This is caused by the concentration of phosphate which exceeds allowable values (ROZPORZĄDZENIE 1991).

DISCUSSION

With its 19 species of snails and 2 genera of bivalves, the malacocenosis of Liwiec is moderately abundant. It is dominated by planorbid and lymnaeid pulmonates, prosobranchs being much less abundant; of the latter group Bithyniidae were the most common.

Environmental conditions in the Liwiec River are favourable for molluscs: natural (except headwaters) riverbed, many bends and spots of slack water. Moreover, some mollusc species are also favoured by appropriate substratum and submerged and emerged vegetation.

Table 2. Environmental conditions in the Liwiec River

Site	Substrate	Aquatic vegetation	Water flow [m/s^2]	O_2 [mgO_2/l]	BOD_5 [mg O_2/l]	PO_4^{3-} [mg/l]
1	sandy	*Elodea canadensis*, *Potamogeton* sp.	0.15	6.2	4.7	0.6
2	sandy	*Elodea canadensis*, *Potamogeton* sp., *Glyceria maxima*	0.14	8.5	6.5	0.4
3	clay and muddy	*Nuphar lutea, Sagittaria sagittifolia*	0.08	7.9	5.6	0.5
4	very muddy	*Lemna minor*	0.15	5.8	5.4	1.4
5	muddy		0.14	7.9	7.5	4.4
6	muddy	*Lemna minor, Sagittaria sagittifolia*	0.10	8.3	6.7	1.5
7	sandy-muddy		0.25	9.6	6.7	0.5
8	sandy-muddy	*Elodea canadensis*	0.28	9.0	5.3	0.5
9	sandy		0.33	10.2	4.7	0.4
10	sandy		0.17	10.3	5.4	0.4
11	sandy and gravelly		diverse	10.0	5.7	0.4
12	sandy and gravelly		0.33	10.4	5.4	0.4

However, the species diversity and the density of molluscs vary along the river course. Some sites, especially in the upper section of Liwiec, harbour particularly reach mollusc communities. That is in accordance with PIECHOCKI's (1979) opinion that headwaters are more favourable for molluscs compared to mid or lower sections of rivers. Despite the upper section of Liwiec being canalised, the slow water flow, and the vegetation (Table 2) create favourable conditions for molluscs. The upper section of Liwiec (sites 1, 2, 3) (Table 1) are inhabited by *V. piscinalis, B. tentaculata, Ph. fontinalis, P. carinatus*, and *U. crassus*. These species are common both in the current and outside it. They are often found among vegetation, where they find food, refuge, and breeding grounds. They prefer sandy bottom and well oxygenated water. Other molluscs, especially Planorbidae, prefer slack water, dense vegetation, or oxbows (Tables 1 and 2).

The mid section of Liwiec (sites 4, 5) has a very poor mollusc community: 5 species of snails and *Sphaerium* sp. The snails found in that region (*L. auricularia, L. peregra, L. stagnalis, A. vortex,* and *P. corneus*) are common in various types of waters, also in muddy reservoirs. They are tolerant to water pollution, and drying. In that region the bottom of the river is very muddy, the water is turbid, containing much suspension (RAPORT 1997). The poor environmental conditions might have resulted from the inflow of insufficiently purified wastewater from the Siedlce sewage treatment plant for many years. The plant has recently been modernized, and the water quality improved (RAPORT 1999). However, the conditions for molluscs are still inadequate because of the thick layer of deposited mud. Due to natural riverbed in the mid and lower sections, and the lack of other pollution sources, the river is self-purifying. The results of that process are obvious already in the mid section, and become even more distinct downstream. Viviparidae, Valvatidae, Bithyniidae, Physidae and Unionidae reappear (Table 1). The bottom character changes from muddy to sandy and muddy, and in the river mouth it is sandy and gravelly. The development of mollusc communities in the lower section of Liwiec is probably limited by the fast water flow (Table 2).

The changes in the density of molluscs observed during the sampling period are related mainly to their reproduction. Most of the recorded mollusc species breed in spring, and thus the densities considerably increase in summer and autumn. It should be stressed that some species die soon after reproduction. For example, *Physa fontinalis* produces two short-living generations, and only the last one survives until next season (PIECHOCKI 1979). As a result the density of the species increases in September (Fig. 3c). The life span of planorbid species is only one year, and their densities increase in September (Fig. 3c). *L. auricularia, L. peregra,* and *L. stagnalis* produce two generations per year, and survive until 2–5 years (PIECHOCKI 1979). Thus, their highest densities occur in autumn (Fig. 3c).

The malacocenoses of the Liwiec River are similar to those found in other lowland rivers. For example, in Wieprz 10 species of snails and 10 species of bivalves were observed, among which no Unionidae were found (PIECHOCKI 1979). In the Liwiec, Unionidae were present although they did not reach as high densities as in Krutynia (3–66 indiv. m^{-2}) (LEWANDOWSKI 1996). The 1980 and 1981 studies in the Bug River revealed 9 snail and 15 bivalve species (JURKIEWICZ-KARNKOWSKA 1986). The number of gastropod species found in the Liwiec is much higher than in Bug, but the number of bivalve species is hardly comparable because of inaccurate identification of Sphaeriidae from the Liwiec. The mollusc community of Pasłęka River seems more diverse compared to the Liwiec. PIECHOCKI (1972) found there 23 snail and 20 bivalve species.

Studies on mollusc communities of the Liwiec River should be continued. The water quality is improving, which might result in a further development of the malacocenoses, especially in the mid section part of the river. Moreover, the study should involve also the tributaries of Liwiec.

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