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RUINS OF CARPATHIAN CASTLES AS REFUGES OF LAND SNAILS

RUINY ZAMKÓW KARPACKICH JAKO REFUGIA ŚLIMAKÓW LĄDOWYCH

Stefan Witold ALEXANDROWICZ

Katedra Stratygrafii i Geologii Regionalnej
Akademia Górniczo-Hutnicza, Al. Mickiewicza 30, 30–059 Kraków

Abstract Rich and diverse snail assemblages were found in the ruins of castles in the Polish Outer Carpathians. They contain 64 species, including several threatened ones. The enrichment of habitats with calcium carbonate from disintegrating walls is particularly favourable for molluscs. Two types of assemblages can be distinguished: one connected with shady places, and the other with open habitats. The occurrence of *Truncatellina cylindrica* is noteworthy because this taxon has been noted only occasionally in this region. Old ruins and their immediate surroundings are refuges for many species of land snails. That is why many of them should be protected not only as historical monuments but also as nature reserves, nature-landscape groups and areas of ecological interest.

Key words: snail communities, endangered species, protection of ruins of Carpathian castles, southern Poland

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Treść W ruinach zamków karpackich i w ich najbliższym otoczeniu występują bogate i zróżnicowane zespoły mięczaków. Obejmują one 64 gatunki ślimaków lądowych, w tym liczne gatunki uznane za zagrożone. Wyróżniono dwa typy zespołów mięczaków, z których jeden jest związany z siedliskami zacienionymi, a drugi z otwartymi. Zwraca uwagę bardzo liczne występowanie *Truncatellina cylindrica*, gatunku notowanego dotychczas w Beskidach i na Pogórzu Karpat jedynie sporadycznie. Ruiny dawnych budowli fortyfikacyjnych wraz z otoczeniem są naturalnymi refugiami dla zespołów ślimaków lądowych a zarazem prezentują znaczne walory krajobrazowe, geologiczne i inne. Zasługują one na ochronę nie tylko jako zabytki historii i kultury materialnej ale również jako obiekty przyrodnicze, takie jak rezerwaty przyrody, użytki ekologiczne i zespoły przyrodniczo-krajobrazowe.

INTRODUCTION

Many castles, towers, castellated manors and monasteries were built in the Polish Carpathians close to the southern border of the country during the Middle Ages or somewhat later. In the course of time nearly all of them fell into disrepair, were abandoned, burned and destroyed, becoming ruins or even vanishing almost without a trace. Relics of such buildings are situated along the main river valleys on hills or mountain ranges in the Carpathian Foothills and in the Beskidy Mountains. Most of them have been overgrown with forests and bushes but some rise from open areas or in towns. Only a few castles and palaces are still used and in good repair.

In mountains such as the Outer Carpathians, formed of flysch (sandstone alternating with conglomerate, mudstone and shale), brown soil and other types of acid soils poor in calcium carbonate usually occur, whereas around the remains of ancient abandoned buildings the substratum is locally enriched in lime. It comes mainly from disintegrated walls containing a considerable content of calcareous mortar cementing the stones and bricks. Such places are particularly favourable for some petrophilous and calciphilous species of plants and animals. In regions devoid of limestone, marl and dolomite, molluscan assemblages living inside the ruins are much more rich than the assemblages living in the whole surrounding area. Some endangered, vulnerable or threatened species

of snails occur mainly or even exclusively in specific habitats among disintegrated walls, while some other species have particularly rich and strong populations in such places. That is why the ruins of old castles and fortifications should be conserved not only as historical monuments but also as habitats promoting the development of certain plant and animal groups, particularly land snails. Specific habitats like these small refuges can play an important role in regional protection of selected species and populations. The values of inanimate nature are additional reasons to conserve some localities described below.

Snails inhabiting castle ruins have already been described from several localities, mainly in South Germany (Zeissler 1968, 1975, 1980; Münzig 1977; Matzke 1985; Haldemann 1990). In Poland, molluscan fauna have been recorded from such localities in the Sudety Mountains and from the Cracow–Częstochowa Upland (Wiktor 1959; Berger 1961; Urbański 1973; Pokryszko 1984), but only the fauna of the Wawel Castle in Cracow has been described in detail (S. W. Alexandrowicz 1988).

MATERIAL AND METHODS

Thirty-one ruins were considered on the basis of catalogues of castles and ancient fortifications known in the Polish Carpathians (Bogdanowski 1966; Leńczyk 1983; Marszałek 1993). Twenty of them were selected for malacological investigations. The remaining ones have been completely destroyed and their sites recultivated, ploughed, or covered with new buildings, or else they have been reconstructed and are now in use (Fig. 1).

The material was collected in 1992–1994 using standard methods (sampling of litter and soil supplemented with manual collecting of shells) described by Dzięczkowski (1977) and S. W. Alexandrowicz (1990). It comprises over 130 samples. In each of them all the specimens were identified and counted. The numbers of shells calculated versus the numbers of samples are presented as symbols on a logarithmic scale. Quantitative methods such as taxonomic analysis according to the Steinhaus formulas d_{St} and d_{SA}, the molluscan spectra MSI introduced by Ložek (1964), constancy-domination analysis, diversity indices and a few others described by the author (S. W. Alexandrowicz 1987) were used for interpretation of data. Particular taxa are listed in the order defined as the Q-index (geometric mean of constancy and domination). The same index was used to identify the species most typical of the main snail communities.

