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TERRESTRIAL MALACOCOENOSES OF THE MONASTERY PARK IN HENRYKÓW NEAR ZĄBKOWICE ŚLĄSKIE (SW. POLAND)

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ABSTRACT: The malacofauna sampled at 10 sites in Henryków includes 45 species, with 13–32 (mean 21) species per site; similarity between the sites (Nei) ranges from 0.28 to 0.79, Whittaker's indices are: I_w 2.14 and I_{max} 1.41. Overall similarity between the communities from Henryków and from the nature reserve Muszkowicki Las Bukowy, 5 km away, is 0.75. The nature reserve malacocoenosis is richer (total of 48 species, with 31–37 species per site and mean of 34.5), similarity between the four examined sites is higher (0.79–0.92), and the between-site heterogeneity – lower (I_w 1.22, I_{max} 1.14). The dominance and frequency structure differs between the two malacocoenoses: in Henryków species of the highest F × D values are (in the order of importance): *Balea biplicata, Perforatella incarnata, Bradybaena fruticum, Carychium tridentatum, Aegopinella minor, Discus rotundatus, D. perspectivus, Aegopinella pura, Helix pomatia* and *Perforatella bidentata*, in Muszkowice *Carychium tridentatum, Balea biplicata, Discus perspectivus, D. rotundatus, Aegopinella pura, Ae. minor, Macrogastra plicatula, Columella edentula, Acicula polita* and *Perforatella incarnata. Acicula polita, Succinea oblonga, Ena montana, Arion silvaticus, Vitrea diaphana, Daudebardia rufa, Cochlodina laminata, Macrogastra ventricosa, Clausilia pumila, Bulgarica cana, Perforatella vicina, Helicodonta obvoluta* and *Causa holosericum* occur only in the nature reserve, *Carychium minimum, Succinea putris, Vertigo pusilla, V. substriata, Vallonia costata, Arion circumscriptus, Zonitoides nitidus, Deroceras laeve, Ruthenica filograna* and *Perforatella rubiginosa* are found only in the park. Comparison of the Henryków malacocoenosis with the communities of other parks in Poland, despite their rather low similarity (0.55–0.67), made it possible to distinguish a community of typically park species which are present in all the studied parks (*Succinea putris, Cochlicopa lubrica, Vallonia costata, Discus rotundatus, Arion fasciatus, Vitrina pellucida, Vitrea crystallina, Nesovitrea hammonis, Zonitoides nitidus, Bradybaena fruticum, Perforatella bidentata, P. incarnata, Cepaea hortensis, Helix pomatia*). Finding in Henryków such rare species as *Discus perspectivus, Aegopinella epipedostoma, Ruthenica filograna* and *Deroceras praecox* suggests that the park is an important refugium for gastropods.

KEY WORDS: terrestrial gastropods, malacocoenosis, park, Poland, refugium

INTRODUCTION

Because of its calcium-rich loess substratum and the natural character of the forest, the nature reserve Muszkowicki Las Bukowy holds one of the richest malacoenoses in Lower Silesia (WIKTOR 1972, POKRYSZKO & CAMERON 2005). The nearby monastery park in Henryków, with its old tree stands, provides an opportunity to check to which extent originally rich malacocoenoses can survive in a site under human impact. SULIKOWSKA (1998) suggests that parks may be essential for survival of local malacofaunas. Our aim was to ascertain the composition of park malacofauna in Henryków and compare it with the natural, unchanged malacocoenosis of the nature reserve Muszkowicki Las Bukowy, and with malacocoenoses of other studied parks, in order to estimate the significance of parks as refugia for gastropods.

STUDY AREA

The monastery park in Henryków near Ząbkowice Śląskie (SW. Poland) is ca. 5 km away from the nature reserve Muszkowicki Las Bukowy (Fig. 1): 50°39'91''N, 18°07'81''E. The park, 116 ha in area, was established in the 19th c. based on a forest (EYSYMONTT 1972). It is crossed by the Oława river with two small tributaries. The soils are loess-derived podzols and brown soils (WALCZAK 1968). The park is within the submontane climatic region (WALCZAK 1968). At present it is protected as a landscape park.

