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MALACOCOENOSES OF ALDER CARRS (WIELKOPOLSKA, POLAND)

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ABSTRACT: Malacoceonoses of alder carrs in 20 localities in central Wielkopolska, on the Warta River, were composed of 46 species of terrestrial gastropods. The density ranged from 16 to 828 indiv./m^2, the species diversity (*H*) from 1.48 to 3.75. In the summer in litter the most frequent and most abundant species were *Carychium minimum, Perforatella incarnata, Zonitoides nitidus, Nesovitrea hammonis, Cochlicopa lubrica* and *Discus rotundatus*. The following species are common to alder forests of Poland (Chodzież Region, boundary of Wielkopolska, Silesia and Cracow-Wieluń Jura, Kaczawskie Mts, banks of the Smolnica River in the Notecka Forest and central Wielkopolska): *C. minimum, Succinea putris, S. oblonga, C. lubrica, Euconulus fulvus, Punctum pygmaeum, Vitrea crystallina, Aegopinella pura* and *Arion circumscriptus*.

KEY WORDS: terrestrial gastropods, Poland, Wielkopolska, alder forests

INTRODUCTION

The distribution range of alder carrs, class *Alnetea glutinosae,* includes the whole of lowland and upland Poland. They do not occur in the mountains. In the Carpathians similar habitats are occupied by *Caltho-Alnetum* of the group of riverine forests. Alder carr as the plant community rather closely corresponds to the habitat type "alder carr". Alder carr communities are composed of black alder with a smaller or greater admixture of birch, pine, spruce, common oak or ash. Alder carrs are associated with areas periodically flooded by groundwater. Their structure includes hummocks and hollows. The spatial variation often results in the presence of species with extremely different habitat requirements (MATUSZEWSKI 2005). In Wielkopolska alder carrs develop mainly on rivers in the central-western part of the region. Black alder grows there mainly in places with high level of groundwater, on peaty and peaty-humic soils.

Malacocoenoses of alder carrs in Poland are insufficiently known. In the literature there are no exact data on snail communities of such habitats. The Polish literature, besides SZYBIAK's (2001) paper on a malacocoenosis of an alder carr on the Smolnica River, includes scanty information on snails of alder forests contained in papers on malacofauna of various areas (BERGER 1961, KĘDRA 1971, POKRYSZKO 1984)

The aim of this paper was to study the structure of malacocoenoses of alder carrs in Wielkopolska and to identify species of terrestrial gastropods which are characteristic of such malacocoenoses.

MATERIAL AND METHODS

Alder carr malacocoenoses in central Wielkopolska, on the Warta River (Fig. 1) were studied in the summer 2007. The sites hold alder stands aged 120, 70 or 50 years, and younger, even 15 years old. They represent natural alder regeneration growing in clear-felled areas. The following sites were studied: Forest district Góra: Site 1. Alder forest aged 70; dominance of black alder, admixture of ash and elm

