FOLIA MALACOLOGICA
Folia Malacol. 22(3): 209–220
ISSN 1506-7629
The Association of Polish Malacologists
Faculty of Biology, Adam Mickiewicz University
Bogucki Wydawnictwo Naukowe
Poznań, September 2014
http://dx.doi.org/10.12657/folmal.022.013

THE MOLLUSC FAUNA OF ŻYWIEC TOWN (SOUTHERN POLAND)

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ABSTRACT: The malacofauna of Żywiec was sampled from May to November in 2012 and 2013 in 33 localities. A total of 57 species (one with its form) were recorded: 53 gastropods (40 terrestrial, 13 freshwater) and 4 bivalves. Among them, two protected species (*Anodonta cygnea* and *Trochulus bielzi*) and ten listed in the Red List of Threatened Animals in Poland were found. These threatened species are mostly Carpathian in distribution. The molluscan fauna could be separated into two aquatic and six terrestrial ecological groups. Species typical of lakes and reservoirs dominated the aquatic fauna, while woodland species constituted 67% of all terrestrial species. Although woods and sites dominated by *Petasites* held the most species, and most of those regarded as threatened, even human-induced habitats contained some of the latter. This suggests that fragments of semi-natural habitats constitute important refugia for gastropods within urban environments, among others for the rare and endangered clausiliids *Macrogastra tumida*, *Vestia gulo* and *V. turgida*.

KEY WORDS: molluscs, urban faunas, threatened species, Żywiec, Poland

INTRODUCTION

Detailed studies of the malacofauna of limited areas are important, as they highlight the local range of habitats occupied by species, which may differ among regions. They are especially necessary when the local fauna holds rare and endangered species. There have been a number of such studies in Poland over the last two decades, but most have been carried out in areas known to be of high conservation interest, for example in the Pieniny National Park (SZYBIAK 2000), Świętokrzyski National Park (BARGA-WIĘCŁAWSKA 2011), the glen Kotlina Wałbrzyska and highlands Pogórze Wałbrzyskie (MALTZ 1999), Wzgórza Ostrzeszowskie hills (BAUCZ-MALIJ 1998) and some others. There are fewer studies of urban areas, yet a recent Czech study has shown that such areas, perhaps especially in smaller towns, may hold anthropophobic species in remnants of natural habitats (HORSÁK et al. 2009). In Poland, only the city of Wrocław has been thoroughly investigated (KOSIŃSKA 1979). Some other papers concern selected habitats in Szczecin (JANICKI 1999), Henryków near Ząbkowice Śląskie (POTOCZAK & POKRYSZKO 2008), Lębork (PAKUŁA & GÓRSKA 2006) or Cracow (GOŁAS-SIARZEWSKA 2013).

The town of Żywiec (S. Poland) has not been studied in detail, although it lies close to areas known to hold rare and endangered species. The fauna is known only from general publications (URBAŃSKI 1957, RIEDEL 1988, WIKTOR & RIEDEL 2002, WIKTOR 2004). This study aimed to establish the occurrence of mollusc species in different habitats located within the administrative boundaries of the town. In particular, it sought to identify the extent to which rare or threatened species were present within this much-altered area.

STUDY AREA

Żywiec, a town in Silesia province, is located at the altitude of 345–612 m a.s.l. in the glen Kotlina Żywiecka which belongs to the Western Beskids (Fig. 1). Within the administrative boundaries of Żywiec eight districts are distinguished: Moszczanica, Śródmieście, Oczków, Sporysz, Zabłocie, Kocurów-Koleby, Podlesie and Rędzina (MIODOŃSKI 2012). The town area is 50.54 km^2, whereas the total human population is more than 32,000 people. It is located at the confluence of two rivers, Soła and Koszarawa, with many creeks and streams like Łękawka or Sporyszek as tributaries. The town is situated on Żywieckie Lake which constitutes a storage reservoir on the Soła River. The aquatic environment is enhanced by the presence of fish ponds in the Moszczanica district (Fig. 2), supplied with water by the Moszczanica stream. Within the administrative boundaries of Żywiec there are several valuable natural areas like Grapa Nature Reserve (Sporysz district), Grojec Hill (the confluence of Soła and

