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STABILITY OF MALACOCOENOSES IN AN ASH-ELM FOREST BASED ON TWO-YEAR OBSERVATIONS

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ABSTRACT: The paper presents results of two-year (2003–2005) monthly studies on terrestrial malacocoenoses in an ash-elm forest (*Fraxino-Ulmetum*) near Duszniki in western Wielkopolska (W. Poland). Species composition, dominance structure and abundance of malacocoenoses of selected plots were analysed. Twenty species of ten families were recorded, represented by 7,619 specimens. The main components of the malacocoenoses were *Nesovitrea hammonis* (Ström), *Columella edentula* (Drap.), *Vallonia costata* (O. F. Müll.), *Punctum pygmaeum* (Drap.), *Cochlicopa lubricella* (Porro) and *Vertigo pusilla* O. F. Müll. The species composition was stable but the abundance varied considerably.

KEY WORDS: terrestrial gastropods, ecology, malacocoenosis, species richness, diversity, abundance

INTRODUCTION

Earlier malacological studies in Wielkopolska (W. Poland) were mostly faunistic (KORALEWSKA-BATURA 1989, 1992, 1993a, b, JANKOWIAK et al. 1991) and considered seasonal changes in gastropod communities only to a small extent. For a few years we have been studying species composition and structure of malacocoenoses in various forest ecosystems in order to investigate their stability (KORALEWSKA-BATURA et al. 2006). Analysis of malacocoenoses in several types of forests has shown that the richest and most abundant gastropod communities occur in ash-elm forests (*Fraxino-Ulmetum*).

The main aim of this study was to trace the seasonal quantitative variation and to check the long term stability of such communities. We also found that the community structure depended on the degree of compactness of tree stands and the development of shrub layer.

STUDY AREA

Samples were taken from May 2003 till April 2004 and from July 2004 till June 2005 in a small forest complex near Duszniki, ca. 27 km west of Poznań (UTM: WU 91). The study area (100 × 100 m) was an ash-elm forest in its floristically impoverished variant, developed after a clear-felling as a result of natural regeneration. Species of the *Alno-Ulmion* association, such as *Padus avium*, *Stachys sylvatica* and *Plagiomnium undulatum* and other plants of class *Querco-Fagetea*, were important components of the vegetation. Species of rich habitats were constant: *Sambucus nigra*, *Geranium robertianum* and other species of class *Artemisietea*. The studied forest has two forms: with rather compact tree stands (J-I) and with sunny stands (J-II). Within the latter form samples were taken from under hazel shrubs (J-IIa) and in a clearing (J-IIb).

MATERIAL AND METHODS

Ninety six unit samples were taken in the first year of studies from plot J-II, without its further division. On each occasion a series of eight samples (total area of 0.5 m^2) was taken with Oekland frame (25 × 25 cm). In the second year identical series of samples were taken in each of the two forms of the forest, considering shaded and sunny places. The number of unit samples in the first year was 96, in the second year (except February) – 264. The material is kept in the Natural History Collections, Faculty of Biology, Adam Mickiewicz University in Poznań.

The following ecological indices were used in the data analysis: dominance (D), constancy of occurrence (C), density, Marczewski and Steinhaus similarity index and cluster analysis (MARCZEWSKI & STEINHAUS 1959, GÓRNY & GRÜM 1993). Dominance and constancy classes followed BŁOSZYK (1999).

RESULTS AND DISCUSSION

SPECIES COMPOSITION AND STRUCTURE OF MALACOCOENOSIS

During the two years the malacocoenosis was composed of 20 species, representing 10 families (total of 7,619 specimens). The most abundant were *Nesovitrea hammonis* (24.9 %), *Columella edentula* (17.8 %), *Vallonia costata* (11.1 %), *Punctum pygmaeum* (10.1%), *Cochlicopa lubricella* (8.9 %) and *Vertigo pusilla* (4.7 %). These species were also the most frequent in the studied forest and their constancy usually exceeded 50% (Table 1).