The endangerment of particular species living in ruins is assumed according to the catalogue of land snails of Poland (Riedel 1988) and the Red List of Threatened Animals in Poland (ed. Głowaciński 1992a) with regard to the data from Slovakia (Steffek 1990).

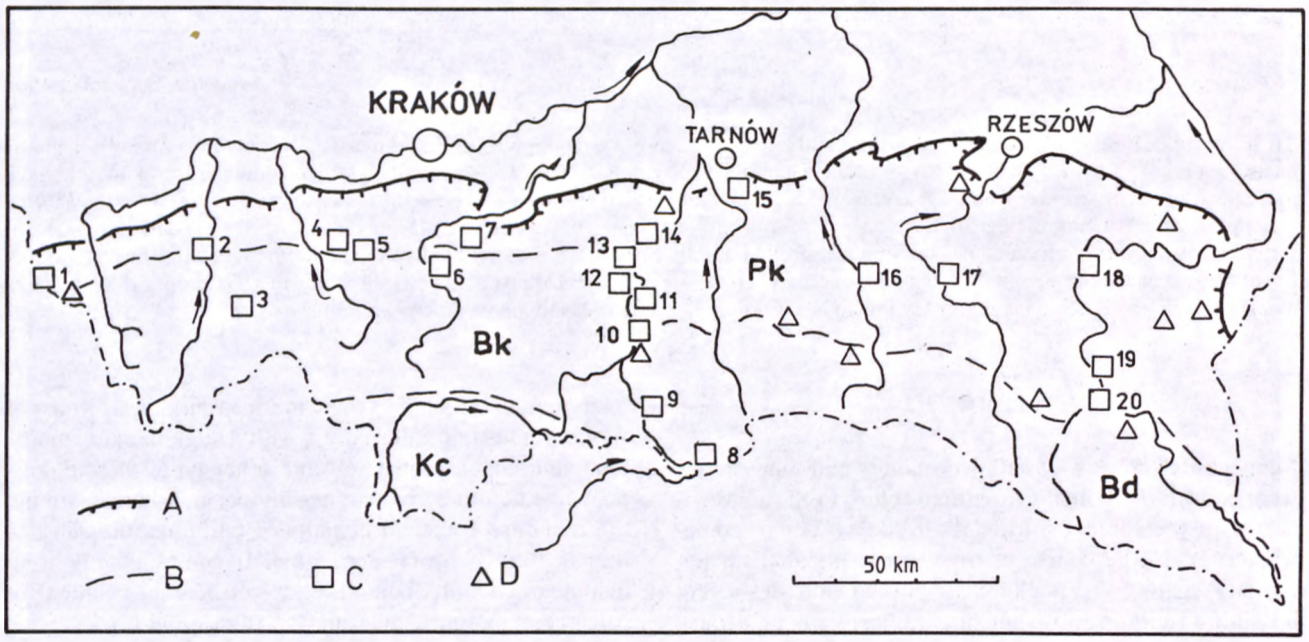


Fig. 1. Location of ruins in the Polish Outer Carpathians: A – northern border of Carpathians, B – limits of main regions of Carpathians, Pk – Carpathian Foothills, Bk – Beskidy Mountains, Bd – Bieszczady Mountains, Kc – Central Carpathians, C – ruins of castles described in the text (1–20 – numbers of particular localities), D – other ruins

Ryc. 1. Lokalizacja ruin zamków w Polskich Karpatach Zewnętrznych: A – północny brzeg Karpat, B – granice regionów fizjograficznych, Pk – Pogórze Karpat, Bk – Beskidy, Bd – Bieszczady, Kc – Karpaty Centralne, C – ruiny zamków opisane w tekście (1–20 – numery stanowisk), D – pozostałe ruiny

DESCRIPTION OF LOCALITIES

The location of the ruins presented below was shown in three ways: with coordinates according to both the UTM--system and the system proposed in the Polish Red Data Book of Animals (ed. Głowaciński 1992b), as well as directly on the map (Fig. 1). Historical data are given after Marszalek (1993).

1. **Cieszyn** (CA21, P10-g, Fig. 1–1, Tab. 1-CS)

The castle in Cieszyn is situated in the north-western part of the town on a small hill rising above the Olza River Valley. The romanesque rotunda dating from the 11th or 12th centuries, as well as a tower and fragments of walls built at the end of the 13th century, are relics of a large castle destroyed several times and pulled down at the beginning of the last century. The whole area of the Castle Hill is recently arranged and used as a park with cultivated lawns and clumps of trees and bushes. A poor molluscan assemblage has been found at the foot of the old walls among grasses with an admixture of herbs (*Urtica* sp., *Taraxacum* sp., *Chelidonium majus* and *Potentilla* sp.). It comprises 12 species represented by fairly numerous specimens. Snails typical of open habitats and mesophilous taxa are the main components of this assemblage.

2. **Kobiernice** (CA72, P11-h, Fig. 1–2, Tab. 1-KB)

The ruins of the small Wolek Castle are situated at the top of Walisko Hill on the left side of the Sola River Valley, close to its outlet from the Beskid Maly Range. Small fragments of walls as well as foundations of two buildings and a tower, built mainly of the Lgota Sandstone, are sole remains of this fortification. The castle was built in the 14th century and destroyed about 100 years later. The hill is covered with a beech forest with an admixture of firs and spruces, while the ruins are overgrown with clumps of trees and bushes (*Fagus sylvatica*, *Sambucus* sp.) and herbs (*Urtica* sp., *Chelidonium majus*). A lot of snails from more than 20 taxa occur in this site. Snails living in shady and partly shady habitats are accompanied by a few open-country species.