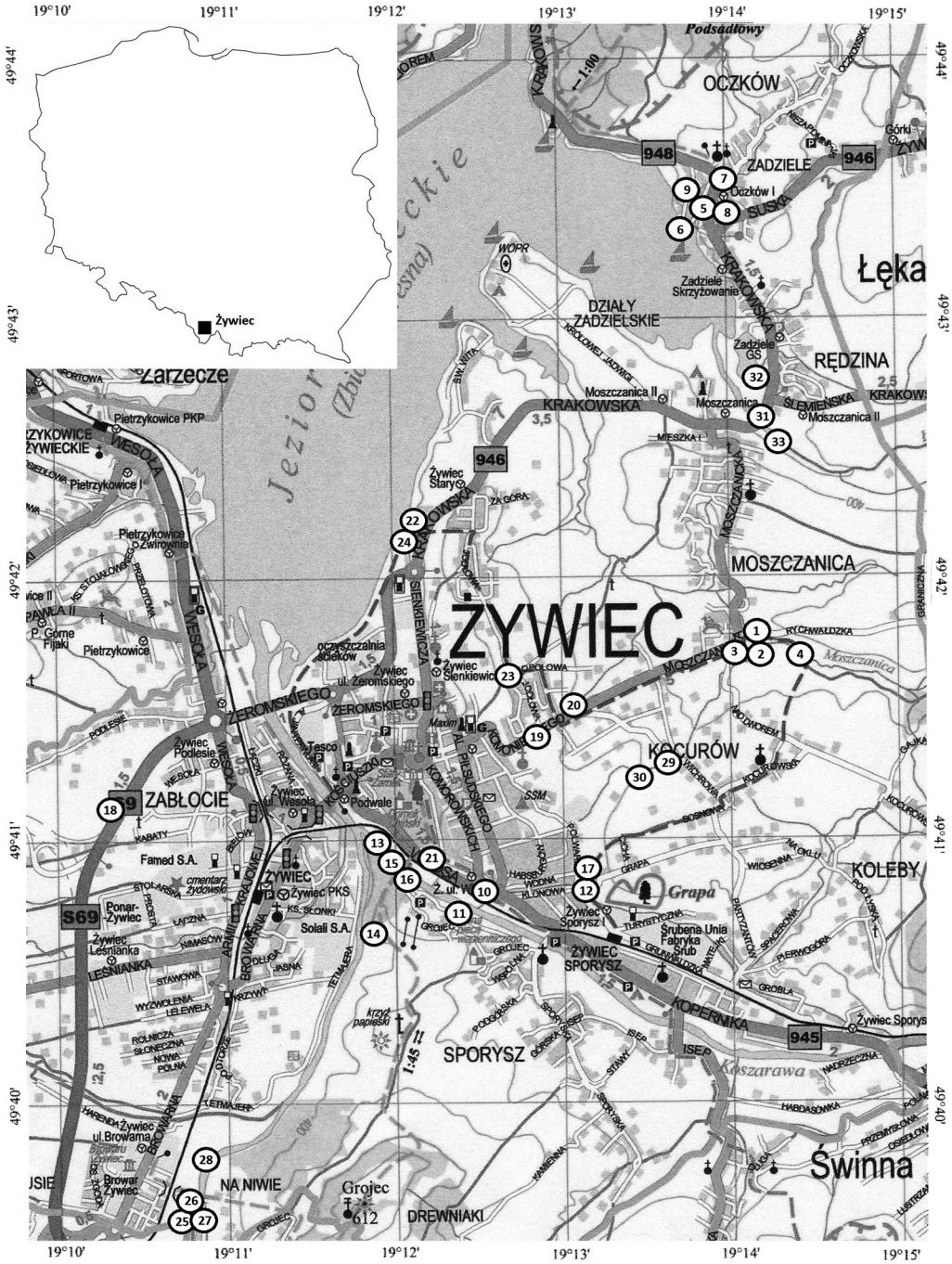

Fig. 1. A map of the studied area; points denote localities

Fig. 2. Fish ponds in Moszczanica district

Koszarawa streams) and a part of Żywiec Landscape Park (Oczków district).

Kotlina Żywiecka including Żywiec lies on rocks called Carpathian flysch, which is composed of sandstones, conglomerates and shales. In the area of Grojec Hill, which is a part of Sporysz district, there are brown and podzolic soils. They originated from weathered Carpathian rocks, while rendzinas, derived from calcareous rocks, are also subjected to weathering. This type of soil is rather uncommon in the Beskids. Alluvial muds, formed from river sediment layers, are typical soils in areas of rivers (MIKOŁAJSKI & SOŁTYSIK 1997).

The average temperature in Żywiec is 7.8°C. The average temperature in January ranges from –2°C to –4°C, whereas in July it is 14–16°C. The annual sum of precipitation is characteristic for a mountain area and ranges from 800 to 1,200 mm. Most precipitation occurs from May to November. Western and north-western winds prevail in the town, which bring wet and cool air in summer and warm, wet air in winter (FIGIEL & KRZYWDA 2006).

MATERIAL AND METHODS

Faunistic research was carried out from May to November in 2012 and 2013, and had a qualitative character. Gastropods were collected by eye for at least 2 person-hours at each site. Aquatic molluscs were also collected by eye and additionally triangular drag net, mesh 1 mm was used. Specimens were collected at 33 localities within the administrative boundaries of Żywiec (Fig. 1). The localities were chosen on the basis of ample diversity of habitats in each district. Details of the location and vegetation of each sampling locality is given in the Appendix. The sites were allocated to eight habitat types: aquatic (8), mixed woods (6), riparian woods (3), mid-field thickets (2), sites dominated by *Petasites* (6), human-modified habitats (parks, gardens, etc.; 6), open xerothermic (1) and riverside herbs (1). It should be noted that some *Petasites* sites held trees, and that the mixed woods varied greatly in character and composition.