The species composition of the malacocoenosis was very stable and its similarity (S) between the years

Table 1. Characteristics of the studied malacocoenosis in the two-year study period

No.	Species	Years of studies						Total		
		May 2003–April 2004			July 2004–June 2005					
		N	D%	C%	N	D%	C%	N	D%	C%
1	*Nesovitrea hammonis*	335	28.7	64.6	1,559	24.2	95.8	1,894	24.9	87.5
2	*Columella edentula*	190	16.3	38.5	1,162	18.0	90.0	1,352	17.8	76.1
3	*Vallonia costata*	147	12.6	40.6	700	10.9	72.0	847	11.1	63.6
4	*Punctum pygmaeum*	64	5.5	25.0	703	10.9	72.0	767	10.1	59.4
5	*Cochlicopa lubricella*	144	12.3	41.7	536	8.3	80.7	680	8.9	70.3
6	*Vertigo pusilla*	41	3.5	19,8	317	4.9	52.3	358	4.7	43.6
7	*Carychium minimum*	68	5.8	16.7	238	3.7	47.0	306	4.1	38.9
8	*Cepaea hortensis*	38	3.3	19.8	252	3.9	46.2	290	3.8	39.2
9	*Vertigo substriata*	37	3.2	17.7	216	3.4	42.4	253	3.3	35.8
10	*Acanthinula aculeata*	31	2.7	16.7	160	2.5	38.3	191	2.5	32.5
11	*Aegopinella nitidula*	12	1.0	7.3	177	2.7	39.0	189	2.5	30.6
12	*Vitrea crystallina*	4	0.3	2.1	140	2.2	25.4	144	1.9	19.2
13	*Perforatella incarnata*	33	2.8	14.6	100	1.6	29.2	133	1.8	25.3
14	*Euomphalia strigella*	10	0.9	9.4	88	1.4	24.6	98	1.3	20.6
15	*Euconulus fulvus*	5	0.4	5.2	66	1.0	18.2	71	0.9	14.7
16	*Aegopinella pura*	6	0.5	5.2	28	0.4	7.6	34	0.5	6.9
17	*Succinea oblonga*				6	0.1	2.3	6	0.1	1.7
18	*Vallonia pulchella*	3	0.3	2.1				3	0.04	0.6
18	*Succinea putris*				2	0.03	0.4	2	0.03	0.3
20	*Arion subfuscus*	1	0.1	1.0				1	0.01	0.3
Number of individuals			1,169			6,450			7,619	
Number of species			18			18			20	
Number of unit samples			96			264			360	
Mean density, indiv. m^{-2}			195			391			338.6	

was 80%. Only four of the recorded species were not constant components of the community and appeared only in one of the study years (Table 1). These were *Vallonia pulchella* and *Arion subfuscus* in the first year, and *Succinea oblonga* and *S. putris* in the second. The dominance structure was similar between the years, with a slightly lower frequency in the first year.

The lower frequency was probably associated with the smaller mean density of gastropods which was 195 indiv. m^{-2} in the first and 391 indiv. m^{-2} in the second year. The differences in the abundance of individual gastropod species between the years were statistically significant (Mann-Whitney test, U=3156367.5; z=14.26 p<0.001).

EFFECT OF VEGETATION ON THE SPECIES COMPOSITION AND STRUCTURE OF MALACOCOENOSIS

In the second year in the study area we distinguished three plots of different vegetation. Two (J-I and J-IIa) were more shaded because of their trees and shrub layer, the third (J-IIb – a clearing) was sunny (Table 2). Differences in the number of species recorded from these plots were small. The fewest species (16) were found in the sunny plot (J-IIb), the most numerous (18) in the most shaded plot (J-IIa). The most abundant species in the shaded plots (J-I and J-IIa) were *Columella edentula*, and in J-II, irrespective of the shadiness – *Nesovitrea hammonis*. The mean density of the six most abundant species is presented in Fig. 1. These species showed also a high frequency (Table 2). The mean number of snails collected from shaded and sunny plots differed statistically significantly (ANOVA, Kruskal-Wallis; H (2, N=4,491)= 10.24; p < 0.01 (0.00598222)), which indicates that the compactness of tree crowns affects the gastropod abundance and distribution through humidity and temperature of the substratum.

ANNUAL DYNAMICS OF ABUNDANCE OF MALACOCOENOSIS

The greatest mean fluctuations in the gastropod abundance were observed from January till May (Fig. 2). This was associated with considerable changes in relative humidity which most often is related to decrease or increase in air temperature near the soil.