Floristic characteristics of the park has been provided by FUGLEWICZ (1979). Most of the area is covered in a transformed but never clear-felled forest with some very old trees, for example oaks of 3.5–5 m trunk perimeter or ash trees of ca. 4 m trunk perimeter. An oak-hornbeam forest of varied proportion of oak and hornbeam, and with an admixture of lime, maple, sycamore and beech predominates. Spruce is numerous in places. The shrub layer, well-developed in most of the area, is composed of young trees (hornbeam, lime, sycamore) and shrubs (*Corylus avellana, Evonymus europaea, Cornus sanguinea, Crataegus monogyna, C. oxyacantha, Sambucus nigra, Lonicera xylosteum, Padus avium*). The herb layer, with the degree of coverage of 60–80%, is composed, among others, of *Actaea spicata, Asperula odorata, Stellaria holostea, Oxalis acetosella, Campanula trachelium, Galium mollugo, Ranunculus lanuginosus, Urtica dioica, Fragaria vesca, Veronica persica* and *Glechoma hederacea*. The wet bank of one of the streams holds a young alder stand with *Myosotis palustris, Lychnis flos-cuculi, Cardamine pratensis, Sanguisorba officinalis, Galium palustre, Carex gracilis, Ranunculus repens, Geum rivale* and *Caltha palustris*. During the park's history numerous alien trees and shrubs were planted: *Tsuga canadensis, Ribes sanguineum, Chamaecyparis* sp., *Taxus baccata, Aesculus pavia, Ae. octandra, Amorpha fruticosa* and *Physocarpus opulifolius*, while the herb layer includes some synanthropic species (*Poa annua, Capsella bursa-pastoris, Aethusa cynapium, Galinsoga quadriradiata, Lamium purpureum, L. maculatum, Urtica dioica, U. urens*).

Fig. 1. Location of the study area in the monastery park in Henryków (circle) in Poland and in relation to the nature reserve Muszowicki Las Bukowy (square) in SW. Poland

Ten sites were selected in the park in such a way that all habitat types were represented. Each site was approximately 400 m^2 (CAMERON & POKRYSZKO 2005). Since the meadows in the park are heavily managed: regularly mown, fertilized and treated with pesticides, and no snails were found there during preliminary search, all the studied sites were tree stands.

Site 1 (Fig. 2) (7.10.2006): stand with dominance of oak, with few lime, hornbeam and ash trees; shrub layer composed of young maple, in herb layer *Glechoma hederacea*, *Asperula odorata*, some grass; small quantity of dead timber in the form of small sticks and medium-sized branches.

Site 2 (7.10.2006): small fragment of riverine ash forest with a few very old ash trees and admixture of alder and aspen; shrub layer of young lime trees, *Symphoricarpus, Sambucus nigra*, *Ribes* sp.; in herb layer *Glechoma hederacea, Stachys silvatica, Urtica dioica, Aegopodium podagraria*; small quantities of dead timber in the form of small sticks and medium-sized branches.

Site 3 (7.10.2006): fragment of riverine ash forest with numerous old ash trees and admixture of alder; shrub layer of young lime trees; in herb layer *Filipendula ulmaria, Urtica dioica*, *Glechoma hederacea, Stachys silvatica,* ferns, in places abundant mosses; much dead timber in the form of small sticks and medium-sized branches.

Site 4 (15.10.2006): steep slope and adjacent stream bank; lime-hornbeam stand with admixture of sycamore maple; near the stream alder; no shrubs, herb layer of *Urtica dioica* and *Glechoma hederacea*; much dead timber in the form of small pieces and several logs.

Site 5 (Fig. 3) (13.05.2007): stand with dominance of old oak trees, admixture of lime and hornbeam; shrub layer of young sycamore maple, Norway maple, lime, elder shrubs; herb layer of *Stachys silvatica, Glechoma hederacea, Geranium robertianum, Stellaria* sp., in places *Urtica dioica*; fairly much dead timber in the form of small fragments.

Site 6 (Fig. 4) (13.05.2007): young alder stand, with *Rubus* sp. and herb layer of grasses, sedges, in places *Urtica dioica*; no dead timber.