The molluscs were identified using specialist keys (PIECHOCKI & DYDUCH-FALNIOWSKA 1993, GLÖER & MEIER-BROOK 1998, WIKTOR 2004) and the designations of molluscs were checked by dr hab. EWA STWORZEWICZ, and Professor ANDRZEJ FALNIOWSKI. The nomenclature and systematic arrangement of terrestrial gastropods were adopted from WIKTOR (2004), aquatic gastropods from GLÖER & MEIER-

BROOK (1998) and VINARSKI & GLÖER (2008, see also VINARSKI 2012), and clams from PIECHOCKI & DYDUCH-FALNIOWSKA (1993). As a result of the ICZN ruling, OPINION 2079 (BZN 61 (3) Sep 2004) *Trochulus* Chemnitz, 1786 instead of *Trichia* Hartmann, 1840 was used. Authorities for all names are given in Tables 1 and 2. To divide species into ecological groups, the classification of LOŽEK (1964) supplemented by ALEXANDROWICZ (1987) and ALEXANDROWICZ & ALEXANDROWICZ (2011) was applied. The division into zoogeographical groups was based on ALEXANDROWICZ's (1987) classification. One species, *Trochulus bielzi* (E. A. Bielz, 1860) was represented in the samples by only two empty shells, and it has been excluded from zoogeographical calculations.

RESULTS

The malacofauna of Żywiec revealed in this study includes 57 species comprising 4 species of bivalves, 13 aquatic gastropods (14 regarding *Radix balthica* f. *ampla* as distinct from the typical form) and 40 terrestrial gastropods. Tables 1 and 2 show the occurrence of each species at each site for aquat-

Table 1. The aquatic molluscs found in Żywiec, with details of their designated habitat preference – H (AE – lakes and reservoirs; AR – rheophilous), their geographical range – GR (Eu – European; Es – Euro-Siberian; Ho – Holarctic; Pa – Palaearctic). Presence in each site is indicated by ×. Details of each site are given in the appendix. # – species listed in the Polish Red Data Book (GŁOWACIŃSKI & NOWACKI 2004). * – species listed in the Red List of Threatened Animals in Poland (PIECHOCKI 2002)

	H	GR	Aquatic								Total number of sites
			3	6	7	16	17	28	32	33	
BIVALVES											
1. *#Anodonta cygnea* (Linnaeus, 1758)	AE	Es	×								1
2. *Anodonta anatina* (Linnaeus, 1758)	AR	Es		×					×		2
3. *Pisidium amnicum* (O. F. Müller, 1774)	AR	Pa		×					×		2
4. *Pisidium casertanum* (Poli, 1791)	AE	Ho	×	×							2
AQUATIC GASTROPODS											
5. *Bithynia tentaculata* (Linnaeus, 1758)	AE	Pa	×								1
6. *Valvata piscinalis* f. *antiqua* (Morris, 1838)	AE	Es		×							1
7. *Lymnaea stagnalis* (Linnaeus, 1758)	AE	Ho	×						×		2
8. **Ladislavella terebra* (Westerlund, 1885)	AE	Es				×					1
9. *Galba truncatula* (O. F. Müller, 1774)	AE	Ho								×	1
10. *Radix auricularia* (Linnaeus, 1758)	AE	Pa	×						×		2
11. *Radix balthica* (Linnaeus, 1758)[1]	AE	Pa				×				×	2
Radix balthica f. *ampla*	AE	Pa					×				1
12. *Anisus spirorbis* (Linnaeus, 1758)	AE	Pa	×								1
13. *Gyraulus albus* (O. F. Müller, 1774)	AE	Ho	×						×		2
14. *Gyraulus crista* (Linnaeus, 1758)	AE	Ho							×	×	2
15. *Planorbarius corneus* (Linnaeus, 1758)	AE	Es							×		1
16. *Ancylus fluviatilis* (O. F. Müller, 1774)	AR	Eu			×	×		×		×	4
17. *Physa acuta* (Draparnaud, 1805)	AE	Eu			×					×	2
Number of species			7	4	2	3	1	1	7	5	

[1] Formerly known as *Radix ovata* (Draparnaud, 1805)

Table 2. The terrestrial molluscs found in Żywiec, with details of their habitat preference – H (W – woods, E – euryoecious, X – xerothermic, O – open, H – hydrophilic, M – mesophilic), and their geographical ranges – GR (Ca – Carpathian/Alpine, Eu – European, Es – Euro-Siberian, In – introduced, Ho – Holarctic, Pa – Palaearctic, Pb – Pontic/Balkan). Sites are arranged by biotope (see appendix) and × indicates presence in the site. * – species listed in the Red List of Threatened Animals in Poland (WIKTOR & RIEDEL 2002)