Table 2. Characteristics of malacocoenoses of the study plots of the ash-elm forest in the second year of studies

No.	Species	Plots								
		J-I			J-IIa			J-IIb		
		N	D%	C%	N	D%	C%	N	D%	C%
1	*Columella edentula*	412	19.7	92.1	492	19.1	93.2	258	14.5	84.1
2	*Nesovitrea hammonis*	375	17.9	90.0	628	24.3	100.0	556	31.3	97.7
3	*Punctum pygmaeum*	278	13.3	79.6	235	9.1	73.9	190	10.7	62.5
4	*Vertigo pusilla*	162	7.8	60.2	89	3.5	55.7	66	3.7	40.9
5	*Cochlicopa lubricella*	136	6.5	72.7	254	9.8	86.4	146	8.2	83.0
6	*Aegopinella nitidula*	113	5.4	62.5	39	1.5	33.0	25	1.4	21.6
7	*Vallonia costata*	111	5.3	45.5	338	13.1	84.1	251	14.1	86.4
8	*Vitrea crystallina*	104	5.0	51.1	19	0.7	14.8	17	1.0	10.2
9	*Carychium minimum*	79	3.8	46.6	104	4.0	58.0	55	3.1	36.4
10	*Vertigo substriata*	70	3.4	43.2	70	2.7	37.5	76	4.3	46.6
11	*Cepaea hortensis*	70	3.4	40.9	115	4.5	60.2	67	3.8	37.5
12	*Acanthinula aculeata*	50	2.4	39.8	82	3.2	53.4	28	1.6	21.6
13	*Perforatella incarnata*	42	2.0	35.2	50	1.9	43.2	8	0.5	9.1
14	*Euconulus fulvus*	36	1.7	26.1	16	0.6	14.8	14	0.8	13.6
15	*Euomphalia strigella*	26	1.2	22.7	42	1.6	31.8	20	1.1	19.3
16	*Aegopinella pura*	22	1.1	15.9	4	0.2	4.6	2	0.1	2.3
17	*Succinea oblonga*	4	0.2	4.6	2	0.1	2.3			
18	*Succinea putris*				2	0.1	1.1			
Number of individuals		2,090			2,581			1,779		
Number of species		17			18			16		
Number of unit samples		88			88			88		
Mean density, indiv. m^{-2}		380			469.3			323.5		

Fig. 2 shows the lowest mean density of gastropods in May. From June till December the abundance was more constant. Its values exceeded the annual mean which was 329 indiv. m^{-2}.

Abundance of the six dominant species over the year showed a clear decrease in May (Fig. 3). It was probably this that contributed to the lowest mean density of the malacocoenosis observed in May in the two-year observations (Fig. 2). The numbers of dominant species in consecutive months varied slightly and reached high values in the winter-spring and summer–autumn periods (Fig. 3).

Dynamics of gastropod abundance in the three plots sampled in the second year (July 2004 till June 2005) was generally similar, though the abundance distinctly varied between the plots (Fig. 4).

Ash-elm forests provide favourable conditions for many gastropod taxa. The studied malacocoenosis

