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TERRESTRIAL GASTROPODS OF THE CARPATHIAN BEECH FOREST IN THE MAGURA NATIONAL PARK (SE. POLAND)

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ABSTRACT: The malacocoenosis of rich Carpathian beech forest *Dentario glandulosae-Fagetum* of the Magura National Park includes 26 species. The most abundant species in quantitative samples was *Carychium tridentatum* (Risso), in qualitative samples – *Macrogastra latestriata* (A. Schmidt). The mean density was 86 indiv. m^{-2}. Dominant species were *C. tridentatum, Aegopinella pura* (Alder) and *Vitrea crystallina* (O. F. Müller). The species diversity index H' (2.2) and the Pielou index J (30%) were low. The community included mostly typical forest-dwellers. Biogeographically, montane, C. European (lowland and highland), and European components dominated. In its structure the malacocoenosis was much similar to that of the Carpathian beech forest of the Pieniny National Park. Shell parameters in the population of *Macrogastra latestriata* differed from those found in the Beskid Zachodni and were close to those from the Eastern Carpathian foothills.

KEY WORDS: Magura National Park, Carpathian beech forest, malacocoenosis structure, *Macrogastra latestriata*

INTRODUCTION

Terrestrial gastropods from the Beskid Zachodni Mts have been subject to fairly numerous studies, among others by BĄKOWSKI (1878, 1884), KOTULA (1882), WAGNER (1907), GEYER (1927), URBAŃSKI (1932), RIEDEL (1957, 1978), DZIĘCZKOWSKI (1972), UMIŃSKI (1980) and ALEXANDROWICZ (1984). Most papers, however, contain only faunistic data based on qualitative samples. The structure of malacocoenoses of the Beskid Niski Mts, and especially of the Magura National Park, has not been studied to date.

The aim of the study was an analysis of the structure of the malacocoenosis in the Carpathian beech forest *Dentario glandulosae-Fagetum* of the Magura National Park. Our studies are a part of the project "Inventory and diversity analysis of the Magura National Park", and especially of the beech forests of the eastern end of the Beskid Zachodni Mts.

STUDY AREA

The Magura National Park was established in 1995. It is 19,961 ha in area. It is located on the transition between the Western and Eastern Carpathians, and includes the mid part of the Beskid Niski Mts. The landscape is formed of low and moderately high hills, ranging from 380 to 400 m a.s.l.; few exceed 800 m a.s.l. Forests occupy 93% area of the park. The remaining 7% are meadows, pastures and other non-forested areas. The park includes two vegetation zones: the submonate zone up to 530 m a.s.l. occupies about half of the park area. Fragments of natural forest communities have been preserved here: oak-hornbeam forest, Carpathian alder forest, alder swamps, riverine forest. A large area is covered by fir and spruce forests, as well as plantations with pine as dominant. The lower mountain forest zone extends from 530 m a.s.l.

to the summits. Here rich Carpathian beech forests predominate. Small patches of acid beech forest, fir and fir-spruce forest, as well as plantations of birch and pine, are also found. The vegetation cover of the park has been well preserved. It is largely natural, little changed, with a high percentage of protected species (FALIŃSKI 1975, MICHALIK 1981, 1995, DENISIUK et al. 1990).

Preliminary quantitative and qualitative studies on the malacofauna were carried out in the dominant forest community – the rich Carpathian beech forest *Dentario glandulosae-Fagetum*. It occupies richer habitats in lower parts of the slopes. In the herb layer *Dentaria glandulosa* and *Symphytum cordatum* dominate.