	H	GR	Woods						Riparian			Petasites						Human induced						Thickets		Xero-thermic	Stream-side	Total number of sites
			4	9	12	13	22	25	10	11	27	1	2	5	15	24	26	8	18	19	20	21	23	29	30	14	31	
TERRESTRIAL GASTROPODS																												
18. *Acicula polita* (Hartmann, 1840)	W	Eu													×													1
19. *Succinea oblonga* Draparnaud, 1801	M	Es												×			×											2
20. *Succinea putris* (Linnaeus, 1758)	H	Es			×		×		×	×	×	×	×	×	×	×	×	×	×		×		×				×	16
21. *Succinea elegans* Risso, 1826	H	Pa										×				×												2
22. *Cochlicopa lubrica* (O. F. Müller, 1774)	E	Ho				×		×				×		×			×											5
23. *Columella edentula* (Draparnaud, 1805)	M	Ho				×				×		×		×	×			×										6
24. *Vallonia pulchella* (O. F. Müller, 1774)	O	Ho																				×						1
25. *Ena montana* (Draparnaud, 1801)	W	Eu				×			×						×									×	×		×	6
26. *Ena obscura* (O. F. Müller, 1774)	W	Eu				×																						1
27. *Discus rotundatus* (O. F. Müller, 1774)	W	Eu			×											×												2
28. **Discus perspectivus* (M. von Mühlfeld, 1818)	W	Pb			×	×						×	×									×						5
29. *Arion vulgaris* Moquin-Tandon, 1855	E	In	×		×							×	×	×	×	×		×	×	×	×		×	×				13
30. *Vitrina pellucida* (O. F. Müller, 1774)	E	Pa								×					×													2
31. *Vitrea crystallina* (O. F. Müller, 1774)	W	Eu				×																		×				2
32. *Vitrea diaphana* (Studer, 1820)	W	Eu			×	×																		×				3
33. **Aegopinella nitens* (Michaud, 1831)	W	Eu				×						×	×		×	×					×						×	7
34. *Oxychilus draparnaudi* (Beck, 1837)	E	Eu										×																1
35. **Oxychilus glaber* (Rossmässler, 1835)	W	Ca				×						×																2
36. *Oxychilus depressus* (Sterki, 1880)	W	Eu				×						×	×		×													4

	H	GR	Woods					Riparian				Petasites						Human induced					Thickets		Xero-thermic	Stream-side	Total number of sites
			4	9	12	13	22	25	10	11	27	1	2	5	15	24	26	8	18	19	20	21	23	29	30	14	31	
37. **Daudebardia brevipes* (Draparnaud, 1805)	W	Eu																						×				1
38. *Limax maximus* Linnaeus, 1758	W	In																		×	×			×				3
39. **Macrogastra tumida* (Rossmässler, 1836)	W	Ca																									×	1
40. *Macrogastra ventricosa* (Draparnaud, 1801)	W	Eu			×	×											×											3
41. *Laciniaria plicata* (Draparnaud, 1801)	E	Eu			×	×		×			×	×				×				×				×	×			9
42. *Alinda biplicata* (Montagu, 1803)	W	Eu			×	×		×	×	×	×		×			×	×			×	×			×	×		×	14
43. **Vestia gulo* (E. A. Bielz, 1859)	W	Ca											×															1
44. **Vestia turgida* (Rossmässler, 1836)	W	Ca											×														×	2
45. *Bulgarica cana* (Held, 1836)	W	Eu										×																1
46. *Bradybaena fruticum* (O. F. Müller, 1774)	W	Eu										×		×		×	×				×							5
47. *Helicella obvia* (Menke, 1828)	X	Pb				×																				×		2
48. *Perforatella incarnata* (O. F. Müller, 1774)	W	Eu		×	×	×		×				×		×		×	×				×			×	×		×	12
49. *Trochulus hispidus* (Linnaeus, 1758)	E	Eu					×				×	×				×	×				×							6
50. **Trochulus unidentatus* (Draparnaud, 1805)	W	Ca			×	×		×				×	×		×						×			×			×	9
51. **Trochulus lubomirskii* (Ślósarski, 1881)	E	Ca				×			×				×	×	×	×		×	×				×			×		10
52. **Trochulus bielzi* (A. E. Bielz, 1860)	W	Ca				×																						1
53. *Arianta arbustorum* (Linnaeus, 1758)	W	Eu				×			×	×							×										×	5
54. *Chilostoma faustinum* (Rossmässler, 1835)	W	Ca				×		×	×					×			×		×				×				×	8
55. *Isognomostoma isognomostoma* (Schröter, 1784)	W	Eu			×	×						×	×															4
56. *Cepaea nemoralis* (Linnaeus, 1758)	W	Eu	×	×	×	×	×							×	×	×	×	×	×	×	×	×	×		×		×	17
57. *Helix pomatia* Linnaeus, 1758	W	Eu	×		×	×	×		×	×	×					×	×	×	×	×		×	×	×	×			16
Total number of species			3	2	13	23	4	6	7	6	5	17	11	10	11	13	12	6	6	6	10	4	6	11	6	2	11	

ic and terrestrial molluscs, respectively. They also show the geographical distribution pattern of each species (Fig. 3).

The faunas from aquatic habitats had no species in common with those on land. The aquatic species (Table 1) are categorised as those of lakes or reservoirs (AE), or of running water (rheophilous, AR). No aquatic species has a restricted Carpathian distribution. The richest sites (3 and 32) are the fish ponds at Moszczanica and Rędzina; between them, they hold 11 species not found at the other aquatic sites, including the very rare *Anodonta cygnea*.