Site 7 (13.05.2007): edge of mixed forest with oak, hornbeam, aspen, no shrubs, in herb layer *Asperula odorata*, *Urtica dioica, U. urens, Cirsium oleraceum*,

Fig. 2. An ash stand in the park in Henryków (site 2)

Fig. 3. A stand with dominance of oak in the park in Henryków (site 5)

Fig. 4. An alder stand in the park in Henryków (site 6)

Fig. 5. A stand with dominance of sycamore in the park in Henryków (site 9)

Fig. 6. A lime-sycamore stand in the park in Henryków (site 10)

grasses; small quantities of dead timber in the form of small fragments.

Site 8 (22.08.2007): stand of sparse hornbeam trees of varied age, admixture of oak, lime, no shrub layer, herb layer of *Glechoma hederacea* and grasses, very little dead timber.

Site 9 (Fig. 5) (22.08.2007): stand with dominance of sycamore maple, admixture of single hornbeam, oak and lime trees; shrub layer of elder shrubs and young sycamore trees, herb layer of *Stachys silvatica, Glechoma hederacea*; much dead timber in the form of fragments of various size.

Site 10 (Fig. 6) (22.08.2007): stand of old lime and sycamore trees, a single spruce, shrub layer of elder shrubs and hazel; herb layer of *Urtica dioica, Stachys silvatica, Impatiens* sp., ferns, grasses, some logs.

MATERIAL AND METHODS

Samples were taken from October 2006 till August 2007 (see dates at site descriptions) with the standard method adopted in studies on terrestrial malacocoenoses (CAMERON & POKRYSZKO 2005). Because of the difficulties implied in estimating slug abundance (CAMERON & POKRYSZKO 2004, POKRYSZKO & CAMERON 2005), only their presence was noted. Consequently, slugs were included only in calculations based on the presence/absence. The material is deposited in the collection of the Natural History Museum, Wrocław University.

Completeness of the data set was estimated using Chao index (CAMERON & POKRYSZKO 2005); the diversity among the sites was assessed with Whittaker's index (I_w) and maximum Whittaker's index (I_{max}) (CAMERON & POKRYSZKO 2005). Similarity between the sites, and between the fauna from Henryków and other faunas was calculated as the Nei index (POKRYSZKO & CAMERON 2005). Frequency and dominance were calculated for each species (DZIĘCZKOWSKI 1972), as well as „importance" index (frequency × dominance) which reflects the significance of the species in the whole set of sites. The nomenclature follows KERNEY et al. (1983).

RESULTS

COMPLETENESS OF DATA SET

The Chao index for most sites (sites 1–3, 5, 6, 8 and 10) was 0; for the remaining sites its values were small: site 4 – 0.25, site 7 – 0.5 and site 9 – 0.17; the frequency-based Chao index for the whole set of sites was 0.42. It is thus possible that one more species was present but remained undetected.

SPECIES LIST

The list of species is presented in Table 1. Forty five terrestrial gastropod species were recorded from the park in Henryków; the total number of snail specimens was 2,624, the number of specimens per site ranged from 70 (site 8) to 510 (site 4), the number of species per site – from 13 to 32, the mean number of species per site was 21.

STRUCTURE AND SIMILARITY OF MALACOCOENOSES

The number of sites, specimens and indices describing significance of each species are shown in Table 2. Most species showed low values of dominance (<5%) and frequency (<50%). Based on F × D the most important components of the park malacocoenosis were *Balea biplicata, Perforatella incarnata, Bradybaena fruticum, Carychium tridentatum* and *Aegopinella minor.* The proportion of synanthropic, introduced species was low; forest-dwellers constituted the majority. Values of the Nei index for the sites from the park in Henryków are presented in Table 3. Whittaker's index was $I_w = 2.14$, maximum Whittaker's index $I_{max} = 1.41$, showing that the richest site does not hold all or even most species of the park.

DISCUSSION

MALACOCOENOSES FROM THE PARK IN HENRYKÓW AND FROM THE NATURE RESERVE MUSZKOWICKI LAS BUKOWY

The nature reserve Muszkowicki Las Bukowy is only 5 km away from the park in Henryków. The number of species in the park is only slightly smaller (see Table 1), and the overall similarity of the two localities (Nei 0.75) is rather high, of the same order as the similarity between most natural forest localities in the Sudetes (POKRYSZKO & CAMERON 2005).