METHODS

Quantitative studies, carried out in September 2002, included two localities. Quantitative samples, of litter and surface layer of soil, were taken with a 25 × 25 cm frame, to a total of 1 m^2 (16 samples) in each site. The samples were hand-sorted. Only live specimens were taken into account in statistical analysis. In June and July 2001, gastropods were collected by direct search. The structure of the malacocoenosis was described using the following indices and parameters: density, dominance (D), frequency (F), Shannon index of species diversity (H´), species diversity index TDI, Pielou equitability index (J), Morisita index as modified by Horn, Marczewski and Steinhaus similarity index, ecological and biogeographical grouping (MARCZEWSKI & STEINHAUS 1959, PIELOU 1974, ALEKSANDROWICZ 1987, RIEDEL 1988, TROJAN 1992, GÓRNY & GRÜM 1993, MAGURRAN 1996). The nomenclature and systematics follow KERNEY et al. (1983). The population of *Macrogastra latestriata* was subject to biometrical analysis. The following shell characters were analysed: height, width, aperture height and width, number of ribs on the penultimate whorl. The analysis involved 93 adult, undamaged shells.

RESULTS

The total of 364 specimens, collected in the rich Carpathian beech forest, represented 26 snail species of 10 families (Table 1). The richest in species were Clausiliidae (9 species), followed by Zonitidae (5) and Helicidae (3). Quantitative samples contained 172 specimens representing 16 species which is 62% all species.

The mean density was 86 indiv. m^{-2}. The most abundantly represented species in quantitative samples was *Carychium tridentatum* (54 indiv. m^{-2}; D – 62.2%, F – 12.3%), and in qualitative samples – *Macrogastra latestriata*. *Aegopinella pura* showed the highest frequency (F – 21.9%, D – 11.6%) (Table 1).

Table 1. Species composition, dominance (D), frequency (F), number of specimens in the Carpathian beech forest of the Magura NP [ecological groups: 1 – typical forest-dwellers, very rarely found in other habitats, 2 – species living mainly in forests but common also in parks and other shaded habitats, 3 – forest and shade-loving species typical for very humid and sometimes marshy habitats, 7 – euryoecious snails, 8 – species of humid but not marshy habitats of varied degree of shadiness, 9 – snails of very humid, periodically flooded habitats; zoogeographical groups: Ce – Central European lowland and upland, Ep – European, Es – Eurosiberian, Hl – Holarctic, Ma – montane (Alpine and Carpathian), Pl – Palaearctic, Se – S. European]

No.	Species	Site 1 & 2 (2 m^2)		Total number of individuals (qualitative and quantitative samples)
		D%	F%	
	Ellobiidae			
1.	*Carychium minimum* O. F. Müller, 1774 [9, Es]	5.2	3.1	9
2.	*Carychium tridentatum* (Risso, 1826) [8, Ep]	62.2	12.5	107
	Cochlicopidae			
3.	*Cochlicopa lubrica* (O. F. Müller, 1774) [7, Hl]	0.6	3.1	2
	Vertiginidae			
4.	*Columella edentula* (Draparnaud, 1805) [8, Hl]	0.6	3.1	1
	Enidae			
5.	*Ena obscura* (O. F. Müller, 1774) [1, Ep]	0.6	3.1	2
6.	*Ena montana* (Draparnaud, 1801) [1, Ce]			2