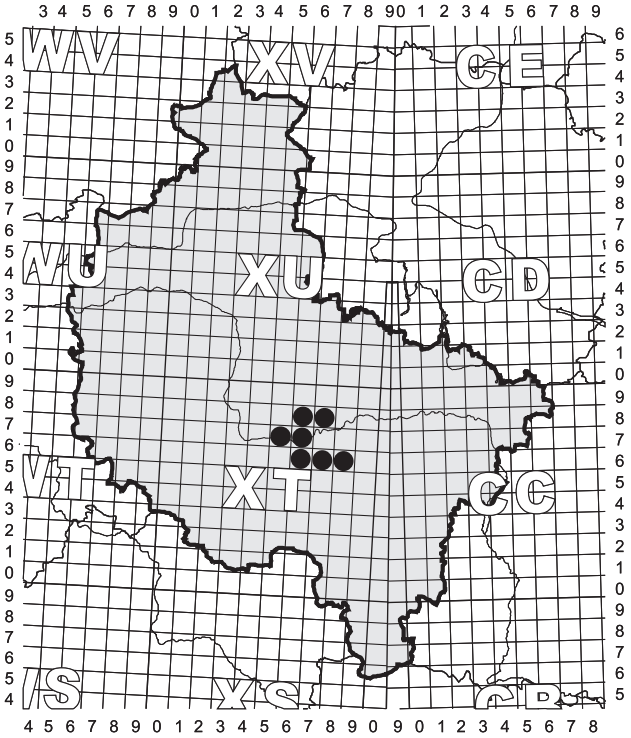

Fig. 1. Study area – location of study sites

(UTM: XT 66 21); Site 2. Black alder forest aged 80 (UTM: XT 66 21). Forest district Nowe Miasto: Site 3. Half of the stand formed by black alder aged 70, the other half by birch with an admixture of poplar (UTM: XT 67 54). Forest district Sarnice: Site 4. Half of the stand formed by black alder aged 75, the other half composed of equal proportion of ash and birch with an admixture of spruce (UTM: XT 68 22); Site 5. 40% of the stand composed of black alder aged 95, 30% of ash, linden and hornbeam, the remaining 30% – oak aged 140 (UTM: XT 68 22); Site 6. Alder forest with dominance of black alder aged over 100; the remaining 60% composed of oak, ash, linden and honbeam (UTM: XT 68 22). Forest district Spławik: Site 7. Alder forest aged 30, with 80% black alder and an admixture of ash and birch (UTM: XT 78 21); Site 8. Stand with dominant black alder aged 30; 40% oak, and birch (UTM: XT 78 21. Forest district Racendów: Site 9. Stand of black alder aged 35 (UTM: XT 86 11); Site 10. Stand of black alder aged 70, admixture of birch (UTM: XT 86 11). Forest district Tarce: Site 11. Stand of black alder aged 15 (UTM: XT 76 74); Site 12. Stand of black alder aged 75 (UTM: XT 76 74). Forest district Tumidaj: Site 13. Stand with dominant black alder aged 85 and an admixture of birch (UTM: XT 76 31); Site 14: Stand with dominant black alder aged 120 and hornbeam, a small admixture of oak (UTM: XT 76 31). Forest district Cielcza: Site 15. Stand of black alder aged 85 with a small admixture of birch (UTM: XT 76 05). Forest district Stoki: Site 16. Stand with 60% black alder aged 40 and 20; the remaining part composed of hazel and birch (UTM: XT 67 59). Forest district Luboniecek: Site 17. Stand of black alder aged 70 and 40 (UTM: XT 57 19); Site 18. Stand of black alder aged 90 (UTM: XT 57 19); Site 19. Stand of black alder aged 40 (UTM: XT 57 19); Site 20. Stand of black alder aged 60 and 40 (UTM: XT 57 19).

Each of the 20 sites was sampled once, using Oekland frame 25 × 25 cm, to the total area of 0.5 m^2; the litter was processed with standard methods (SZYBIAK 2001). The studies included mainly snails which in the summer stay in litter. Only live snails were considered in the analysis. The analysis included density, abundance and frequency. The similarity of snail communities was calculated as the Nei index (POKRYSZKO & CAMERON 2005).

RESULTS AND DISCUSSION

The 20 sites of alder carrs in central Wielkopolska yielded a total of 46 gastropod species (Table 1). The quantitative analysis included 43 species which stay in the litter during summer. The number of species per 0.5 m^2 ranged from 4 to 34, the density from 8 to 414 indiv./0.5 m^2. Species diversity (*H*) for particular sites ranged from 1.48 to 3.75. For six communities (sites 2, 5, 6, 7, 8, 10) it was fairly high and exceeded 3.00 (Table 1). They were malacocoenoses of alder forests with an admixture of ash, hornbeam, linden, birch or oak. It seems that diversity of leaves forming the litter favours gastropod species diversity (foraging, shelter, places for egg-laying and hibernation) which is probably associated with different decomposition rate of leaves of different tree species.

The most abundant species were *Nesovitrea hammonis* in 14 sites and *Cochlicopa lubrica* and *Perforatella incarnata* in 12 sites (Table 1). At the same time they were the most frequent snails. *P. incarnata* was the most frequent species in five sites. *N. hammonis* was constant in four sites, and *C. lubrica* in three. The most abundant species of all the malacocoenoses combined were *Carychium minimum, P. incarnata, Zonitoides nitidus, N. hammonis, C. lubrica* and *Discus rotundatus* (Table 2). *N. hammonis, C. lubrica* and *P. incarnata* were at the same time accessory species, but they were the most frequent in the malacocoenoses.

Individual sites differed in the number of dominant species (2 to 10). The greatest number of sites (4), where specimens of dominant species constituted more than 60% of all specimens, had three, four or seven dominant species.