3. **Ślemień** (CA80, P11-k, Fig. 1–3, Tab. 1-SL)

Basements and foundations are sole remains of a castle in the Łękawka River Valley at Ślemień. The castle was built in the early 17th century and rebuilt as a residence about 100 years later. In the last century it became ruins, pulling down step by step. The relics of these ruins, situated on a flat river terrace, are surrounded by clumps of trees (*Fraxinus excelsior*, *Acer* sp., *Quercus* sp., *Tilia* sp. and *Populus* sp.) and bushes. The habitat is shady or partly shady, and humid. A poor molluscan assemblage, composed of 7 taxa, occurs in this locality. The species connected with wet habitats were found only around the ruins of the castle. They form a specific assemblage.

4. **Barwald** (DA02, P12-d, Fig. 1–4, Tab. 1-BW)

Foundations of the walls of a small fortification are found at the top of Żarek Range (former Włodkowa Góra Hill). This castle was built in the 14th century and existed a little longer than 100 years. It was damaged and became ruins at the end of the 15th century. Scarce remains of this building are completely overgrown with bushes (*Sambucus* sp., *Sorbus aucuparia*, *Ribes* sp., *Corylus avellana*). They are surrounded by a light forest with beeches, maples and firs. Molluscan fauna comprises more then 20 taxa. Among them there are abundantly occurring species of open habitats, as well as mesophilous and shade-loving snails. An interesting taxon – *Acicula parcelineata* – has been found only in this locality.

5. **Lanckorona** (DA02, P12-c, Fig. 1–5, Tab. 1-LK)

The castle crowning Góra Lanckorońska Hill was a big fortification dominating the Wieliczka Foothills. It was built in the 14th century, enlarged in the 18th century, and finally damaged in the last century. Only small fragments of walls and a tower have remained. They are surrounded (and partly overgrown) with a mixed forest (*Fagus sylvatica*, *Abies alba*, *Picea abies*, *Acer* sp.) and clumps of bushes (*Corylus avellana*, *Sambucus* sp., *Ribes* sp.). A rich snail community inhabits the site. It comprises more then 25 taxa. The strong population of *Laciniaria plicata* is characteristic of this assemblage. Open country snails are important components of the described fauna.

6. **Myślenice** (DA21, P12-i, Fig. 1–6, Tab. 1-MC)

Relics of a small ancient fortification have remained on the western slope of Mount Uklejna in Myślenice–Zarabie in the Zamczysko nad Rabą nature reserve (ed. Z. Alexandrowicz 1989). It was a watch-castle rising above the Raba River Valley upstream of a large castle in Dobczyce. The fortification was built in the 13th century and destroyed about 200 years later. Fragments of the overturned tower are visible among a mixed forest composed of *Abies alba*, *Fagus sylvatica* and *Picea abies*, with an admixture of *Carpinus betulus* and *Quercus* sp. Two plant communities: *Asplenietum trichomano-rutae-murariae* and *Asplenio viridis-cystopteridetum* have developed in this place (Jędrzejko, Stebel 1994). Molluscan fauna is rich and contains 25 species.

7. **Dobczyce** (DA32, P13-d, Fig. 1–7, Tab. 1-DB)

Remains of a large castle tower a rocky hill bounding the right bank of the Raba River Valley, just above a dam and a vast dam reservoir. The oldest part of the castle dates back to the 13th, or 14th century. Later on, the fortification was enlarged and damaged a few times. Finally, it became ruins and was partly pulled down the last century. These ruins have recently been reconstructed and designated as a historical monument. Grassland with small clumps of trees and bushes (*Sambucus* sp., *Corylus avellana*) develop among walls and fragments of old buildings.

Molluscan fauna is poor (17 taxa). It is composed mainly of open-country species. Shadow-loving and mesophilous snails are connected mainly with bushes and fragments of walls.

8. **Muszyna** (DV96, R14-l, Fig. 1–8, Tab. 1-MN)

A castle in Muszyna was built at the beginning of the 13th century as a fortification protecting the southern frontier of the country. It is situated in the southern part of Baszta Hill dominating the Poprad River Valley. The castle was partly damaged in the late 15th century but after reconstruction it filled its role for the consecutive 200 years. Finally, at the end of the 18th century, it became ruins. Some fragments of buildings and a tower have remained on the ridge crest of the hill. Among the ruins there grow bushes (*Corylus avellana*, *Ribes* sp., *Sambucus* sp.) and herbs (*Urtica* sp., *Chelidonium majus*). They are surrounded by a mixed forest with beeches, larches, pines and firs. There is a rich and diverse molluscan fauna containing more then 40 taxa in this locality, connected with microhabitats among the ruins, particularly favourable for molluscs.

9. **Rytro** (DV78, R14-h, Fig. 1–9, Tab. 1-RT)

Fragments of a round tower and walls crowning the hill at the right side of the Poprad River Valley are remains of a watch-castle in Rytro. It was built in the 13th century as a fortification dominating the valley which was then an important route through the Carpathians, linking Hungary and Poland. The castle was enlarged in the 15th century. Destroyed in the middle of the 17th century, it became ruins. A mixed forest with *Fagus sylvatica*, *Abies alba*, *Pinus sylvestris* and *Larix* sp. surrounds remains of old buildings. A rich molluscan assemblage composed of nearly 40 species occurs in this locality. Beside the numerous shells of open-country taxa, snails connected with shady and partly shady habitats are important components of this fauna.