No.	Species	Site 1 & 2 (2 m^2)		Total number of individuals (qualitative and quantitative samples)
		D%	F%	
	Endodontidae			
7.	*Discus rotundatus* (O. F. Müller, 1774) [2, Ce]	0.6	3.1	1
	Vitrinidae			
8.	*Semilimax semilimax* (Férussac, 1802) [1, Ce]	0.6	3.1	1
	Zonitidae			
9.	*Vitrea crystallina* (O. F. Müller, 1774) [2, Ep]	5.8	12.5	10
10.	*Vitrea transsylvanica* (Clessin, 1877) [1, Ma]	3.5	12.5	6
11.	*Aegopinella pura* (Alder, 1830) [1, Ep]	11.6	21.9	20
12.	*Nesovitrea hammonis* (Ström, 1756) [7, Pl]	3.5	18.8	6
13.	*Daudebardia brevipes* (Draparnaud, 1805) [1, Se]	2.3	6.3	4
	Euconulidae			
14.	*Euconulus fulvus* (O. F. Müller, 1774) [7, Hl]	0.6	3.1	1
	Clausiliidae			
15.	*Cochlodina laminata* (Montagu, 1803) [1, Ep]			5
16.	*Cochlodina orthostoma* (Menke, 1830) [1, Ce]			6
17.	*Macrogastra plicatula* (Draparnaud, 1801) [1, Ep]			12
18.	*Macrogastra latestriata* (A. Schmidt, 1857) [1, Ma]			112
19.	*Macrogastra tumida* (Rossmässler, 1836) [3, Ma]			1
20.	*Clausilia pumila* C. Pfeiffer, 1828) [3, Ce]			2
21.	*Balea biplicata* (Montagu, 1803) [2, Ce]			18
22.	*Balea stabilis* (L. Pfeiffer, 1847) [1, Ma]	0.6	3.1	5
23.	*Vestia gulo* (E. A. Bielz, 1859) [3, Ma]			25
	Helicidae			
24.	*Perforatella incarnata* (O. F. Müller, 1774) [1, Ce]	1.2	6.3	2
25.	*Perforatella vicina* (Rossmässler, 1842) [3, Ma]			3
26.	*Chilostoma faustinum* (Rossmässler, 1835) [1, Ma]	0.6	3.1	1
	Total specimens	172		364
	Total species	16		26

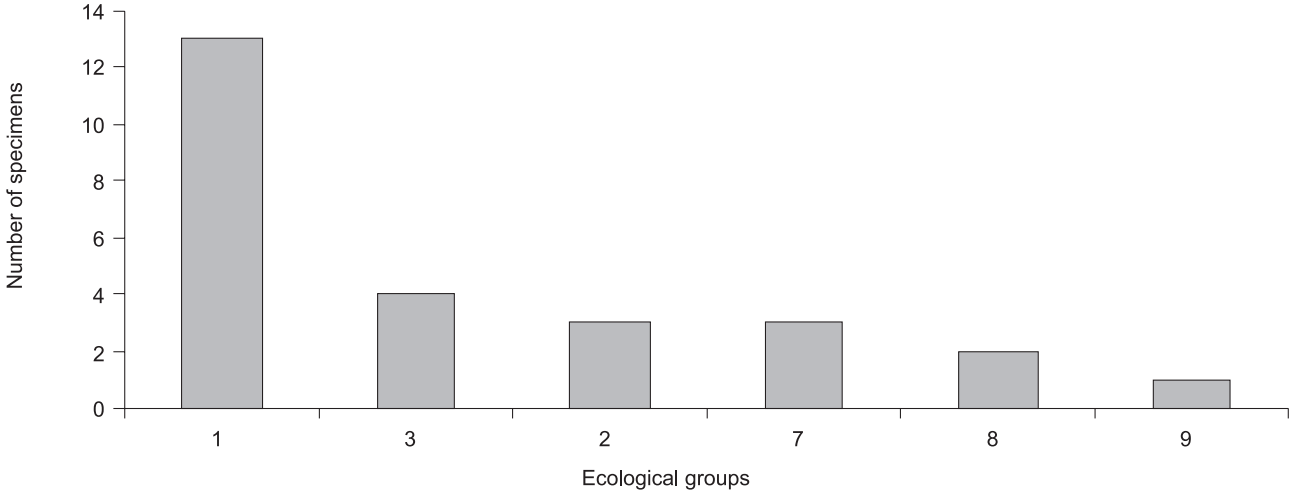

Fig. 1. Ecological structure of the malacocoenosis from the Carpathian beech forest in the Magura NP – species spectrum; 1–9 – ecological groups, for further explanations see heading to Table 1

The dominant species were *Carychium tridentatum* – superdominant, *Aegopinella pura* – eudominant, *Vitrea crystllina* and *Carychium minimum* – dominants. They constituted 85% of the community (Table 1). The remaining species were subdominants (9%), subrecedents (5%) and recedents (1%). All species found in quantitative samples were accidental, with a frequency up to 25%. In the dominance structure of the malacocoenosis subrecedent species formed the highest proportion. The group included eight species: *Cochlicopa lubrica, Columella edentula, Ena obscura, Discus rotundatus, Semilimax semilimax, Euconulus fulvus, Balea stabilis, Chilostoma faustinum.* Their relative abundance did not exceed 1.0%.