Globally in the alder carrs of central Wielkopolska there are no typically dominant species or species

Table 1. Number of individuals, abundance, frequency, density and diversity of gastropods per 0.5 m^2 in individual sites in central Wielkopolska

Species	Number of individuals, abundance and frequency in individual sites																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Aciculidae																				
Acicula polita (Hartmann, 1840)							5 1.81 37.50													
Ellobiidae																				
Carychium minimum O.F. Müller, 1774			3 6.25 12.50	3 7.50 12.50			15 5.43 75.00		6 3.68 25.00		208 50.24 62.50							35 60.34 50.00		15 13.76 12.50
Carychium tridentatum (Risso,1826)							1 0.36 12.50				3 0.72 12.50									
Succineidae																				
Succinea oblonga (Draparnaud, 1801)		*						3 7.14 12.50												
Succinea. putris (Linnaeus,1758)							*		10 6.13 62.50	14 11.57 25.00	42 10.14 50.00				2 5.41 12.50				2 1.19 25.00	
Cochlicopidae																				
Cochlicopa lubrica (O. F. Müller, 1774)	5 22.72 12.5	4 11.11 25.0	1 2.08 12.50	2 5.00 25.00	9 12.33 62.50	1 1.49 12.50	28 10.14 75.00		8 4.91 50.00	9 7.44 37.50	13 3.14 37.50	2 25.00 12.50	3 15.79 25.00	2 5.71 25.00	3 8.11 37.50	1 4.17 12.50	5 14.29 37.50		29 17.26 75.00	18 16.51 50.00
Cochlicopa lubricella (Porro,1838)	4 18.18 50.0	3 8.33 25.0		6 15.00 50.00	1 1.37 12.50	*	*	5 11.90 50.00								*				
Cochlicopa nitens (Gallenstein,1848)	1 4.54 12.5																			
Vertiginidae																				
Columella edentula (Draparnaud, 1805)	1 4.54 12.5	3 8.33 25.0			2 2.74 12.50	2 2.99 12.50	3 1.09 37.50		1 0.61 12.50							*				
Vertigo pusilla O. F. Müller, 1774				*					*		1 0.24 12.50					1 4.17 25.00	1 2,86 12.50			
Vertigo antivertigo (Draparnaud, 1801)							*		*		33 7.97 12.50				1 2.70 12.50					1 0.92 12.50

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Vertigo substriata (Jeffreys, 1833)											1 0.24 12.50					*				
Valloniidae																				
Vallonia costata (O. F. Müller, 1774)	1 4.54 12.5		*	*			*		2 1.23 12.50			1 12.50 12.50				7 29.17 12.50			*	
Vallonia pulchella O. F. Müller, 1774							*									1 4.17 12.50			12 7.14 50.00	
Vallonia excentrica Sterki, 1892																2 8.33 12.50			7 4.17 37.50	
Acanthinula aculeata (O. F. Müller, 1774)		1 2.77 12.5			13 17.81 37.50	1 1.49 12.50	17 6.16 75.00		1 0.61 12.50					1 2.86 12.50	1 2.70 12.50					
Endodontidae																				
Punctum pygmaeum (Draparnaud, 1801)	1 4.54 12.5	2 5.55 12.5				1 1.49 12.50	6 2.17 50.00												3 1.79 37.50	18 16.51 37.50
Discus rotundatus (O. F. Müller, 1774)					4 5.48 25.00	*	32 11.59 100.0 0			41 33.88 37.50	4 0.97 12.50			21 60.00 62.50		*				
Arionidae																				
Arion subfuscus (Draparnaud, 1805)					1 1.37 12.50			3 7.14 37.50	1 0.61 12.50		1 0.24 12.50									
Arion rufus (Linnaeus, 1758)							*		2 1.23 25.0											
Arion circumscriptus Johnston, 1828								1 2.38 12.50												
Arion distinctus Mabille, 1868							*													
Vitrinidae																				
Vitrina pellucida (O. F. Müller, 1774)			*						*							*				