The park malacofauna is not a subset of the malacofauna from the nature reserve, though the latter fauna is richer and includes 48 species (see Table 1). Thirteen species are present only in the nature reserve and not in the park: *Acicula polita, Succinea oblonga, Ena montana, Arion silvaticus, Vitrea diaphana, Daudebardia rufa, Cochlodina laminata, Macrogastra ventricosa, Clausilia pumila, Bulgarica cana, Perforatella vicina, Helicodonta obvoluta, Causa holosericum.* Ten species are present only in the park and not in the nature reserve: *Carychium minimum, Succinea putris, Vertigo pusilla, V. substriata, Vallonia costata, Arion circumscriptus, Zonitoides nitidus, Deroceras laeve, Ruthenica filograna* and *Perforatella rubiginosa.*

The sites in the park are more heterogenous; the similarity between the four sites studied in the nature reserve (POKRYSZKO & CAMERON 2005 and unpublished) is much higher than between the similarly spread park sites; the indices of between-site heterogeneity (I_w and I_{max}) are much lower (Table 4). In the park, despite the similar total number of species, much fewer species are present in each site. The high values of I_w and I_{max} (considerable heterogeneity) for a group of closely situated and eclogically similar sites may reflect anthropogenic changes, most of all fragmentation of the habitat.

The differences between the park and the nature reserve seem to result not only from human ingerence in the former. The two localities probably never held identical malacocoenoses because of their different topography, substratum and the resulting forest type. The reserve Muszkowicki Las Bukowy is situated in a gorge with steep slopes (WIKTOR 1972), on a calcium-rich loess with forming tufa, and the forest is beechwood and oak-hornbeam, with a significant proportion of hornbeam and sycamore maple. The park in Henryków is located on an almost flat ground, the soil is loess-derived, with much lower calcium content (WALCZAK 1968), while the tree stands are mainly oak-hornbeam with dominance of oak, and fragments of riverine forest and an alder stand. The differences may at least partly account for the occurrence of some species in one of the two localities only. Out of 10 species recorded only from the park as many as five (*Carychium minimum, Succinea putris, Zonitoides nitidus, Deroceras laeve* and *Perforatella rubiginosa*) are hygrophiles, usually associated with alder swamps and very wet riverine forests (RIEDEL 1988, WIKTOR 2004, SZYBIAK et al. 2007), further two (*Vallonia costata* and *Ruthenica filograna*) clearly prefer ash forests (WIKTOR 2004, SZYBIAK et al. 2007) – none of the two habitats is present in the nature reserve. It is difficult to explain the absence of three otherwise rather common species in Muszkowice: *Vertigo pusilla, V. substriata* and *Arion circumscriptus* (POKRYSZKO 1990, WIKTOR

Table 1. List of species found in 10 sites in Henryków (1–10) and in the nature reserve Muszkowicki Las Bukowy (M) (WIKTOR 1972, POKRYSZKO & CAMERON 2005)