10. **Nowy Sącz** (DV79, R14-b, Fig. 1–10, Tab. 1-NS)

Ruins of a castle dating from the 14th century are situated on a high terrace at the confluence of the Dunajec River and Kamienica Nawojowska River in the northern part of the old city of Nowy Sącz. The buildings and walls of this castle were partly damaged in the last century, then reconstructed and finally blown up during the second world war. Clumps of bushes (*Sambucus* sp., *Sorbus aucuparia*, *Corylus avellana*), grasses and herbs (*Urtica* sp., *Taraxacum* sp., *Chelidonium majus*) grow among the ruins and in the surrounding area. A poor molluscan assemblage composed of 12 taxa occurs in this place.

11. **Rożnów** (DA71, P14-h, Fig. 1–11, Tab. 1-RN)

Walls of a small castle are found on Zamczysko Hill forming the neck of an incised meander of the Dunajec River close to a dam reservoir. The fortification was built in the 14th century. It was abandoned 100 years later, becoming ruins. The place is now overgrown with clumps of bushes (*Sambucus* sp., *Sorbus aucuparia*), herbs, and partly with a light forest (*Pinus silvestris*, *Acer* sp., *Fagus sylvatica*). Both open-country snails and species connected with partly shady habitats (18 species) occur in this locality.

12. **Wytrzyszczka** (DA71, P14-g, Fig. 1–12, Tab. 1-WT)

The remains of the Tropsztyn castle crown the top of a rocky hill surrounded by a dam reservoir in the Dunajec River Valley. The fortification was raised in the later part of the 14th century and destroyed at the beginning of the 17th century. Fragments of walls and a tower have remained until now. They are overgrown with a beech forest and partly with ivy (*Hedera helix*). A snail assemblage containing 17 taxa lives in this place.

13. **Czchów** (DA71, P14-g, Fig. 1–13, Tab. 1-CZ)

Ruins of a tall round tower and foundations of walls are relics of a watch-castle crowning a hill on the left side of the Dunajec River Valley in Czchów. The castle was built at the beginning of the 14th century as a fortification and a custom at the trans-carpathian trade route. It was abandoned about 300 years later and fell into disrepair. Grassland and clumps of trees and bushes (*Pinus sylvestris*, *Acer* sp., *Robinia pseudacacia*, *Sambus* sp., *Sorbus aucuparia*) surrounding the tower form a mosaic of open and partly shady habitats with the soil enriched in decomposed calcareous mortar. Molluscan fauna embraces 20 species including xerophile and open-country snails.

14. **Melsztyn** (DA72, P14-e, Fig. 1–14, Tab. 1-ML)

Ruins of a relatively large castle are situated on the eastern tip of the ridge crest of a rocky hill raising about 40 meters above the Dunajec River Valley in Melsztyn. The castle was built in the middle of the 14th century and enlarged a few times within the next two centuries. In the late part of the 18th century it was burned, damaged and abandoned, falling into disrepair. Fragments of walls and a 25 m tower have remained until now. The hill is overgrown with a loose mixed forest with *Pinus sylvestris*, *Quercus* sp., *Acer* sp., *Carpinus betulus* and *Fraxinus excelsior*, while clumps of bushes (*Sambucus* sp., *Corylus avellana*, *Sorbus aucuparia*) and herbs grow among the remains of old buildings on the soil with a considerable content of calcareous mortar. A rich snail assemblage composed of 22 species inhabits the ruins.

15. **Tarnów** (EA03, P14-c, Fig. 1–15, Tab. 1-TR)

A large castle was founded on St. Martin's Hill about 2 km to the south of the town center of Tarnów. It dates from the early 14th century and it was modernized 200 years later. At the end of the 17th century the castle was partly abandoned, falling gradually into disrepair. Fragments of walls surrounding the ancient fortification, as well as remains of two towers and buildings are found

on the northern slope of the hill. The ruins are overgrown with clumps of bushes (*Sambucus* sp., *Corylus avellana*), grasses and herbs (*Urtica* sp., *Chelidonium majus*). A poor molluscan assemblage (12 taxa) dominated by open-country snails occurs in this locality.

16. **Krajowice** (EA31, P15-i, Fig. 1–16, Tab. 1-KR)

The ruins of the Golesz castle are situated at the top of a hill rising over the Wisloka River Valley, about 6 km northward of Jaslo. The castle was built at the end of the 13th century as a watch fortification dominating the trade route along the valley. It was burned in the 17th century and became ruins. Remains of walls with a front door and a tower rise among trees and bushes (*Quercus* sp., *Pinus sylvestris*, *Acer* sp., *Corylus avellana*, *Sorbus aucuparia*). A rich molluscan fauna inhabits this locality. The assemblage contains 22 taxa, both shade-loving and mesophilous snails. Sandstone tors, walls and corridors connected with a large landslide forming a rocky labyrinth surround the ruins (Z. Alexandrowicz, S. W. Alexandrowicz 1988). The whole of the hill, including the ancient fortifications, has been proposed as a nature reserve (Z. Alexandrowicz 1987a).