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Zonitidae																				
Vitrea crystallina		3					1										2			
(O. F. Müller, 1774)		8.33					0.36										5.71			
		25.0					12.50										12.50			
Aegopinella pura			2	5	12	3	49	4	2	3				3		1				
(Alder, 1830)			4.17	12.50	16.44	4.48	17.75	9.52	1.23	2.48				8.57		4.17				
			12.50	62.50	62.50	37.50	100.0	37.50	25.0	12.50				37.50		12.50				
Aegopinella nitidula					1	3	2	5		10										
(Draparnaud, 1805)					1.37	4.48	0.72	11.90		8.26									*	
					12.50	12.50	25.0	25.00		12.50										
Nesovitrea hammonis	7	6		11	4	1	29	1	14	14	9		11	5	6	3	17	15	3	15
(Ström, 1765)	31.81	16.66		27.50	5.48	1.49	10.51	2.38	8.59	11.57	2.17	*	57.89	14.29	16.22	12.50	48.57	26.79	1.79	13.76
	50.0	37.5		37.50	37.50	12.50	100.0	12.50	87.50	50.00	50.00		50.00	50.00	50.00	12.50	75.00	50.00	37.50	75.00
Nesovitrea petronella				2	4	3			3	1	2									
(L. Pfeiffer, 1853)				5.00	5.48	4.48			1.84	0.83	0.48	*								
				25.00	25.00	25.00			37.50	12.50	25.00									
Zonitoides nitidus				1					3	4	48	1			14		7		79	27
(O. F. Müller, 1774)				2.50			*		1.84	3.31	11.59	12.50			37.84		20.00	*	47.02	24.77
				12.50					25.0	12.50	62.50	12.50			50.00		50.00		87.50	37.50
Limacidae																				
Limax cinereoniger					1	2		1								1				
Wolf, 1803					1.37	2.99		2.38								4.17				
					12.50	12.50		12.50								12.50				
Malacolimax tenellus						3		3												
O. F. Müller, 1774						4.48	*	7.14												
						25.00		37.50												
Euconulidae																				
Euconulus fulvus				1	1		4		4		2				2			2		
(O. F. Müller, 1774)				2.50	1.37		1.45		2.45		0.48	*			5.41	*		3.57		
				12.50	12.50		50.0		37.50		25.00				12.50			25.00		
Euconulus alderi											2			1	8		3	2	6	12
(Gray, 1840)							*				0.48			2.86	18.92		8.57	3.57	3.57	11.01
											12.50			12.50	25.00		25.00	25.00	50.00	50.00
Clausiliidae																				
Cochlodina laminata					5	2	14	2		3										
(Montagu, 1803)					6.85	2.99	5.07	4.76		2.48										
					25.00	25.00	87.50	25.00		12.50										
Ruthenica filograna			21				25													
(Rossmässler, 1836)			43.75				9.06													
			62.50				75.00													

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Macrogastra ventricosa (Draparnaud, 1801)							3 1.09 25.00													
Macrogastra plicatula (Draparnaud, 1801)							13 4.71 50.0			7 5.79 12.50										
Bulgarica cana (Held, 1836)							*													
Clausilia bidentata (Ström, 1765)			16 33.33 50.00		13 17.81 37.50	17 25.37 62.50	4 1.45 50.0	9 21.43 62.50								2 8.33 12.50				
Bradybaenidae																				
Bradybaena fruticum (O. F. Müller, 1774)		6 16.66 37.5					*			1 0.83 12.50										
Helicidae																				
Perforatella bidentata (Gmelin, 1791)	1 4.54 12.5	2 5.55 12.5	* 			6 8.96 37.50	1 0.36 12.50		28 17.18 87.50	2 1.65 12.50	19 4.59 75.00							1 1.79 12.50		
Perforatella rubiginosa (A. Schmidt, 1853)							*												26 15.48 75.00	3 2.75 25.00
Perforatella incarnata (O. F. Müller, 1774)	1 4.54 12.5	6 16.66 37.5	5 10.42 50.00		2 2.74 37.5	20 29.85 100.0	19 6.88 87.50	5 11.90 62.50	77 47,24 100.0	12 9.92 37.50	25 6.04 75.00	4 50.00 37.5	4 21.05 25.00	2 5.71 25.00		5 20.83 37.50		1 1.79 12.50		
Trichia hispida (Linnaeus, 1758)				9 22.50 62.50		1 1.49 12.50	5 1.81 37.50				1 0.24 12.50		1 0.52 12.50							
Helix pomatia Linnaeus, 1758						1 1.49 12.50		*	1 0.61 12.50											
Deroceras laeve (O. F. Müller, 1774)																			1 0.60 12.50	
Number of species	9	11	9	11	15	18	34	13	19	13	17	7	4	7	8	16	5	7	12	8
Density	22	36	48	40	73	67	276	42	163	121	414	8	19	35	37	24	35	56	168	109
H	2.61	3.14	1.95	2.76	3.35	3.13	3.75	3.31	2.65	3.03	2.52	1.75	1.57	1.91	2.47	2.92	2.06	1.48	2.33	2.70

* shells or visual search, H species diversity

Table 2. Abundance and frequency of gastropods in alder carrs of central Wielkopolska