Terrestrial species' occurrence is shown in Table 2, where the sites are grouped by their habitat type. Species are classified to six ecological groups: euryoecious species (E), hygrophilous species (H), mesophilous species (M), open-country species (O), xerophilous species (X) and woodland species (W) (Table 2). The number of species per locality ranged from 1 (localities 7, 17, 28) to 23 (locality 13). Locality 13, the deciduous forest at Czarny Grojec, is characterised by fertile soils and thick leaf litter. These factors positively affect land-snail diversity and abundance (NEKOLA 2003). The mean number per locality was 7 species.

In terms of geographical range, the largest category for terrestrial species is of those with European ranges (21 species). There are three Holarctic species and two each for Palaearctic and Euro-Siberian ranges. Two introduced species are west European in origin. Within these categories only two species, *Daudebardia brevipes* and *Aegopinella nitens*, are listed as rare or endangered in Poland (WIKTOR & RIEDEL 2002). By contrast, among the ten species (*Discus perspectivus, Oxychilus glaber, Macrogastra tumida, Vestia gulo, V. turgida, Trochulus unidentatus, T. lubomirskii, T. bielzi, Chilostoma faustinum* and *Helicella obvia*) with more restricted distributions, categorised as Carpathian/Alpine (Ca) or Ponto-Caspian/Balkan (Pb), only the last two lack this designation. *H. obvia* is now widely spread in xerothermic sites across central Europe. *Ch. faustinum* is widespread in the southern Polish mountains, and is also known from Romincka forest in the far north of the country (MARZEC 2005). The record of *T. bielzi*, based on just two empty shells from one site, requires confirmation.

Figure 4 shows the breakdown of species into ecological groups. Among aquatic species, those typical of still waters outnumber those associated with flowing water. Among terrestrial species those typical of forests are easily the largest group; together with euryoecious species they constitute 65% of all terrestrial species found. The total number of species and the number of rare or endangered species found in each habitat type are shown in Table 3. The number of species varied greatly among individual sites, especially in woods (Table 2), but woods and *Petasites*-dominated sites held the most species overall. Only 12 out of the 40 species were confined to a single habitat type, while 15 were present in four or more habitats. There was much overlap in species composition among habitats. Five species were present in more than half of all the sites investigated: *Succinea putris, Alinda biplicata, Helix pomatia, Cepaea nemoralis* and *Arion vulgaris*. The last two are not native to south-east Poland. Of the ten rare or threatened terrestrial species only four were

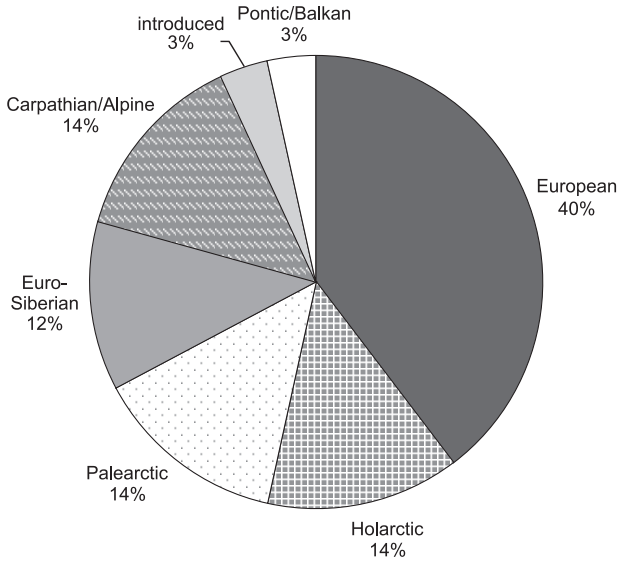

Fig. 3. Zoogeographic composition of the malacofauna of Żywiec

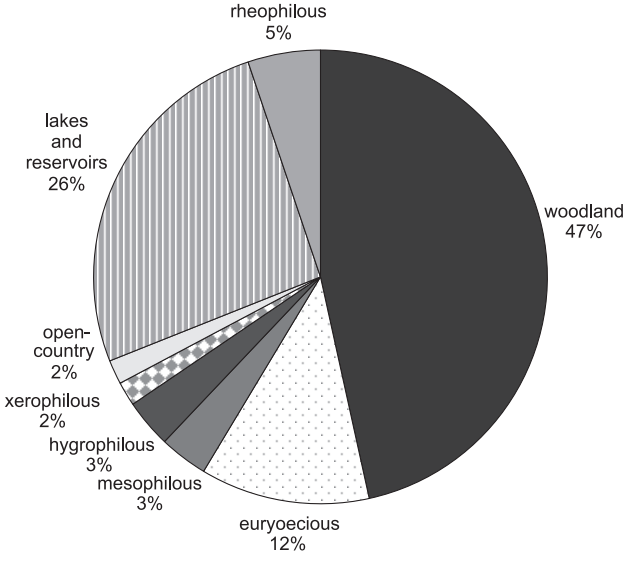

Fig. 4. Diagram of molluscs classification into ecological groups according to LOŽEK (1964) supplemented by ALEXANDROWICZ (1987) and ALEXANDROWICZ & ALEXANDROWICZ (2011)

Table 3. The numbers of species, and of rare or endangered species found in each terrestrial biotope

	Mixed woods	Riparian woods	Petasites sites	Thickets	Human induced	Xerothermic	Streamside
Sites	6	3	6	2	6	1	1
Species	26	11	31	12	17	2	11
Endangered species	6	1	7	2	4	1	4

recorded from a single biotope, and *T. unidentatus* and *T. lubomirskii* were found in five out of the seven biotopes searched (Table 2). Although woods and *Petasites* sites held the largest number of such species, other habitats also contained some of them.