17. **Odrzykoń** (EA50, P16-k, Fig. 1–17, Tab. 1-OD)

The ruins of the large Krzemieniec castle crown a rocky hill with numerous sandstone tors in Odrzykoń – Podegrodzie near Krosno. The castle was built in the 14th century and enlarged in the early part of the 16th century. It was abandoned at the end of the 18th century, falling gradually into desrepair. It has partly been reconstructed during the last thirty years. Grasses and herbs with clumps of trees and bushes (*Quercus* sp., *Pinus sylvestris*, *Sorbus aucuparia*, *Sambucus* sp., *Crategus* sp.) grow around ruins and partly inside them. A rich molluscan assemblage containing 25 species was found in this place. The hill crowned with ruins and three groups of sandstone tors have been proposed as a nature reserve (Z. Alexandrowicz 1987a, b).

18. **Dąbrówka Starzeńska** (EA81, P17-h, Fig. 1–18, Tab. 1-DS)

Ruins of a castle, preserved as fragments of walls and a tower, are situated on the right bank of the San River Valley close to Dynów. The castle, dating from the 16th century and enlarged a few times until the last century, was finally burned and destroyed at the end of the second world war. Fragments of buildings are overgrown with grasses, herbs (*Urtica* sp., *Rumex* sp., *Plantago* sp.) and bushes (*Sorbus aucuparia*, *Sambucus* sp.). A poor molluscan assemblage composed of 11 species occurs in this locality.

19. **Monasterzec** (EV98, R17-e, Fig. 1–19, Tab. 1-MN)

The ruins of the Sobień castle crown a hill dominating the San River Valley, close to the railway station at Zaluż. The fortification was built in the middle of the 14th century and abandoned about 300 years later. Fragments of a tower with a front door, as well as remains of buildings and walls surrounding the ridge crest are remaines of this castle (Dzwonko, Zemanek 1976). Clumps of trees, bushes and herbs grow among the ruins. A beech forest with an admixture of fir and sycamore overgrowing the hill around the ruins is a nature reserve (Z. Alexandrowicz ed. 1989). A rich snail assemblage containing 18 taxa inhabits this locality.

20. **Zagórze** (EV98, R17-e, Ryc. 1–20, Tab. 1-ZG)

Ruins of a cloister dating from the 17th century and destroyed at the end of the second world war are found in Zagórze near Lesko. They are surrounded by grassland, herbs (*Urtica* sp., *Chelidonium majus*) and groups of bushes (*Sorbus aucuparia*, *Sambucus* sp.). A poor molluscan fauna (14 species) dominated by open-country snails was found in this locality.

LIST OF SPECIES

Sixty four species of land snails have been found in ruins of Carpathian castles (Tab. 1). They are ordered according to the Catalogue of the Polish Fauna (Riedel 1988).

Acicula parcelineata (Clessin), *Acicula polita* (Hartmann), *Carychium tridentatum* (Risso), *Succinea putris* (Linnaeus), *Cochlicopa lubrica* (O. F. Müller), *Cochlicopa lubricella* (Porro), *Columella edentula* (Draparnaud), *Truncatellina cylindrica* (Férussac), *Vertigo pusilla* O. F. Müller, *Vertigo pygmaea* (Draparnaud), *Vertigo alpestris* Alder, *Orcula doliolum* (Bruguière), *Pupilla muscorum* (Linnaeus), *Vallonia pulchella* (O. F. Müller), *Vallonia costata* (O. F. Müller), *Acanthinula aculeata* (O. F. Müller), *Ena montana* (Draparnaud), *Ena obscura* (O. F. Müller), *Punctum pygmaeum* (Draparnaud), *Discus rotundatus* (O. F. Müller), *Discus perspectivus* (Megerle von Mühlfeld), *Vitrina pellucida* (O. F. Müller), *Eucobresia nivalis* (Dumont et Mortillet), *Semilimax semilimax* (Férussac), *Vitrea diaphana* (Studer), *Vitrea transsylvanica* (Clessin), *Vitrea crystallina* (O. F. Müller), *Vitrea contracta* (Westerlund), *Aegopinella pura* (Alder), *Aegopinella minor* (Stabile), *Aegopinella nitens* (Michaud), *Nesovitrea hammonis* (Ström), *Oxychilus draparnaudi* (Beck), *Oxychilus orientalis* (Clessin), *Oxychilus glaber* (Rossmässler), *Daudebardia rufa* (Draparnaud), *Daudebardia brevipes* (Draparnaud), *Zonitioides nitidus* (O. F. Müller), *Euconulus fulvus* (O. F. Müller), *Cecilioides acicula* (O. F. Müller), *Cochlodina laminata* (Montagu), *Cochlodina orthostoma* (Menke), *Ruthenica filograna* (Rossmässler), *Clausilia dubia* Draparnaud, *Laciniaria plicata* (Draparnaud), *Alinda biplicata* (Montagu), *Balea perversa* (Linnaeus), *Bradybaena fruticum* (O. F. Müller), *Helicella obvia* (Menke), *Perforatella bidentata* (Gmelin), *Perforatella dibotryon* (M. V. Kimakowicz), *Perforatella incarnata* (O. F. Müller), *Perforatella vicina*