	Species/site	1	2	3	4	5	6	7	8	9	10	M
	Acicula polita (Hartmann, 1840)											X
1	*Carychium minimum* O. F. Müller, 1774						27					
2	*Carychium tridentatum* (Risso, 1826)	15	19	101	25				21	35	27	X
	Succinea oblonga Draparnaud, 1801											X
3	*Succinea putris* (Linnaeus, 1758)		2	8	3		9	9				
4	*Cochlicopa lubrica* (O. F. Müller, 1774)	3	5	12	3	2	3	3	9	1	12	X
5	*Columella edentula* (Draparnaud, 1805)	7	2	6	1	3				2	7	X
6	*Vertigo pusilla* O. F. Müller, 1774	2		2					5	9	11	
7	*Vertigo substriata* (Jeffreys, 1833)		4	3	3					8		
8	*Vallonia costata* (O. F. Müller, 1774)		2	7		2						
9	*Acanthinula aculeata* (O. F. Müller, 1774)	3		2	3	3			6		4	X
	Ena montana (Draparnaud, 1801)											X
10	*Ena obscura* (O. F. Müller, 1774)		7		2						3	X
11	*Punctum pygmaeum* (Draparnaud, 1801)		5	6	2	3			3	11	7	X
12	*Discus rotundatus* (Férussac, 1821)	13	5	3	17	9	16			3	9	X
13	*Discus perspectivus* (Megerle von Mühlfeld, 1816)			32	65		2	2		17		X
14	*Arion rufus* (Linnaeus, 1758)	+		+	+	+	+	+	+			X
15	*Arion subfuscus* (Draparnaud, 1805)	+	+	+	+	+	+		+	+		X
16	*Arion circumscriptus* Johnston, 1828				+	+			+			
	Arion silvaticus Lohmander, 1937											X
17	*Arion fasciatus* (Nilsson, 1822)		+		+	+						X
18	*Arion distinctus* Mabille, 1868				+	+						X
19	*Vitrina pellucida* (O. F. Müller, 1774)					19						X
	Vitrea diaphana (Studer, 1820)											X
20	*Vitrea crystallina* (O. F. Müller, 1774)			6								X
21	*Aegopinella minor* (Stabile, 1864)	25	14	24	28	28		3	2		8	X
22	*Aegopinella epipedostoma* (Fagot, 1879)						3				3	X
23	*Aegopinella pura* (Alder, 1830)	6	5	35	4	6		20		4		X
24	*Nesovitrea hammonis* (Ström, 1865)	3		2			8					X
25	*Oxychilus cellarius* (O. F. Müller, 1774)			2	12	3				2	2	X
26	*Zonitoides nitidus* (O. F. Müller, 1774)		36	10			14					
	Daudebardia rufa (Draparnaud, 1805)											X
27	*Limax cinereoniger* Wolf, 1803	+			+	+			+			X
28	*Malacolimax tenellus* O. F. Müller, 1774			+								X
29	*Lehmannia marginata* (O. F. Müller, 1774)					+						X
30	*Deroceras praecox* Wiktor, 1966				+				+			X
31	*Deroceras laeve* (O. F. Müller, 1774)			+			+	+				
32	*Boettgerilla pallens* Simroth, 1912				+	+						X
33	*Euconulus fulvus* (O. F. Müller, 1774)	5	3	2	12		2	1		11		X
	Cochlodina laminata (Montagu, 1803)											X
34	*Ruthenica filograna* (Rossmässler, 1836)			56							30	
35	*Macrogastra plicatula* (Draparnaud, 1801)		5	2				3		51	10	X
	Macrogastra ventricosa (Draparnaud, 1801)											X

	Species/site	1	2	3	4	5	6	7	8	9	10	M
	Clausilia pumila C. Pfeiffer, 1828											X
	Bulgarica cana (Held, 1836)											X
36	*Balea biplicata* (Montagu, 1803)	13	72	57	182	12	5		7	33	61	X
37	*Bradybaena fruticum* (O. F. Müller, 1774)	3	77	43	37	6	36	44		17	2	X
38	*Perforatella bidentata* (Gmelin, 1788)		2	17	30		54					X
39	*Perforatella incarnata* (O. F. Müller, 1774)	38	72	41	51	24	37	8	17	53	18	X
	Perforatella vicina (Rossmässler, 1842)											X
40	*Perforatella rubiginosa* (A. Schmidt, 1853)		12	3								
41	*Trichia hispida* (Linnaeus, 1758)				19	5	2			3		X
	Helicodonta obvoluta (O. F. Müller, 1774)											X
	Causa holosericum (Studer, 1820)											X
42	*Euomphalia strigella* (Draparnaud, 1801)		5					5		2		X
43	*Arianta arbustorum* (Linnaeus, 1758)		38	2				3				X
44	*Cepaea hortensis* (O. F. Müller, 1774)	3	51	3		3		4			2	X
45	*Helix pomatia* Linnaeus, 1758	3	8	2	11	7	3	7		13	3	X
	Total snail specimens	142	451	489	510	135	221	112	70	275	219	
	Total snail species	15	23	28	20	15	16	13	8	18	18	
	Total species	18	25	32	28	23	19	15	13	19	18	48

2004). Six of the 13 species, found only in the nature reserve, are rare and/or occurr very locally, and are limited to natural forests (*Ena montana, Daudebardia rufa, Bulgarica cana, Perforatella vicina, Helicodonta obvoluta* and *Causa holosericum*) (RIEDEL 1988, MALTZ 2003, WIKTOR 2004); furthermore, one of them (*Helicodonta obvoluta*) depends on large rotting logs for hibernation and reproductuion (MALTZ 2003); such logs are few in the park. Reasons for the absence of two clausiliids (*Macrogastra ventricosa, Clausilia pumila*) in the park fauna may be similar (removal of dead timber). Further two species (*Acicula polita, Cochlodina laminata*), though found in various forest types, usually prefer beech litter which is absent in Henryków. Ecological requirements and distribition of *Succinea oblonga, Arion silvaticus* and *Vitrea diaphana* (RIEDEL 1988, WIKTOR 2004) do not explain their absence in the park malacocoenosis.