The species diversity index H' of the malacocoenosis was 2.2, Pielou (J) index – 30%. The TDI index, directly comparing the equitability and diversity of the community, irrespective from its component taxa, was 0.593.

Gastropods of the malacocoenosis of the beech forest represented six out of nine ecological groups distinguished by ALEXANDROWICZ (1987) (Table 1; Fig. 1). Forest species (group 1) and species living mainly in forests but found also in other habitats (group 3), as well as shade-loving species of very humid habitats (group 2) formed 76% of the malacocoenosis (Table 1). The remaining species were

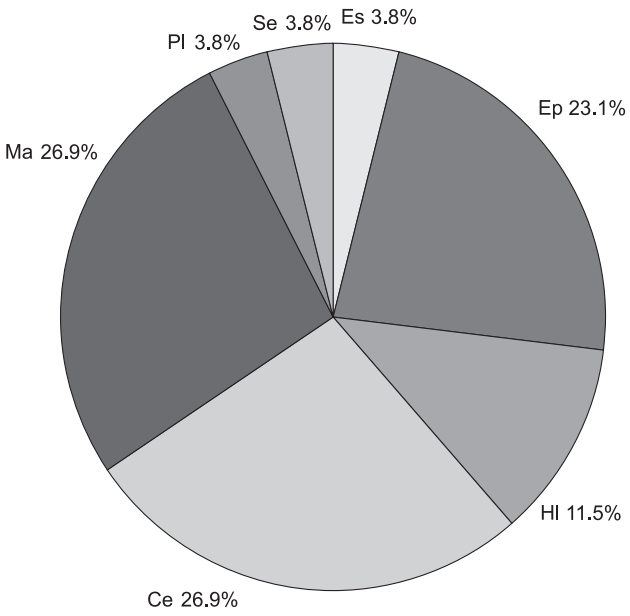

Fig. 2. Zoogeographical composition of the malacocoenosis of the Carpathian beech forest in the Magura NP. For further explanations see heading to Table 1