Table 1. Malacofauna of the ruins of Carpathian castles. Symbols of localities: CS – Cieszyn, DB – Dobczyce, NS – Nowy Sącz, TR – Tarnów, DS – Dąbrowka Starzeńska, CZ – Czchów, ML – Melsztyn, BW – Barwałd, ML – Myślenice, LK – Lanckorona, MN – Muszyna, RT – Rytro, KR – Krajowice, RN – Rożnów, WT – Wytrzyszczka, SL – Ślemień; number of specimens: I – 1–3, II – 4–9, III – 10–31, IV – 32–99, V – 100–316 (according to the logarythmic scale)

Tabela 1. Malakofauna ruin zamków karpackich. Symbole stanowisk i liczebności okazów – jak wyżej

No l.p.	Species Gatunek	CS	KB	SL	BW	LK	MC	DB	MN	RT	NS	RN	WT	CZ	ML	TR	KR	OD	DS	MT	ZG
1	*Truncatellina cylindrica*	II	–	–	–	III	I	III	IV	V	III	IV	III	V	V	II	–	V	III	I	V
2	*Vallonia pulchella*	III	I	I	III	III	III	II	III	IV	III	II	I	III	IV	III	III	IV	–	II	III
3	*Vitrina pellucida*	II	II	I	III	III	III	III	III	III	II	II	–	IV	IV	–	II	III	II	I	III
4	*Vallonia costata*	II	–	–	–	–	–	III	II	II	II	–	I	–	III	II	II	V	III	I	IV
5	*Laciniaria plicata*	–	–	–	III	IV	I	III	III	III	III	–	III	–	II	III	–	IV	III	III	III
6	*Punctum pygmaeum*	I	III	–	I	II	III	–	III	III	–	III	III	I	IV	–	–	II	I	I	–
7	*Alinda biplicata*	III	II	–	II	III	IV	–	I	I	III	–	–	III	–	I	III	III	I	–	–
8	*Aegopinella pura*	–	I	–	III	I	III	–	II	IV	–	III	II	–	–	–	IV	–	–	II	II
9	*Pupilla muscorum*	I	–	–	–	I	–	II	II	I	–	I	I	III	I	III	–	III	–	I	II
10	*Aegopinella minor*	I	I	–	I	I	I	I	I	II	–	II	I	–	III	–	II	II	–	–	–
11	*Discus rotundatus*	II	I	–	I	I	I	II	I	I	–	III	–	–	–	–	III	–	–	–	–
12	*Vitrea diaphana*	–	I	–	II	II	II	–	I	III	–	I	I	I	–	–	III	–	–	I	–
13	*Cochlicopa lubrica*	–	I	III	II	–	I	I	I	I	I	–	–	I	I	–	–	III	II	–	–
14	*Perforatella incarnata*	–	I	–	–	II	I	–	–	I	I	I	I	–	I	–	I	–	–	–	–
15	*Orcula dolium*	–	–	–	–	III	–	–	IV	III	–	–	–	–	–	–	–	II	–	IV	–
16	*Vertigo pusilla*	–	–	–	–	I	I	–	I	III	–	I	II	–	III	–	I	II	–	–	–
17	*Euomphalia strigella*	–	–	–	–	–	–	I	–	–	II	II	I	I	II	III	I	–	I	I	I
18	*Oxychilus glaber*	–	I	–	II	I	I	II	I	I	–	I	I	I	I	–	–	I	–	–	I
19	*Acanthinula aculeata*	–	I	–	–	–	–	–	–	I	–	II	I	–	III	–	I	–	–	I	–
20	*Cochlicopa lubricella*	III	–	–	–	–	–	I	I	I	–	–	–	I	I	–	–	I	I	–	I
21	*Vitrea crystallina*	–	I	–	I	III	I	–	III	I	–	–	I	I	I	–	–	–	–	–	–
22	*Nesovitrea hammonis*	–	–	I	–	–	I	–	I	–	–	–	–	I	II	I	–	I	II	–	I
23	*Carychium tridentatum*	–	I	–	III	–	II	–	II	–	–	–	–	–	–	–	II	I	–	–	–
24	*Acicula polita*	–	I	–	I	II	I	–	I	I	–	–	–	–	–	–	II	–	–	I	–
25	*Ena obscura*	–	–	–	II	I	–	–	–	I	–	II	–	I	–	–	I	I	–	–	–
26	*Cochlodina orthostoma*	–	–	–	–	–	I	–	I	I	–	I	–	–	–	–	I	III	–	–	–
27	*Vitrea contracta*	I	I	II	–	I	–	I	–	–	I	–	–	–	–	I	–	–	–	I	I
28	*Vitrea transsylvanica*	–	II	–	I	I	I	–	I	I	–	–	–	–	–	–	–	–	–	–	I
29	*Helix pomatia*	I	–	–	–	I	–	I	I	I	I	–	–	I	–	I	–	–	–	I	–
30	*Euconulus fulvus*	–	I	–	–	–	–	I	I	I	–	–	–	I	II	–	–	I	–	–	–
31	*Daudebardia rufa*	–	II	I	I	I	I	–	–	I	–	–	–	–	–	–	I	–	–	–	–
32	*Trichia unidentata*	–	–	–	–	–	I	–	I	II	–	–	–	II	–	–	–	–	–	–	–
33	*Clausilia dubia*	–	–	–	–	–	–	I	I	II	–	–	–	–	I	–	–	I	–	–	–
34	*Ruthenica filograna*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	III	I	–	I	–
35	*Helicella obvia*	–	–	–	–	–	–	–	–	–	–	–	–	III	II	–	–	–	–	–	–
36	*Bradybaena fruticum*	–	–	–	–	–	–	–	I	–	II	–	–	–	–	I	–	I	I	–	–
37	*Cochlodina laminata*	–	–	–	–	–	–	–	I	I	–	I	I	–	–	I	–	–	–	–	–
38	*Chilostomella faustinum*	–	–	–	–	–	I	–	I	I	–	II	I	–	–	–	–	–	–	–	–
39	*Trichia lubomirskii*	–	–	–	–	–	–	–	I	–	–	–	–	II	I	–	I	–	–	–	–
40	*Isognomostoma isognomostoma*	–	I	–	I	–	I	–	I	I	–	–	–	–	–	–	I	–	–	–	–
41	*Columella edentula*	–	–	–	–	I	–	–	I	–	–	–	–	–	–	–	I	I	–	–	–
42	*Cecilioides acicula*	–	–	–	–	–	–	–	–	–	–	–	–	III	I	–	–	–	–	–	–
43	*Arianta arbustorum*	–	–	–	–	I	I	I	I	I	–	–	–	–	–	–	–	–	–	–	–
44	*Trichia bielzi*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	I	I	–	II	–
45	*Discus perspectivus*	–	I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
46	*Succinea putris*	–	–	III	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
47	*Vertigo alpestris*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	I	–	I	I