MALACOCOENOSES FROM HENRYKÓW AND OTHER PARKS

Information on malacocoenoses in parks of our climatic and biogeographical zone is scanty. The three available publications pertain to manor parks in the valley of Mroga River on the SW. edge of the Mazovian Lowland (SULIKOWSKA 1998), a park in Obrzycko (Wielkopolska) (SZYBIAK 2004) and a park Na Zdrowiu within the city of Łódź (SULIKOWSKA-DROZD 2007). Comparisons are complicated by a few facts. The character of the parks differs. The parks in the Mroga valley are small, established in the 18th/19th c. as English style parks, and the author (SULIKOWSKA 1998) did not describe her sampling methods or the vegetation. The park in Obrzycko (19 ha) is partly an oak-hornbeam and partly a riverine forest, but sampling methods used were different from those applied by us and the completeness of species set was not tested (SZYBIAK 2004). The park in Łódź, of a size similar to that in Henryków, is mostly oak-hornbeam but here too sampling methods were different and the completeness not tested (SULIKOWSKA-DROZD 2007). Besides, though all the parks are within the same climatic and biogeographical region, still purely biogeographical differences between the park in Henryków on the one hand and the remaining parks on the other can be expected, since many distribution borders cross Lower Silesia (RIEDEL 1988, WIKTOR 2004, POKRYSZKO & MALTZ 2007). The comparison below is limited to species composition (Table 5), and the similarity indices were calculated both including and excluding the species which, because of their distribution, could not occur in all the localities.

The similarity among the park faunas, even excluding species with limited distribution (0.61–0.76), is smaller than such similarity among forests sites separated by comparable distances (POKRYSZKO & CAMERON 2005 and unpublished), and the heterogeneity is within the same range ($I_w = 1.74$ i $I_{max} = 1.33$).

The malacocoenosis from the park in Henryków is the richest in species, has the greatest proportion of forest-dwellers and the smallest proportion of alien species. Its species number is comparable to such numbers in snail communities of rich Central European forests which range from 40 to 57 (CAMERON &

Table 2. Number of specimens (No), sites (Ns), frequency (F), dominance (D) and importance (F × D) for species recorded from the park in Henryków. Species with F × D equal to or exceeding 500 indicated in bold, species of F equal to or exceeding 70% underlined

Species	No	Ns	F	D	F × D
Carychium minimum	27	1	10%	1.03%	10.3
Carychium tridentatum	243	7	70%	9.26%	648.2
Succinea putris	31	5	50%	1.18%	59.0
Cochlicopa lubrica	53	10	100%	2.02%	20.2
Columella edentula	28	7	70%	1.07%	74.9
Vertigo pusilla	29	5	50%	1.11%	55.5
Vertigo substriata	18	4	40%	0.69%	27.6
Vallonia costata	11	3	30%	0.42%	12.6
Acanthinula aculeata	21	6	60%	0.80%	48.0
Ena obscura	12	3	30%	0.46%	13.8
Punctum pygmaeum	37	7	70%	1.41%	98.7
Discus rotundatus	75	8	80%	2.86%	228.8
Discus perspectivus	118	5	50%	4.50%	225.0
Arion rufus		7	70%		
Arion subfuscus		8	80%		
Arion circumscriptus		3	30%		
Arion fasciatus		3	30%		
Arion distinctus		2	20%		
Vitrina pellucida	19	1	10%	0.72%	7.2
Vitrea crystallina	6	1	10%	0.23%	2.3
Aegopinella minor	132	8	80%	5.03%	402.4
Aegopinella epipedostoma	6	2	20%	0.23%	4.6
Aegopinella pura	80	7	70%	3.05%	213.5
Nesovitrea hammonis	13	3	30%	0.50%	15.0
Oxychilus cellarius	21	5	50%	0.80%	40.0
Zonitoides nitidus	60	3	30%	0.23%	6.9
Limax cinereoniger		4	40%		
Malacolimax tenellus		1	10%		
Lehmannia marginata		1	10%		
Deroceras praecox		2	20%		
Deroceras laeve		3	30%		
Boettgerilla pallens		2	20%		
Euconulus fulvus	36	7	70%	1.37%	95.9
Ruthenica filograna	86	2	20%	3.28%	65.6
Macrogastra plicatula	71	5	50%	2.71%	135.5
Balea biplicata	442	9	90%	16.84%	1,515.6
Bradybaena fruticum	265	9	90%	10.10%	909.0
Perforatella bidentata	103	4	40%	3.93%	157.2
Perforatella incarnata	359	10	100%	13.68%	1,368.0
Perforatella rubiginosa	15	2	20%	0.57%	11.4
Trichia hispida	29	4	40%	1.11%	44.4
Euomphalia strigella	12	3	30%	0.46%	13.8
Arianta arbustorum	43	3	30%	1.64%	49.2
Cepaea hortensis	66	6	60%	2.52%	151.2
Helix pomatia	57	9	90%	2.17%	195.3