Species	Abundance	Frequency
Carychium minimum	15.90	12.50
Perforatella incarnata	10.49	36.88
Zonitoides nitidus	10.27	17.50
Nesovitrea hammonis	9.54	43.75
Cochlicopa lubrica	7.98	31.25
Discus rotundatus	5.69	11.88
Aegopinella pura	4.69	20.00
Succinea putris	3.91	8.75
Clausilia bidentata	3.40	13.75
Perforatella bidentata	3.35	13.13
Ruthenica filograna	2.57	6.88
Vertigo antivertigo	1.95	1.88
Acanthinula aculeata	1.95	8.75
Euconulus alderi	1.84	10.00
Punctum pygmaeum	1.73	8.13
Perforatella rubiginosa	1.62	5.00
Cochlodina laminata	1.45	8.75
Aegopinella nitidula	1.17	4.38
Macrogastra plicatula	1.12	3.13
Cochlicopa lubricella	1.06	9.38
Trichia hispida	0.95	6.88
Euconulus fulvus	0.89	8.75
Nesovitrea petronella	0.84	7.50
Vallonia pulchella	0.73	3.13
Columella edentula	0.67	5.63
Vallonia costata	0.61	2.50
Vallonia excentrica	0.50	2.50
Bradybaena fruticum	0.39	2.50
Arion subfuscus	0.33	3.75
Vitrea crystallina	0.33	2.50
Malacolimax tenellus	0.33	3.13
Acicula polita	0.28	1.88
Limax cinereoniger	0.28	2.50
Carychium tridentatum	0.22	1.25
Succinea oblonga	0.17	0.63
Vertigo pusilla	0.17	2.50
Macrogastra ventricosa	0.17	1.25
Arion rufus	0.11	1.25
Helix pomatia	0.11	1.25
Cochlicopa nitens	0.06	0.63
Vertigo substriata	0.06	0.63
Arion circumscriptus	0.06	0.63
Deroceras laeve	0.06	0.63

groups, despite the fact that the studies included the same season – summer, and samples were taken within one month. This could have resulted from varying weather conditions, especially in the case of species which during favourable weather stay on plants – *Columella edentula* (POKRYSZKO 1990), climb live trees – *Cochlodina laminata* or whose occurrence is associated with rotting timber, e.g. *D. rotundatus* (KUVNIK-KOWALSKA 1999). The varied degree of dominance of exclusive litter-dwellers (e.g. *C. tridentatum, Punctum pygmaeum, C. lubrica, Ruthenica filograna*) may result from their short life cycle and/or weather-dependent reproduction (MORTON 1954, BAUR 1989, SZYBIAK in prep.).

Site 7 was the richest in species and specimens. It was a young alder forest, naturally regenerated, situated on the right bank of the Warta River in the Żerkowsko-Czeszewski Landscape Park. The Park is within the Wielkopolskie lakeland, within the South Wielkopolska Lowland, on the floodplain of the Warta River valley and its tributary Lutynia with numerous oxbows. The region holds numerous source areas. The forest, aged 32, is composed of black alder (80%), ash and birch. It harbours 34 species of terrestrial gastropods, including six clausiliids, with *Macrogastra ventricosa* which in Wielkopolska till recently was known only from subfossil sites (SZYBIAK in press). The mean density of gastropods per 0.5 m^2 was 276 individuals. The malacocoenosis showed the highest diversity (H=3.75). The dominants and the most frequent components were *C. lubrica, D. rotundatus, Aegopinella pura, N. hammonis, C. minimum, Acanthinula aculeata, C. laminata, R. filograna, P. incarnata.* The malacocoenosis was the most similar to those from sites 6 and 5 (Fig. 2). They are old alder stands, aged over 100, with an admixture of ash, hornbeam and oak. The Nei similarity in their species composition was 0.61 and 0.60, respectively (Table 3). The three malacocoenoses shared nine species: *C. lubrica, C. edentula, Ae. pura, Ae. nitidula, N. hammonis, A. aculeata, C. laminata, C. bidentata, P. incarnata.*

The group of species found in numerous sites (1, 2, 5, 6, 7, 8, 14, 17, 10, 13, 3, 16, 12) (Table 3, Fig. 2) included, besides the species shared with the first group, also *Sucinea oblonga, Cochlicopa nitens, V. crystallina, Vitrina pellucida, Bradybaena fruticum, Acicula polita, A. circumscriptus, Ae. nitidula, Limax cinereoniger, Malacolimax tenellus, C. laminata, R. filograna, Macrogastra plicatula, Clausilia bidentata, M. ventricosa, Bulgarica cana.* Except *S. oblonga, C. nitens, V. crystallina, V. pellucida* and *B. fruticum* they are forest-dwellers, mainly mesophile, contrary to the first group (Fig. 2), where euryoecious species found also in other habitats of Wielkopolska (KORALEWSKA-BATURA 1992, SZYBIAK 2002) form a majority. Malacocoenoses of geographically close sites were the most similar (sites 1 and 2, 6 and 5, 19 and 20) (Fig. 2).