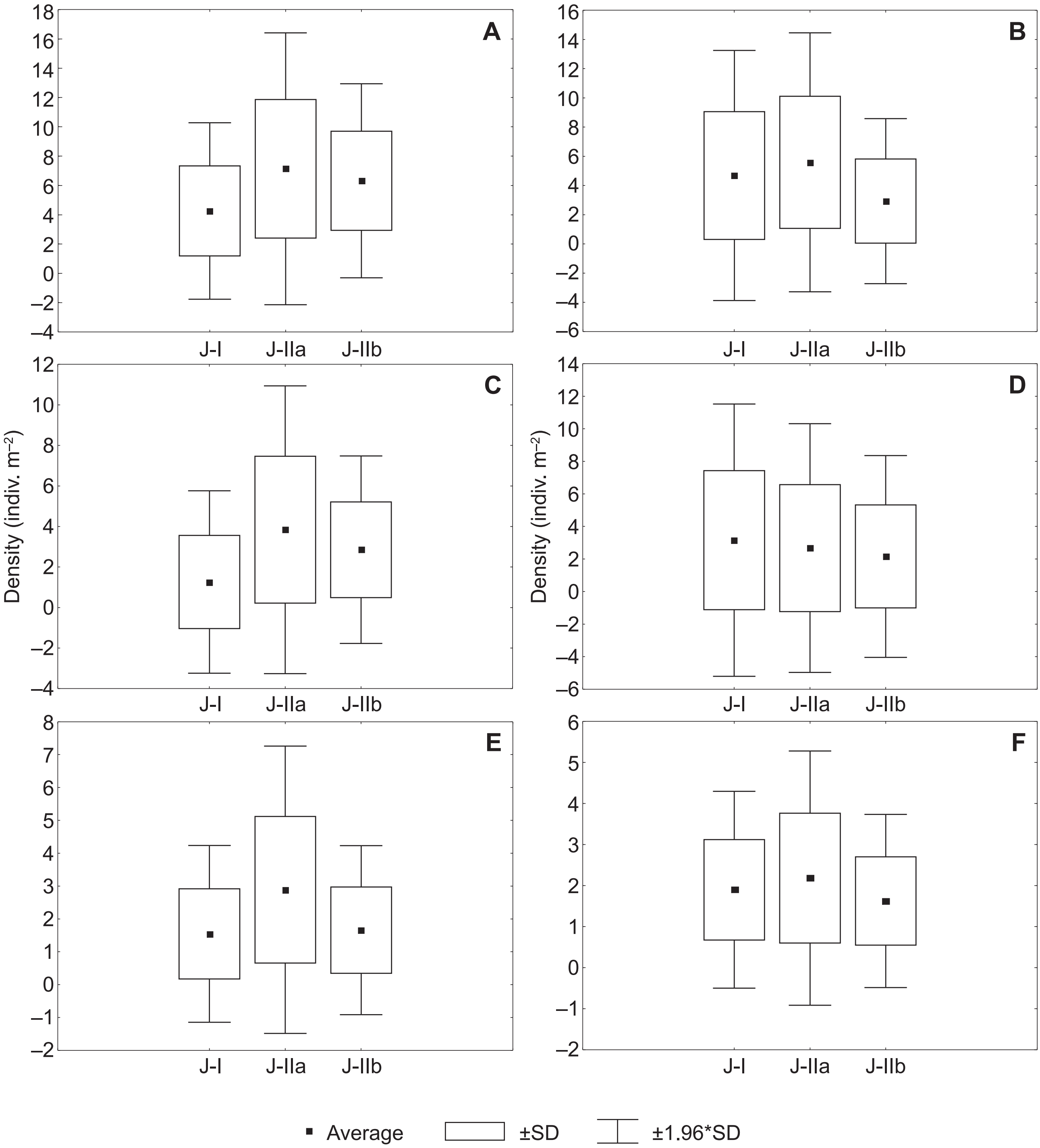

Fig. 1. Mean density of the most abundant snails A – *Nesovitrea hammonis*, B – *Columella edentula*, C – *Vallonia costata*, D – *Punctum pygmaeum*, E – *Cochlicopa lubricella*, F – *Vertigo pusilla* in study plots J-I, J-IIa, J-IIb in ash-elm forest in the second year of studies

showed a very stable species composition which differed from such composition in other forest types, e.g. oak-hornbeam (KORALEWSKA-BATURA 1989, 1992, 1993a, b, KORALEWSKA-BATURA et al. 2006). Among the 20 species recorded from the study plots as many as 16 (80%) were constant over the two year study period

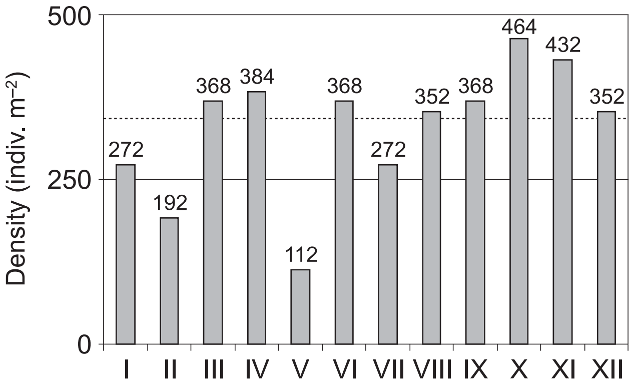

Fig. 2. Mean density of gastropods in the ash-elm forest in annual cycle (based on two-year observations). Dotted line denotes annual mean 329 indiv. m^{-2}

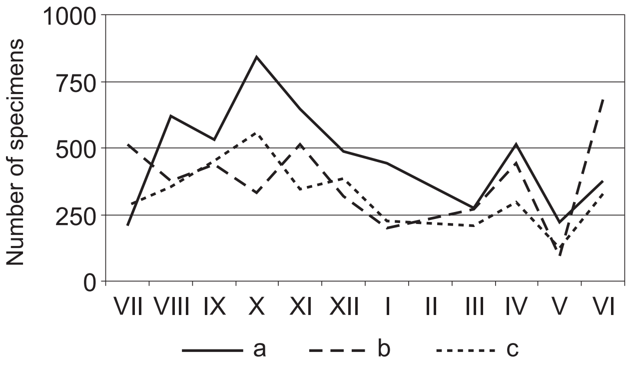

Fig. 4. Abundance dynamics of gastropods in study plots in the ash-elm forest from July 2004 till June 2005: a – J-I, b – J-IIa, c – J-IIb