Table 3. Nei similarity values for sites in the park in Henryków. Extreme values underlined

	1	2	3	4	5	6	7	8	9	10
1		0.613	0.708	0.668	0.688	0.541	0.548	0.654	0.649	0.667
2			0.778	0.680	0.584	0.459	0.620	0.388	0.688	0.613
3				0.668	0.590	0.608	0.639	0.490	0.689	0.667
4					0.788	0.564	0.488	0.629	0.694	0.579
5						0.431	0.431	0.578	0.574	0.590
6							0.533	0.318	0.526	0.379
7								0.287	0.533	0.426
8									0.445	0.523
9										0.595
10										

Table 4. Comparison of selected characteristics of the malacocoenoses from Henryków and the nature reserve Muszkowicki Las Bukowy (indices for the nature reserve based on data from POKRYSZKO & CAMERON (2005) and unpublished data)

Index	Henryków park	Muszkowicki Las Bukowy
number of species	45	48
I_w	2.14	1.36
I_{max}	1.41	1.22
Nei	0.29–0.79	0.77–0.95

POKRYSZKO 2004, POKRYSZKO & CAMERON 2005). With respect of the species composition and number of species it is closest to the community from the city part in Łódź, of a similar size and origin (Table 6), which however has relatively fewer forest species and a greater proportion of alien components. The reason may be its location within the city boundaries.

PARKS AS REFUGIA FOR THE FOREST MALACOFAUNA

The compared parks differ in their size, character and history. Besides, their location and the geograph-

Table 5. Comparison of species composition of malacocoenoses from Henryków and other studied parks (SULIKOWSKA 1998, SZYBIAK 2004, SULIKOWSKA-DROZD 2007)

Species	F/S/O	H/M/X	Henryków	Mroga	Obrzycko	Łódź
Carychium minimum	O	H	+		+	+
Carychium tridentatum	O	M	+			+
Succinea oblonga	O	M			+	
Succinea putris	O	H	+	+	+	+
Cochlicopa lubrica	O	M	+	+	+	+
Cochlicopa lubricella	O	M				+
Columella edentula	O	M	+			+
Vertigo pusilla	F	M	+			+
Vertigo substriata	F	M	+			+
Vertigo pygmaea	O	H-X				+
Vallonia costata	O	H-M	+	+	+	+
Vallonia pulchella	O	M-X		+	+	+
Vallonia excentrica	O	X		+		+
Acanthinula aculeata	F	M	+			+
Pupilla muscorum	O	M-X				+
Ena obscura	F	M	+		+	
Punctum pygmaeum	F	M	+			+
Discus ruderatus	F	M		+		
Discus rotundatus	F	M	+	+	+	+