Tab. 1 cont.

No Lp.	Species Gatunek	CS	KB	SL	BW	LK	MC	DB	MN	RT	NS	RN	WT	CZ	ML	TR	KR	OD	DS	MT	ZG
48	*Eucobresia nivalis*	–	–	–	–	I	–	–	I	I	–	–	–	–	–	–	–	–	–	–	–
49	*Perforatella bidentata*	–	–	III	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
50	*Oxychilus orientalis*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	I	I
51	*Semilimax semilimax*	–	–	–	–	I	–	–	I	I	–	–	–	–	–	–	–	–	–	–	–
52	*Perforatella dibotryon*	–	–	–	–	–	–	–	I	I	–	–	–	–	–	–	I	–	–	–	–
53	*Cepaea hortensis*	–	–	–	–	–	–	–	I	–	–	I	–	–	–	–	–	I	–	–	–
54	*Vertigo pygmaea*	–	–	–	–	–	–	–	I	I	–	–	–	–	–	–	–	–	–	–	–
55	*Balea perversa*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	II	–	–	–
56	*Oxychilus draparnaudi*	–	–	–	–	–	–	–	–	–	II	–	–	–	–	–	–	–	–	–	–
57	*Zonitoides nitidus*	–	–	II	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
58	*Trichia hispida*	I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
59	*Acicula parcelineata*	–	–	–	I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
60	*Daudebardia brevipes*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	I	–	–	–	I
61	*Perforatella vicina*	–	–	–	–	–	I	–	I	–	–	–	–	–	–	–	–	–	–	–	–
62	*Ena montana*	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	I	–	–	–	–
63	*Aegopinella nitens*	–	–	I	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
64	*Perforatella umbrosa*	–	–	–	–	–	–	–	I	–	–	–	–	–	–	–	–	–	–	–	–

(Rossmässler), *Perforatella umbrosa* (C. Pfeiffer), *Trichia hispida* (Linnaeus), *Trichia unidentata* (Draparnaud), *Trichia bielzi* (A. Schmidt), *Trichia lubomirskii* (Ślosarski), *Euomphalia strigella* (Draparnaud), *Arianta arbustorum* (Linnaeus), *Chilostoma faustinum* (Rossmässler), *Isognomostoma isognomostoma* (Schröter), *Cepaea hortensis* (O. F. Müller), *Helix pomatia* (Linnaeus).

MOLLUSCAN ASSEMBLAGES

Main types of snail assemblages have been defined on the basis of taxonomic analysis. Dendrograms corresponding with both the qualitative and semiquantitative Steinhaus formulas (d_{SI} and d_{SA} – S. W. Alexandrowicz 1987) are quite similar and the latter was used for interpretation of data (Fig. 2). Two groups of molluscan assemblages can be distinguished: one enclosing faunas from ten localities (A), and the other enclosing faunas from nine localities (B). The remaining one locality supports a specific fauna of land snails (C).

The discrimination level $d_{SA} = 0.67$ (2/3), assumed in the diagram, divides group A into several elements. The first of them is composed of snail assemblages from six localities, similar to one another (Kobiernice, Barwałd, Lanckorona, Myślenice, Muszyna, Rytro), and the second of two assemblages from Rożnów and Wytrzyszczka. The assemblages from Krajowice and Monasterzec are conjoint with all other with values of d_{SA} exceeding the accepted discrimination level. Group B comprises two subsets. The first of them is composed of three assemblages from Czchów, Melsztyn and Odrzykoń, and the other includes six assemblages from Cieszyn, Dobczyce, Monasterzec, Dąbrowka Starzeńska, Tarnów and Nowy Sącz (Fig. 2). The fauna of Ślemień markedly differs from the others.