DISCUSSION

The results reported here do not represent a full inventory of all mollusc species likely to be found in Żywiec. A number of small species could have been missed, and others under-recorded in terms of the number of sites in which they were found. DZIĘCZKOWSKI's (1972) classification of species into categories based on the proportion of sites occupied is not wholly appropriate to the data, but among terrestrial species there are a few, mostly large and conspicuous species that were found in more than half the sites. Many others were recorded from several biotopes.

The aquatic malacofauna of Żywiec is not diverse. The most common species (in 4 sites) was the abundant *Ancylus fluviatilis* that indicates high water quality (WELTER-SCHULTES 2012). Eight of the 17 species (18 aquatic gastropods including the form *ampla* of *R. balthica*) were recorded only from single sites (Table 1). Most species were typical of lakes or reservoirs; stream faunas were relatively poor, perhaps reflecting the mainly acid rocks and soils of the area. The positive influence of human activity is clear in the rich faunas associated with fish ponds including the endangered species *A. cygnea* (PIECHOCKI 2002, GŁOWACIŃSKI & NOWACKI 2004). This species was scarce, but the other endangered species, *L. terebra,* found at site 16, was locally abundant.

The total of 17 aquatic mollusc species found in Żywiec is similar in a number to those recorded in Szczecin (17 species, JANICKI 1999). The latter study, however, was restricted to selected water bodies, mainly ponds. There are only 7 species found in both Żywiec and Szczecin (JANICKI 1999).

In the terrestrial fauna, the large number of species with woodland affinities reflects the originally forested nature of the region. Much forest remains in the vicinity (MIKOŁAJSKI & SOŁTYSIK 1997). Nevertheless, the most widely-distributed species in the town are those that show an ability to occupy a wide range of biotopes (RIEDEL 1988). Among these are (in order of frequency) *C. nemoralis* (68%), *H. pomatia* (64%), *A. biplicata* (56%), *A. vulgaris* (52%) and *P. incarnata* (48%). *A. vulgaris* is not native to Poland (WIKTOR 2004), but has spread rapidly. *C. nemoralis* is not native to south-east Poland. Its recent spread is well-documented (JUŘIČKOVÁ 1995, SULIKOWSKA-DROZD 2007), and this species together with *H. pomatia* and *P. incarnata*, is classified by some authors (KOSIŃSKA 1979) as synanthropic, preferring man-made habitats to natural ones. *C. nemoralis* is abundant in the urban environment of Wrocław (CAMERON et al. 2009). The wide distribution and wide range of habitats occupied by *A. biplicata* is explained by the combination of selfing and brooding in this species (MALTZ & SULIKOWSKA-DROZD 2014).

These somewhat invasive species are not the only ones to occur in more than one biotope. Many woodland species were recorded in other biotopes in the town. Of particular interest are the ten species regarded as endangered (WIKTOR & RIEDEL 2002). Only four of these were recorded from only one biotope, and two, *T. unidentatus* and *T. lubomirskii,* occurred in most of them. Whatever human actions have taken place in the mixed woods and in the *Petasites* sites, they have not eliminated all the endangered species, and these habitats in particular represent refuges in an urban context. In the poorer riparian sites FOSTER & ZIEGLTRUM (2013) suggested that site variability can affect mollusc community structure and influence taxa resiliency to disturbances such as logging. Overall this study demonstrates the importance of fragments of natural and semi-natural habitats within urban environments as refugia, especially for rare and endangered species (HORSÁK et al. 2009). Moreover, in urban areas the heterogeneity of habitat and land-use types may also influence species richness (KNAPP et al. 2008).

Two endangered species are worthy of additional comment. The record of *T. bielzi*, a species protected by Polish law (ROZPORZĄDZENIE 2011), represents an extension of range, though based only on empty shells. The nearest record comes from the Wisłok River, situated ca. 300 km away (PROĆKÓW 2009).

Repeated searches have not yielded more specimens, probably due to the construction of the pedestrian area in the close vicinity of the locality. The occurrence of *D. perspectivus* in the study area is also noteworthy. It is the first record of the species in the glen Kotlina Żywiecka and thus the westernmost location in the Polish Carpathians (RIEDEL & WIKTOR 1974, RIEDEL 1988). This stenotypic (woodland, calciphile) species was collected from 5 localities among which was a park located in a centre of the town. A large number of specimens, collected in the leaf litter, was found on the outskirts of the park, a part less exploited by human. In other localities *D. perspectivus* was also frequent.