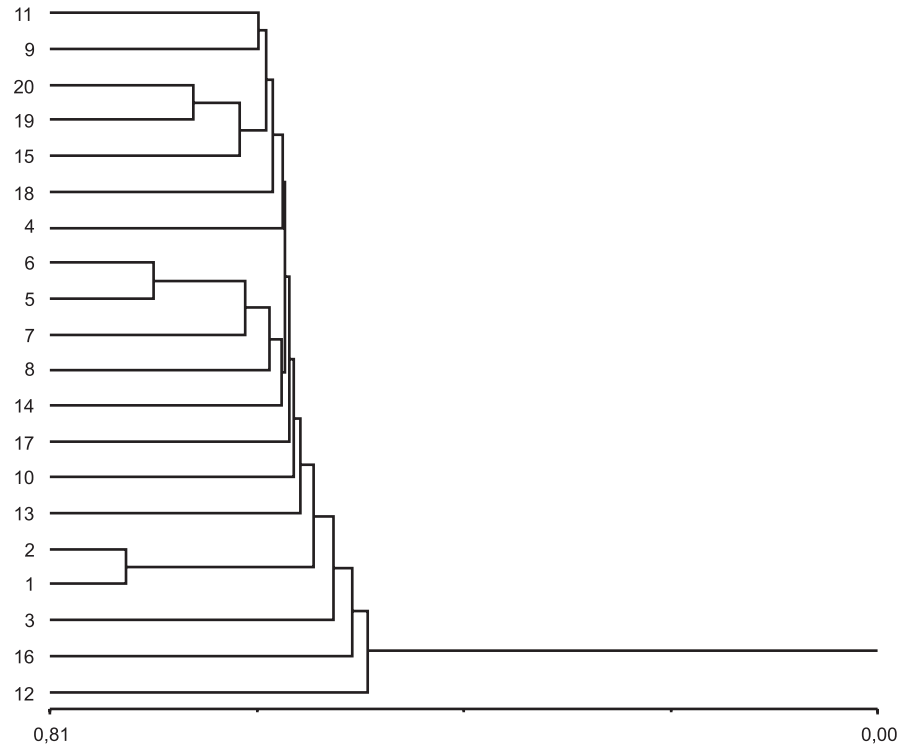

Fig. 2. Dendrogram of Nei similarity among the 20 sites

The species composition of the gastropod communities in the 20 alder carrs in central Wielkopolska was compared with such composition of malacocoenoses of alder carrs in other parts of Poland (Table 4). KĘDRA (1971) recorded 33 terrestrial species from alder forests of the Chodzież region, BERGER (1961) reported 46 species from such forests on the boundary of Wielkopolska, Silesia and the Cracow-Wieluń Jura, POKRYSZKO (1984) – 19 species from analogous habitats in the Kaczawskie Mts, SZYBIAK (2001) – 29 from the Notecka Forest on the Smolnica River.

Alder carr malacocoenoses from central Wielkopolska share 33 species with those from the boundary of Wielkopolska, Silesia and the Cracow-Wieluń Jura. The fewest species are shared with remote malacocoenoses, i.e. those from the Chodzież region and the Kaczawskie Mts (9 species).

Nei-based cluster analysis (Fig. 3, Table 5,) shows alder carr malacocoenoses of the Chodzież region (I) and of the Wielkopolska-Silesia-Jura boundary (II) as the most similar. Communities on the Smolnica River (Notecka Forest) and central Wielkopolska are also rather similar. The species composition of alder carr malacocoenoses in the Kaczawskie Mts departs from the remaining ones. This malacocoenosis includes species whose distribution ranges are different from those of the components of the remaining – lowland – communities: *Eucobresia diaphana* occurring in the Sudetes and Western Carpathians and *Semilimax semilimax* known from the Sudetes, Carpathians and the Świętokrzyskie Mts. Omitting them from smilarity calculations did not change essentially the similarity values, and the community from the Kaczawskie Mts was still the most dissimilar. The geographical distance between the sites has a significant effect on the similarity.