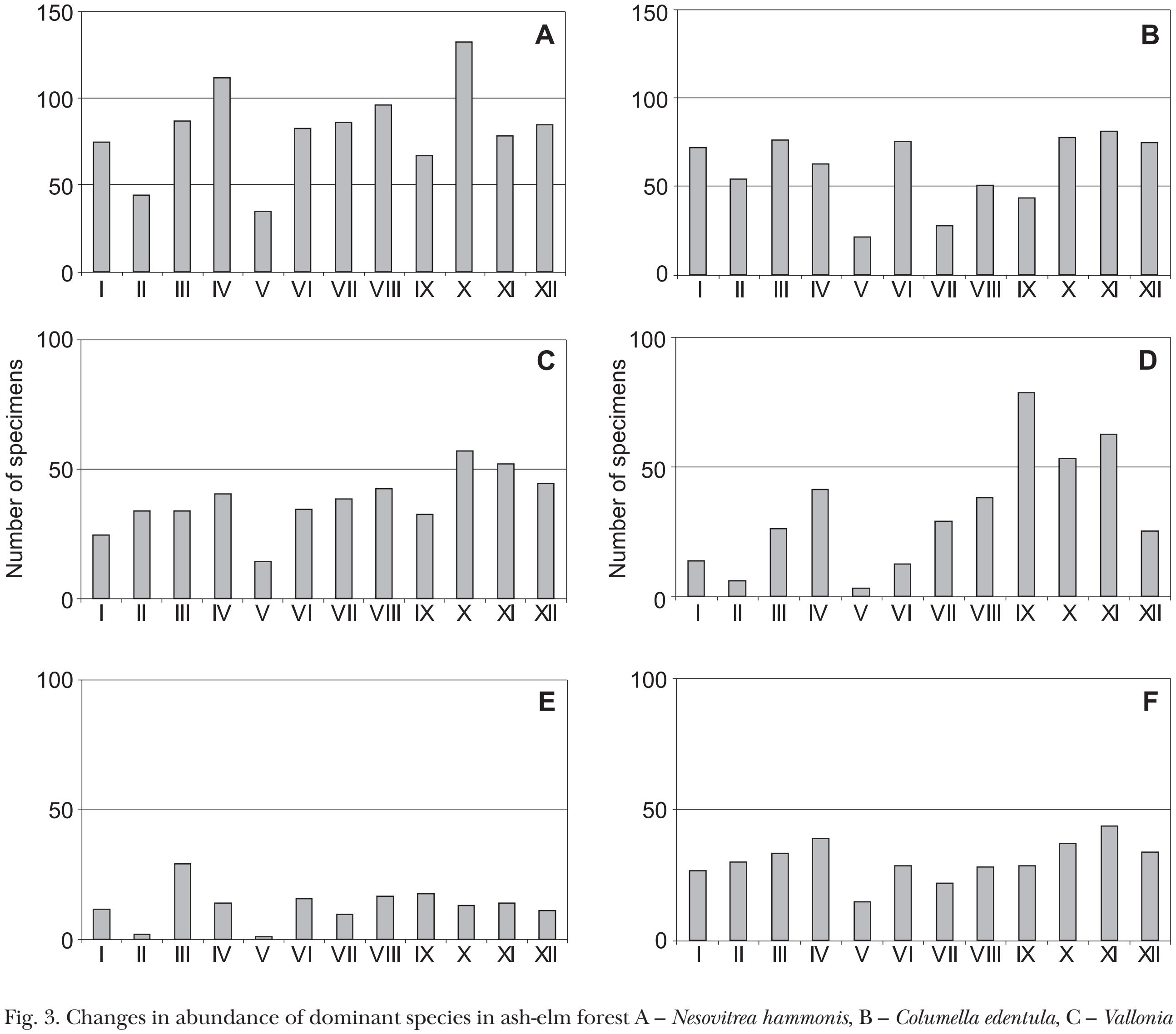

Fig. 3. Changes in abundance of dominant species in ash-elm forest A – *Nesovitrea hammonis*, B – *Columella edentula*, C – *Vallonia costata*, D – *Punctum pygmaeum*, E – *Cochlicopa lubricella*, F – *Vertigo pusilla* in annual cycle (based on two-year observations)

(Table 1). Among them *Vertigo substriata* is noteworthy. The species has scattered localities in the whole country but is rather rare everywhere (WIKTOR 2004).

Variation in abundance of the malacocoenoses of particular plots observed over the year had a similar course (Fig. 3). The density was the highest in the autumn (September–November), the lowest in the winter (December–March). The effect of differences in vegetation on gastropod abundance is probably smaller than that of the seasonally changing weather conditions, mainly relative humidity and air temperature near the soil.

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