The response of local snail assemblages along a gradient of habitat degradation, generalised as a gradual decline in species richness was recorded in three Czech cities (HORSÁK et al. 2009). This trend can be also observed in this study. In anthropogenic biotopes the number of species at each locality was low and varied from 4 in a town park to 10 in gardens (Table 2). The differences result from the number of potential habitats where snails can live.

ACKNOWLEDGEMENTS

I am grateful to dr hab. EWA STWORZEWICZ who checked designations of the land gastropods, and to Prof. ANDRZEJ FALNIOWSKI, who checked designations of freshwater molluscs and helped me a lot with his critical comments while I was writing my bachelor thesis. I am grateful to dr hab. PAULINA KRAMARZ, dr MAŁGORZATA PROĆKÓW and Prof. ANDRZEJ LESICKI for their support. My special thanks are due to Prof. ROBERT A. D. CAMERON for his constructive suggestions which improved the manuscript considerably and to two anonymous reviewers for their helpful comments.

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Received: March 2nd, 2014
Revised: April 18th/May 19th, 2014
Accepted: May 20th, 2014
Published on-line: July 17th, 2014

APPENDIX

LOCATION AND CHARACTERISTICS OF SAMPLING LOCALITIES

1. Moszczanica (49°41'45.0" N, 19°14'11.3" E): community with *Petasites* sp., habitat formed by *Petasites albus* and *P. hybridus*. Also *Urtica dioica, Geranium robertianum, Tussilago farfara, Ranunculus acris, Typha latifolia* and *Phragmites australis* were present.
2. Moszczanica (49°41'43.8" N, 19°14'11.6" E): Moszczanica streambank vegetation formed by *Geranium robertianum, Vinca minor, Urtica dioica, Trifolium pratense, Dryopteris filix-mas* and many species of mosses.
3. Moszczanica (49°41'44.4" N, 19°14'09.7" E) (Fig. 2): four fish ponds with sandy-muddy bottoms.
4. Moszczanica (49°41'41.1" N, 19°14'23.7" E): mixed forest; habitat formed by trees and shrubs: *Carpinus betulus, Alnus incana, Picea abies, Salix caprea, Corylus avellana*. Herb layer was formed by *Dryopteris filix-mas, Carex brizoides* and additionally there were many species of mosses.
5. Oczków (49°43'24.3" N, 19°13'50.6" E): community with *Petasites* sp. formed by *Petasites albus, P. hybridus, Salix alba, Fagus sylvatica, Acer pseudoplatanus, Quercus robur, Urtica dioica, Carduus nutans* and *Chamaenerion angustifolium*.
6. Oczków (49°43'19.8" N, 19°13'41.6" E): Żywieckie Lake with sandy bottom.
7. Oczków (49°43'25.0" N, 19°13'50.3" E): the Oczkowianka stream; sandy-muddy bottom with stones and aquatic plants.
8. Oczków (49°43'24.2" N, 19°13'50.0" E): meadow; habitat formed by *Urtica dioica, Tanacetum vulgare* and *Solidago virgaurea*.
9. Oczków (49°43'22.0" N, 19°13'48.8" E): deciduous forest; habitat formed by *Carpinus betulus, Fraxinus excelsior, Alnus incana, Corylus avellana, Asarum europaeum* and *Polytrichum commune*.
10. Sporysz (49°40'48.1" N, 19°12'31.1" E): riparian forest I; habitat formed by *Salix fragilis, Carpinus betulus, Fraxinus excelsior, Tilia cordata, Frangula alnus, Acer pseudoplatanus, Corylus avellana, Sambucus nigra, S. racemosa, Quercus robur* and *Fagus sylvatica*.
11. Sporysz (49°40'44.9" N, 19°12'22.4" E): riparian forest II; located near the Koszarawa River which deposits fertile mud during floods. Tree layer dominated by *Salix fragilis, Carpinus betulus, Quercus robur, Acer pseudoplatanus, Frangula alnus*. Herb layer is mainly formed by *Urtica dioica, Ficaria verna, Pulmonaria obscura, Asarum europaeum* and *Polygonatum multiflorum*.
12. Sporysz (49°40'47.7" N, 19°13'05.8" E): mixed forest I; habitat located in Grapa Nature Reserve. It is formed by three types of plant associations: lime-oak-hornbeam forest formed by *Carpinus betulus, Quercus robur, Tilia cordata*, ash forest with *Astrantia major* and community with *Lolium perenne* and *Plantago major*.
13. Sporysz (49°40'57.2" N, 19°11'54.9" E): mixed forest II – Czarny Grojec; located on a slope of Grojec Hill. Tree and shrub layers were formed by *Pinus nigra, P. strobus, P. silvestris, Carpinus betulus, Tilia cordata, Frangula alnus* and undergrowth also by many mosses and ferns.
14. Sporysz (49°40'37.8" N, 19°11'51.8" E): xerothermic grasslands with soils formed by weathered limestone rocks. Plants like *Inula salicina, Centaurea scabiosa* and *Viccia cracca* were present.
15. Sporysz (49°40'53.4" N, 19°11'59.8" E): community with *Petasites* sp.; dominant species were *Petasites albus* and *P. hybridus* with *Urtica dioica*.
16. Sporysz (49°40'52.0" N, 19°12'04.0" E): the Koszarawa River with mild course and slow current. Sandy-muddy bottom with stones and aquatic plants.
17. Sporysz (49°40'47.5" N, 19°13'5.5" E): the Młynówka stream; muddy bottom with stones.
18. Podlesie (49°41'07.7" N, 19°10'18.5" E): fields and meadows with trees and shrubs like *Juglans regia* and *Prunus padus*, also herbaceous plants like *Solidago virga-aurea, Armoracia rusticana, Tanaceum vulgare* and *Urtica dioica*.
19. Śródmieście (49°41'22.5" N, 19°12'46.8" E): cemetery; most dominant trees: *Aesculus hippocastanum, Quercus robur, Tilia cordata, Fraxinus excelsior*. Herbaceous plants were *Fragaria vesca, Plantago major, Urtica dioica, Rubus idaeus, R. fruticosus* and *Symphoricarpos albus*.
20. Śródmieście (49°41'28.8" N, 19°13'04.4" E): gardens; habitat formed by *Aesculus hippocastanum, Sambucus nigra* and many garden trees like apple, plum and cherry trees. Herb layer was formed by grasses, and *Primula elatior, Caltha palustris, Leucanthemum vulgare*.
21. Śródmieście (49°40'55.7" N, 19°12'11.0" E): park; habitat formed by different tree species: *Ulmus glabra, Quercus robur, Tsuga canadensis, Acer pseudoplatanus, Gingko biloba, Gleditsia triacanthos, Pinus abies, Fagus sylvatica* and *Tilia ×europaea*.
22. Śródmieście (49°42'20.2" N, 19°12'8.8" E): mixed forest; located near Żywieckie Lake, on a hill, habitat formed mainly by *Carpinus betulus* and *Pinus sylvestris*.
23. Śródmieście (49°41'37.3" N, 19°12'41.4" E): fields and meadows; formed mainly by herbaceous species: *Matricaria chamomilla, Leucanthemum vulgare, Carduus nutans, Rumex acetosella, Armoracia rusticana* and also single trees: *Acer pseudoplatanus,*