The following species are common to all alder carr malacocoenoses studied in Poland: *C. minimum,*

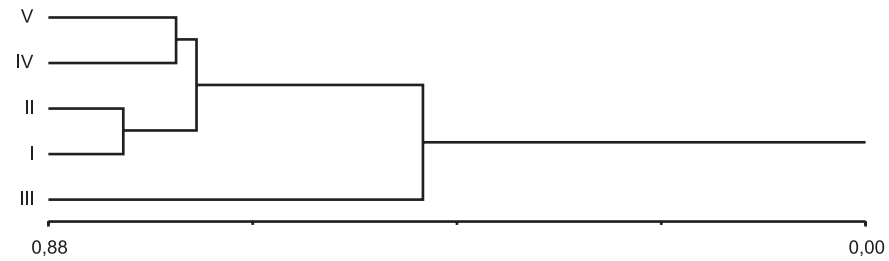

Fig. 3. Dendrogram of Nei similarity among alder carr malacocoenoses of Poland: I – the Chodzież region, II – boundary of Wielkopolska, Silesia and the Cracow-Wieluń Jura, III – Kaczawskie Mts, IV – Notecka Forest on the Smolnica River, V – central Wielkopolska

Table 3. Values of the Nei index for the studied sites (1–20)

Sites	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1	1.00	0.74	0.27	0.33	0.43	0.50	0.44	0.29	0.50	0.37	0.32	0.50	0.50	0.38	0.24	0.42	0.27	0.41	0.32	0.35
2	0.74	1.00	0.26	0.32	0.49	0.55	0.48	0.27	0.32	0.44	0.31	0.32	0.47	0.36	0.34	0.30	0.39	0.39	0.30	0.34
3	0.27	0.26	1.00	0.41	0.42	0.41	0.53	0.35	0.41	0.34	030	0.41	0.41	0.46	0.14	0.52	0.17	0.33	0.13	0.29
4	0.33	0.32	0.41	1.00	0.52	0.42	0.44	0.29	0.58	0.46	0.49	0.33	0.50	0.38	0.47	0.32	0.41	0.41	0.32	0.47
5	0.43	0.49	0.42	0.52	1.00	0.71	0.62	0.60	0.58	0.57	0.44	0.26	0.39	0.59	0.37	0.49	0.21	0.32	0.16	0.18
6	0.50	0.55	0.41	0.42	0.71	1.00	0.60	0.58	0.56	0.55	0.36	0.25	0.50	0.47	0.27	0.40	0.20	0.31	0.24	0.27
7	0.44	0.48	0.53	0.44	0.62	0.60	1.00	0.38	0.38	0.42	0.48	0.22	0.44	0.49	0.31	0.35	0.27	0.45	0.21	0.31
8	0.29	0.27	0.35	0.29	0.60	0.58	0.38	1.00	0.29	0.40	0.21	0.14	0.29	0.33	0.10	0.46	0.12	0.24	0.09	0.10
9	0.50	0.32	0.41	0.58	0.58	0.56	0.38	0.29	1.00	0.55	0.61	0.50	0.38	0.47	0.53	0.40	0.50	0.59	0.38	0.51
10	0.37	0.44	0.34	0.46	0.57	0.55	0.42	0.40	0.55	1.00	0.54	0.42	0.42	0.52	0.39	0.35	0.34	0.34	0.35	0.29
11	0.32	0.31	0.30	0.49	0,44	0.36	0.48	0.21	0.61	0.54	1.00	0.36	0.49	0.46	0.60	0.31	0.50	0.59	0.38	0.51
12	0.50	0.32	0.41	0.33	0.26	0.25	0.22	0.14	0.50	0.42	0.36	1.00	0.50	0.38	0.35	0.47	0.41	0.20	0.32	0.35
13	0.50	0.47	0.41	0.50	0.39	0.50	0.44	0.29	0.38	0.42	0.49	0.50	1.00	0.57	0.35	0.47	0.41	0.41	0.32	0.35
14	0.38	0.36	0.46	0.38	0.59	0.47	0.49	0.33	0.47	0.52	0.46	0.38	0.57	1.00	0.40	0.36	0.46	0.46	0.36	0.27
15	0.24	0.34	0.14	0.47	0.37	0.27	0.31	0.10	0.53	0.39	0.60	0.35	0.35	0.40	1.00	0.22	0.39	0.43	0.56	0.63
16	0.42	0.30	0.52	0.32	0.49	0.40	0.35	0.46	0.40	0.35	0.31	0.47	0.47	0.36	0.22	1.00	0.39	0.26	0.30	0.22
17	0.27	0.39	0.17	0.41	0.21	0.20	0.27	0.12	0.31	0.34	0.50	0.41	0.41	0.46	0.58	0.39	1.00	0.33	0.52	0.58
18	0.41	0.39	0.33	0.41	0.32	0.31	0.45	0.24	0.51	0.34	0.59	0.20	0.41	0.46	0.43	0.26	0.33	1.00	0.26	0.29
19	0.32	0.30	0.13	0.32	0.16	0.24	0.21	0.09	0.32	0.35	0.38	0.32	0.32	0.36	0.56	0.30	0.52	0.26	1.00	0.67
20	0.35	0.34	0.29	0.47	0.18	0.27	0.31	0.10	0.35	0.29	0.51	0.35	0.35	0.27	0.63	0.22	0.58	0.29	0.67	1.00