Species	F/S/O	H/M/X	Henryków	Mroga	Obrzycko	Łódź
Discus perspectivus	F	H-M	+			
Arion rufus	O	H-M	+			+
Arion subfuscus	F	M	+		+	+
Arion circumscriptus	F	M	+	+		+
Arion fasciatus	S	M	+	+	+	+
Arion distinctus	S	M	+			
Vitrina pellucida	O	M	+	+	+	+
Vitrea crystallina	O	H-X	+	+	+	+
Vitrea contracta	O	M-X			+	
Aegopinella minor	F	M	+			
Aegopinella nitidula	F	M			+	
Aegopinella epipedostoma	F	M	+			
Aegopinella pura	F	M	+		+	+
Nesovitrea hammonis	O	H-X	+	+	+	+
Oxychilus cellarius	F	M	+		+	
Oxychilus draparnaudi	S	M				+
Oxychilus alliarius	O	M				+
Zonitoides nitidus	O	H	+	+	+	+
Limax cinereoniger	F	M	+			
Limax maximus	S	M			+	+
Malacolimax tenellus	F	M	+			
Lehmannia marginata	F	M	+			
Deroceras reticulatum	O	M		+	+	+
Deroceras praecox	F	M	+			
Deroceras sturanyi	S	M				+
Deroceras laeve	O	H	+			+
Boettgerilla pallens	O	M	+			
Euconulus fulvus	O	H-M	+		+	+
Ruthenica filograna	F	H-M	+			
Macrogastra plicatula	F	M	+			
Alinda biplicata	F	M	+			+
Clausilia bidentata	F	M			+	
Bradybaena fruticum	F	M	+	+	+	+
Helicella obvia	O	X				+
Perforatella bidentata	F	H	+	+	+	+
Perforatella incarnata	F	M	+	+	+	+
Perforatella rubiginosa	O	H	+	+		
Trichia hispida	O	H-M	+		+	+
Euomphalia strigella	O	M-X	+	+		
Arianta arbustorum	F	M	+		+	+
Cepaea nemoralis	O	M			+	+
Cepaea hortensis	F	M	+	+	+	+
Helix pomatia	O	M	+	+	+	+
Total species			45	21	30	42

F – forest or shade-loving species, S – introduced synanthropic, O – other; H – higrophiles, M – mesophiles, X – xerophiles
Species found in all the parks indicated in bold

Table 6. Similarity (Nei) between the malacocoenoses from Henryków and other studied parks (SULIKOWSKA 1998, SZYBIAK 2004, SULIKOWSKA-DROZD 2007). Nei values for whole communities above the diagonal; Nei values omitting species which can not occur in some parks for biogeographical reasons below the diagonal (distribution data from RIEDEL 1988 and WIKTOR 2004)

	Henryków	Mroga	Obrzycko	Łódź
Henryków	X	0.55	0.60	0.67
Mroga	0.61	X	0.64	0.61
Obrzycko	0.69	0.72	X	0.68
Łódź	0.76	0.63	0.75	X

Table 7. Selected characteristics of malacocoenoses from Henryków and other studied parks (SULIKOWSKA 1998, SZYBIAK 2004, SULIKOWSKA-DROZD 2007)

Park	Henryków	Mroga	Obrzycko	Łódź
Number of species	45	21	30	42
% forest species	53.3	33.3	40.0	33.3
% alien species	4.4	4.8	6.7	9.5
I_N	–	0.55(0.61)	0.60(0.69)	0.67(0.76)

ical distribution of the component species of their malacocoenoses make it unlikely to find exactly the same species sets. Despite this they share a considerable number of species (14; cf. Table 5). This set of "park species" includes *Succinea putris, Cochlicopa lubrica, Vallonia costata, Discus rotundatus, Arion fasciatus, Vitrina pellucida, Vitrea crystallina, Nesovitrea hammonis, Zonitoides nitidus, Bradybaena fruticum, Perforatella bidentata, P. incarnata, Cepaea hortensis* and *Helix pomatia*. None of them is rare or endangered, all are widely distributed and rather euryoecious (RIEDEL 1988, WIKTOR 2004). In our climatic and zoogeographical zone these species may indeed use parks as refugia in a human-transformed, urban or agricultural landscape. Survival of other, less common and more fastidious species in parks will certainly depend on the region, history of the park, local conditions and species distribution ranges. As many as four such species have found a refugium in the Henryków park: *Discus perspectivus, Ruthenica filograna, Deroceras praecox* and *Aegopinella epipedostoma*.

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