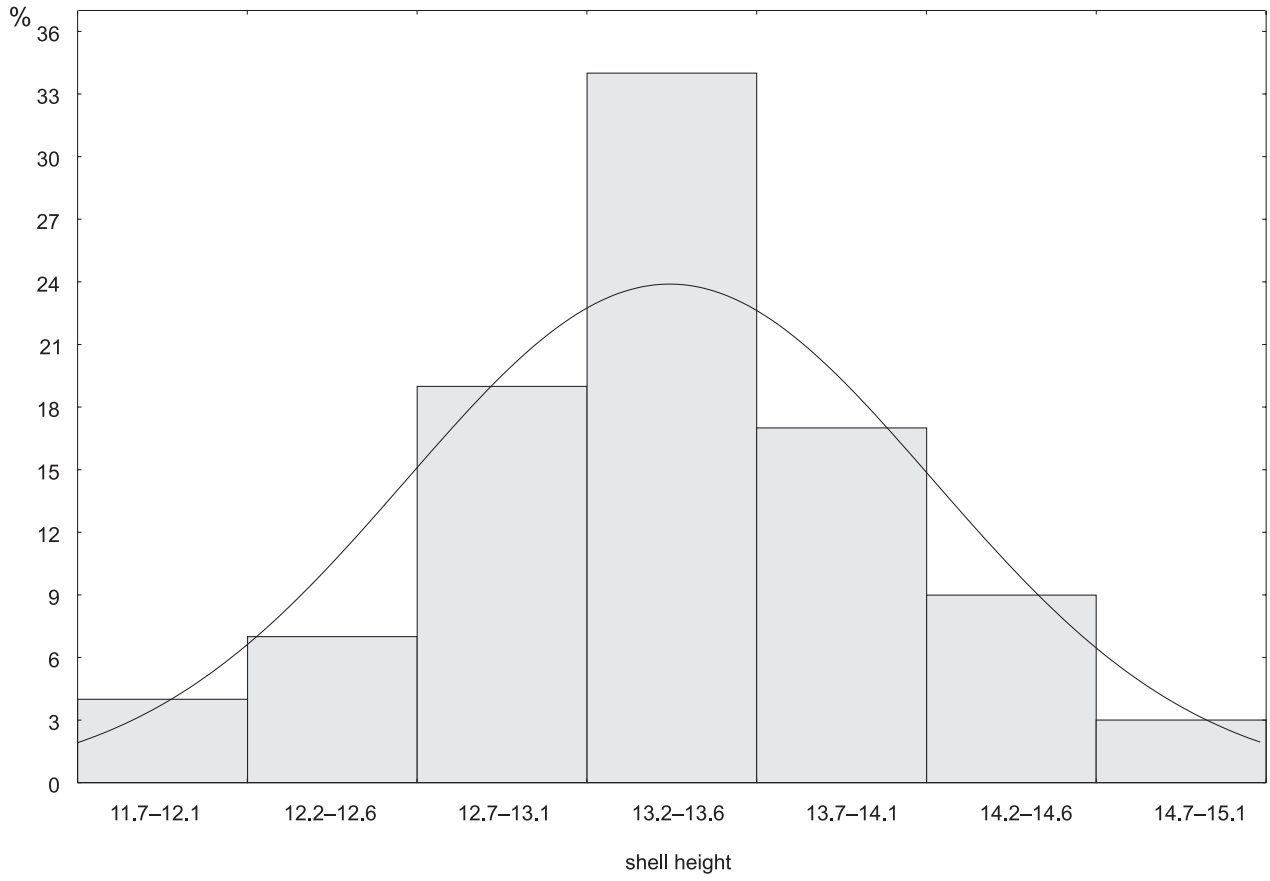

Fig. 3. Shell height in the population of *Macrogastra latestriata*

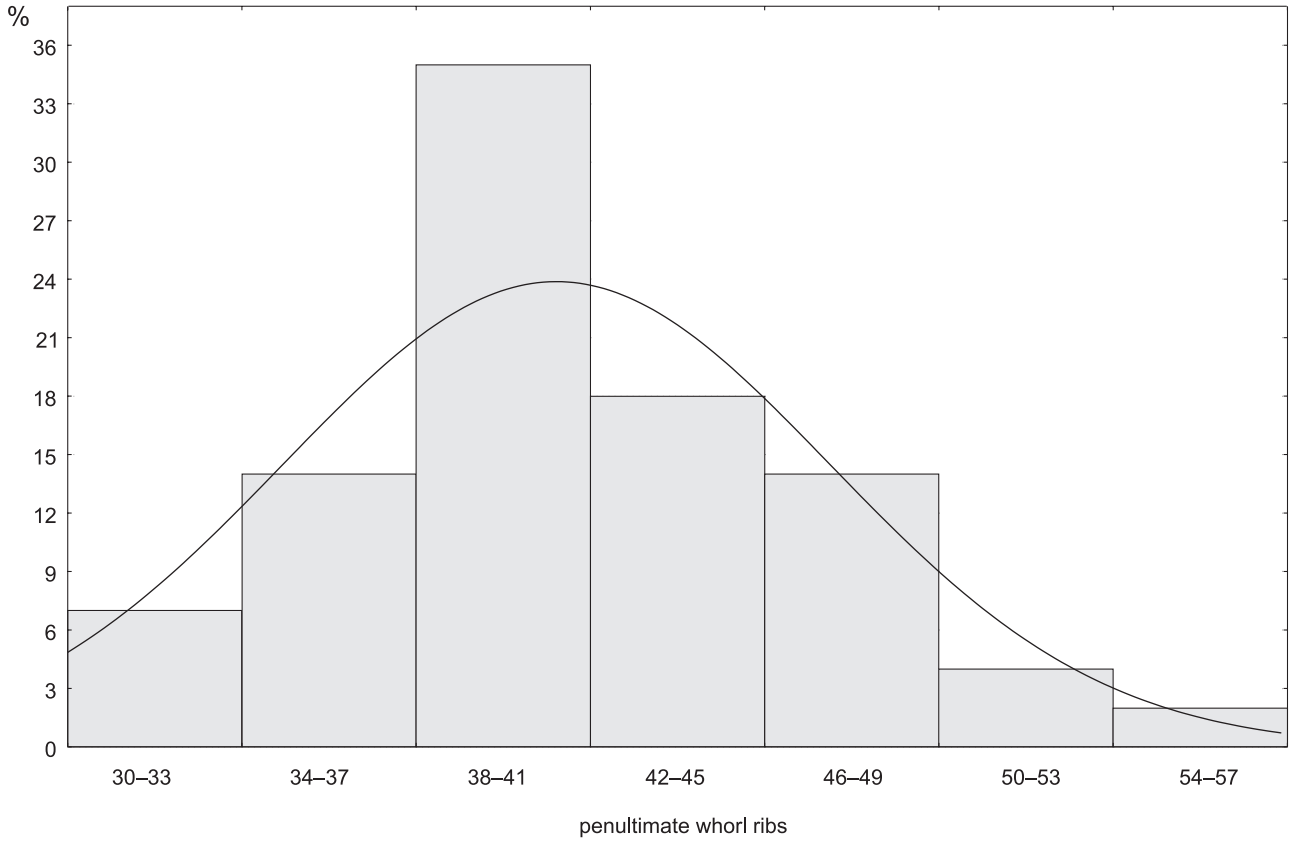

Fig. 4. Number of ribs on the penultimate whorl in the population of *Macrogastra latestriata*

euryoecious (group 7 – 11%), species of humid habitats of varied degree of shadiness (group 8 – 8%) and species of very humid habitats (group 9 – 5%).

The zoogeographical composition of the malacocoenosis is presented in Fig. 2. Montane species formed 26.9%, like C. European lowland and upland species (26.9%). The next largest group included European species (23.1%). Furthermore, Holarctic, Palaearctic, S. European and Euro-Siberian element was represented (Table 1).

The population of *Macrogastra latestriata*, which was the most abundant snail in qualitative samples, deserves a special attention. These snails were most often found on rotting logs and stumps or under loose-hanging bark of beech stumps and logs. The shell height ranged from 12.0 to 15.1 mm, the mean was 13.4 mm. The shell width was less variable (2.9–3.8 mm, mean 3.3 mm). The aperture height and width were 2.4–3.2 mm (mean 2.9) and 2.1–3.0 mm (mean 2.4), respectively. The mean number of ribs on the penultimate whorl was 41 (range 31–55). The shell height distribution (Fig. 3) and the distribution of the number of ribs (Fig. 4) in the population of *M. latestriata* from the Magura National Park was close to normal which suggests a uniformity of the population.

DISCUSSION

All the species found in the Carpathian beech forest of the Magura NP were earlier recorded from the Beskid Zachodni. Quantitative studies in two sites of combined area of 2 m^2 revealed the occurrence of 16 species. Further quantitative studies may well increase this number. For comparison, in the Carpathian beech forest of the Pieniny NP (SZYBIAK 2000), quantitative samples from three sites (combined area of 3 m^2) yielded 42 species, the numbers per site being 28, 21 and 30. Further ten species were found as a result of direct search; eight of them were clausiliids. They were found under bark of stumps, and on rotting logs, and thus absent from the litter samples. The most abundantly represented clausiliid was *Macrogastra latestriata*. It constituted 58% of all specimens found during qualitative search. Two members of Clausiliidae: *Vestia gulo* and *Balea stabilis,* found in the beech forest of the Magura NP., are Carpathian endemics. *Cochlodina laminata, C. orthostoma, Macrogastra plicatula, M. latestriata, Balea biplicata* and *B. stabilis* are typical forest-dwellers. The remaining three species are clausiliids occurring mainly in forests, but typical also of humid habitats:

Clausilia pumila, Vestia gulo and *Macrogastra tumida*. Besides the Carpathian endemics, typical Carpathian and Boreo-Alpine species are *Clausilia pumila* and *Macrogastra tumida. Balea stabilis,* an E. Carpathian species, occurs in the Magura NP near the western border of its distribution range.

The malacocoenosis of the studied beech forest has four dominant species. *Carychium tridentatum,* the superdominant, and the eudominant *Aegopinella pura,* are common in Europe. *C. tridentatum* seemed to show a clustered distribution in the litter, with up to 37 specimens in some subsamples of 25 × 25 cm. It is a very higrophilous species, abundant in litter of wet places. In the Carpathians it occurs at lower altitudes (BERGER 1963). Its high density and the superdominant status indicate very favourable conditions for the species. *C. tridentatum* is also a dominant (eudominant) in the beech forest of the Pieniny NP (SZYBIAK 2000). *Aegopinella pura* is among dominants in the Polish Carpathian beech forests (RIEDEL 1988); in the Pieniny NP it is eudominant (SZYBIAK 2000). The species diversity index H' of the studied malacocoenosis is not high. The low value of the Pielou index (J) is characteristic of communities in which only few species dominate.

Most species in the malacofauna of the beech forest of the Magura NP are forest-dwellers; the same is true of other Carpathian beech forests (DZIĘCZKOWSKI 1972, PIECHOCKI & BORCZYK 1990, SZYBIAK 2000).

In its species composition the malacocoenosis of the Magura NP is much similar to that of the beech forests of the Pieniny NP. The similarity index of Marczewski-Steinhaus is 0.364. The dominance structure of the two malacocoenoses is also rather similar. The Morisita index for the two communities is 0.389. The species diversity of the malacocoenosis from the Magura NP is much lower compared to that from the Pieniny beech forest (H' = 4.65, TDI = 0.93). The snails of the Magura NP represent the same ecological groups as those from the Pieniny, and group 9 – snails of very humid habitats. The forest species common to the two malacocoenoses are: *Ena montana, Discus rotundatus, Vitrea crystallina, V. transsylvanica, Aegopinella pura, Perforatella incarnata, P. vicina, Chilostoma faustinum* and clausiliids – *Cochlodina laminata, C. orthostoma, Macrogastra plicatula, M. latestriata, M. tumida, Clausilia pumila, Balea biplicata, B. stabilis, Vestia gulo*. In both areas forest species form the same proportion in the malacocoenoses (76% all species). Montane species, such as *Vitrea transsylvanica, Macrogastra latestriata*, *M. tumida, Balea stabilis, Vestia gulo, Perforatella vicina* and *Chilostoma faustinum*, found in the Magura NP, were also present in the Pieniny beech forest. Their proportion in the two communities was similar: 26.9% in the Magura NP and 30.6% in the Pieniny.

The most abundant clausiliid in the studied malacocoenosis was *Macrogastra latestriata*. The species inhabits mainly beech forests. It is characteristic for the Carpathian lower forest zone. There are numerous records from the Eastern and Western Carpathians. It was not recorded before from the Magurski NP – a transition betwen the Eastern and Western Carpathians. The shell parameters of specimens from the Magura NP differ from those reported by STĘPCZAK (1970) from the Western Beskidy Mts. The ranges of the shell height and width, as well as aperture height in the studied populations are wider, while the number of ribs on the penultimate whorl is smaller. In shell size the population is the closest to specimens from the foothills of the Eastern Carpathians.

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