Table 4. Terrestrial gastropods of alder carrs of Poland

Gastropods of alder carrs of Poland	Chodzież region (KĘDRA 1971)	Boundary of Wielkopolska, Silesia and the Cracow-Wieluń Jura (BERGER 1961)	Kaczwskie Mts (W. Sudetes) (POKRYSZKO 1984)	Notecka Forest on the Smolnica River (SZYBIAK 2001)	Central Wielkopolska
Aciculidae					
Acicula polita		+			+
Ellobiidae					
Carychium minimum	+	+	+	+	+
Carychium tridentatum	+	+		+	+
Succineidae					
Succinea oblonga	+	+		+	+
Succinea putris	+	+	+	+	+
Sucinea elegans	+	+			
Succinea sarsi	+				
Cochlicopidae					
Cochlicopa lubrica	+	+	+	+	+
Cochlicopa lubricella	+	+		+	+
Cochlicopa nitens	+	+		+	+
Vertiginidae					
Columella edentula	+	+			+
Columella aspera				+	
Vertigo pusilla	+	+			+
Vertigo antivertigo	+	+			+
Vertigo substriata	+	+		+	+
Vertigo angustior	+	+			
Vertigo pygmea	+	+			
Pupillidae					
Pupilla muscorum	+	+			
Enidae					
Ena obscura					
Valloniidae					
Vallonia costata	+	+		+	+
Vallonia pulchella	+	+			+
Vallonia excentrica					+
Acanthinula aculeata	+	+		+	+
Endodontidae					
Punctum pygmaeum	+	+	+	+	+
Discus rotundatus				+	+
Discus ruderatus		+			
Arionidae					
Arion subfuscus		+	+	+	+
Arion rufus		+	+		+
Arion circumscriptus	+	+	+	+	+
Arion distinctus					+
Arion silvaticus			+		

Vitrinidae					
Vitrina pellucida	+	+	+		+
Eucobresia diaphana			+		
Semilimax semilimax			+		
Zonitidae					
Vitrea crystallina	+	+		+	+
Vitrea contracta	+				
Aegopinella pura	+	+	+	+	+
Aegopinella nitidula	+	+		+	+
Nesovitrea hammonis	+	+		+	+
Nesovitrea petronella		+		+	+
Zonitoides nitidus	+	+		+	+
Limacidae					
Limax cinereoniger		+		+	+
Malacolimax tenellus		+			+
Lehmania marginata		+			
Limax maximus				+	
Agriolimacidae					
Deroceras reticulatum	+	+			
Deroceras agreste	+	+	+		
Deroceras laeve		+	+	+	+
Euconulidae					
Euconulus fulvus	+	+	+	+	+
Euconulus alderi					+
Clausiliidae					
Cochlodina laminata					+
Ruthenica filograna					+
Macrogastra ventricosa					+
Macrogastra plicatula		+			+
Laciniaria plicata			+		
Bulgarica cana					+
Clausilia bidentata				+	+
Bradybaenidae					
Bradybaena fruticum	+	+			+
Helicidae					
Perforatella bidentata		+	+	+	+
Perforatella rubiginosa	+	+			+
Perforatella incarnata		+	+	+	+
Trichia hispida					+
Helicigona arbustorum			+		
Cepaea hortensis		+			
Helix pomatia		+		+	+
Euomphalia strigella		+			
Number of species	33	46	19	29	46

S. putris, S. oblonga, C. lubrica, E. fulvus P. pygmaeum, V. crystallina, Ae. pura, A. circumscriptus. The set can be regarded as indicative of alder carr malacocoenoses in Poland. The first three species are Eurosiberian, the next two are Holarctic, the remaining four are Palearctic, European and western-central European. They can mostly occur in a variety of habitats and prefer mesic conditions, but are to a large extent indifferent to pH and calcium content. Only *A. circumscriptus* and *Ae. pura* prefer forest habitats, while *C. minimum* and *S. putris* are regarded as hygrophiles. Alder carrs with their mosaic structure provide adequate conditions for both mesophile and hygrophile species.

Table 5. Values of the Nei index for the studied alder carr malacocoenoses of Poland

Alder carr malacocoenoses of Poland	I	II	III	IV	V
I	1.00	0.80	0.36	0.58	0.64
II	0.80	1.00	0.47	0.63	0.72
III	0.36	0.47	1.00	0.47	0.41
IV	0.58	0.63	0.47	1.00	0.74
V	0.64	0.72	0.41	0.74	1.00

I–V as in Fig. 3

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