Fraxinus excelsior, *Sambucus nigra*, *Quercus robur* and *Qu. petraea*.

24. Śródmieście (49°42'11.9" N, 19°12'07.4" E): community with *Petasites* sp.; dominated by *Petasites albus*, *P. hybridus*, with *Urtica dioica*, *Carduus nutans*, *Chamaenerion angustifolium*, *Salix alba* and *Fagus sylvatica*.
25. Zabłocie (49°39'37.5" N, 19°10'48.6" E): mixed forest; formed by *Pinus sylvestris*, *Sorbus aucuparia*, *Quercus robur*, *Fagus sylvatica* and *Frangula alnus*.
26. Zabłocie (49°39'37.9" N, 19°10'52.2" E): community with *Petasites* sp.; habitat formed by *Petasites albus* and *P. hybridus* with *Salix fragilis*, *Alnus incana*, *Sambucus racemosa*, *Acer pseudoplatanus* and *Calystegia sepium*.
27. Zabłocie (49°39'37.4" N, 19°10'48.8" E): riparian forest; formed by *Salix fragilis*, *Quercus robur*, *Sambucus racemosa*, *Fraxinus excelsior* and *Alnus incana*. Herb layer formed by *Urtica dioica*, *Impatiens noli-tangere*, *Petasites albus*, *Calystegia sepium* and *Rubus idaeus*.
28. Zabłocie (49°39'41.6" N, 19°10'52.2" E): the Soła River; mild course and slow current, sandy-muddy bottom with stones and aquatic plants.
29. Kocurów-Koleby (49°41'17.0" N, 19°13'35.8" E): midfield thickets I; habitat formed by *Populus tremula*, *Frangula alnus*, *Acer pseudoplatanus*, *Tilia cordata*, *Carpinus betulus* and *Betula pendula*.
30. Kocurów-Koleby (49°41'19.5" N, 19°13'27.5" E): midfield thickets II; habitat formed by *Acer pseudoplatanus*, *Tilia cordata* and *Betula pendula*.
31. Rędzina (49°42'35.1" N, 19°14'12.7" E): herbaceous vegetation along Alpine riverbanks; habitat formed by many river stones which have no access to water of the Łękawka stream, and by many plant species: *Salix eleagnos*, *Calamagrostis pseudophragmites*, *Chamaenerion palustre*, *Festuca rubra*, *Equisetum variegatum*, *Poa granitica*, *Rumex scutatus*, *Tussilago farfara*, *Caltha palustris*, *Petasites albus* and *P. hybridus*.
32. Rędzina (49°42'46.2" N, 19°14'12.0" E): fish pond with sandy bottom.
33. Rędzina (49°42'35.1" N, 19°14'11.5" E): the Łękawka stream; mild course and slow current, sandy bottom with stones and aquatic plants.