In the snail assemblages distinguished, the proportions of particular ecological groups forming these communities are different. A considerable share of snails living in shady or partly shady habitats (EG-1, EG-2) characterizes the assemblages of group A, while open-country snails (EG-5) clearly prevail in the assemblages of group B (Fig. 3). The malacospectra from Kobierniki, Barwałd, Myślenice and Lanckorona are similar. Shadow-loving

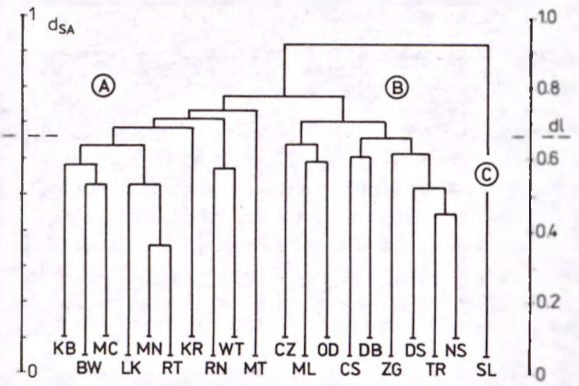


Fig. 2. Taxonomic dendrogram of snail assemblages from the ruins of Carpathian castles. A–C – types of assemblages, d_{SA} – taxonomic distance, dl – discrimination level; symbols of ruins as in Table 1

Ryc. 2. Dendrogram taksonomiczny zespołów ślimaków z ruin zamków karpackich. A–C – typy zespołów, d_{SA} – odległość taksonomiczna, dl – poziom dyskryminacji zbioru; symbole ruin jak w objaśnieniach do tabeli 1

snails of ecological groups EG-1 and EG-2 and mesophilous snails of ecological group EG-7 clearly prevail, reaching 40–60% and 30–50% of all the specimens, respectively, while open-country species are a subordinate component of these assemblages. The assemblages from Muszyna and Rytro have nearly the same molluscan spectra. They contain about 30% woodland snails, 20–30% mesophile snails and about 50% species connected with open habitats. In the remaining assemblages of group A relations between the main ecological components are somewhat different (Fig. 3–A).

In group B the molluscan spectra of assemblages are dominated by open-country snails. This component constitutes more then 60% in five assemblages (Czchów, Melsztyn, Odrzykoń, Monasterzec, Tarnów), while in the remaining four assemblages the proportions of specimens representing ecological groups EG-5 and EG-7 are more equalized. Snails living in partly shady habitats form an important fraction only in the assemblages from Cieszyn and Nowy Sącz (Fig. 3–B). A considerable number of snails connected with humid places (EG-3, EG-9) are characteristic of the malacospectrum of the fauna from Ślemień (Fig. 3–C).

Species typical of these two groups of assemblages (A and B) can be distinguished using the index Q (geometric mean of constancy and domination: $Q = \sqrt{C \cdot D}$). Differences between values of this index, characterizing each taxon in localities of both groups, are calculated according to the general differential formula:

$$T_i = (Q_B - Q_A)/(Q_B + Q_A).$$

The most typical species of these groups correspond with intervals A_2 and B_2 (absolute values of T_i: 0.75–1.00), respectively, while species less typical correspond with intervals A_1 and B_1 (absolute values of T_i: 0.40–

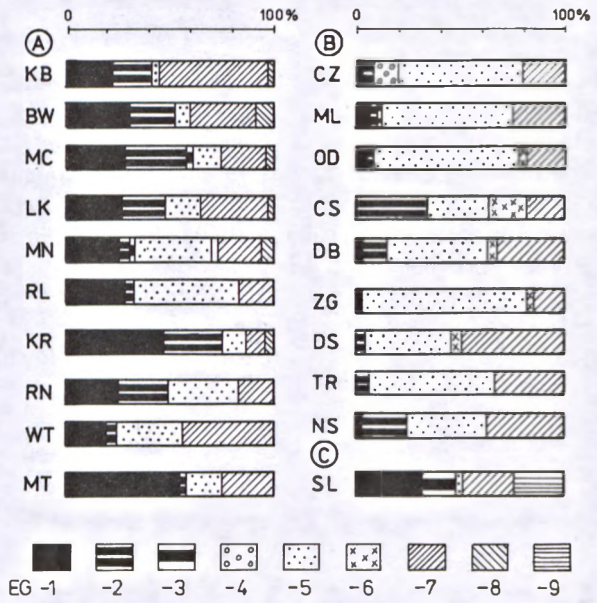


Fig. 3. Malacospectra (MSI) of snail assemblages from the ruins of Carpathian castles. A–C – assemblages distinguished according to the taxonomic diagram (symbols of ruins as in Table 1), EG – ecological groups of molluscs: 1 – woodland snails, 2 – snails of partly shady habitats, 3 – snails of moist forests, 4 – xerophilous species, 5 – open-country snails, 6 – mesophilous snails of dry habitats, 7 – species of moderately humid habitats, 8 – species of humid habitats, 9 – higrophilous snails

Ryc. 3. Spektra malakologiczne (MSI) zespołów ślimaków z ruin zamków karpackich. A–C – zespoły wyróżnione na diagramie taksonomicznym (symbole stanowisk jak w tabeli 1), EG – grupy ekologiczne: 1 – ślimaki leśne, 2 – ślimaki siedlisk częściowo zacienionych, 3 – ślimaki wilgotnych lasów, 4 – gatunki kserofilne, 5 – ślimaki środowisk otwartych, 6 – ślimaki mezofilne środowisk suchych, 7 – gatunki środowisk średnio-wilgotnych, 8 – gatunki środowisk wilgotnych, 9 – ślimaki hygrofilne

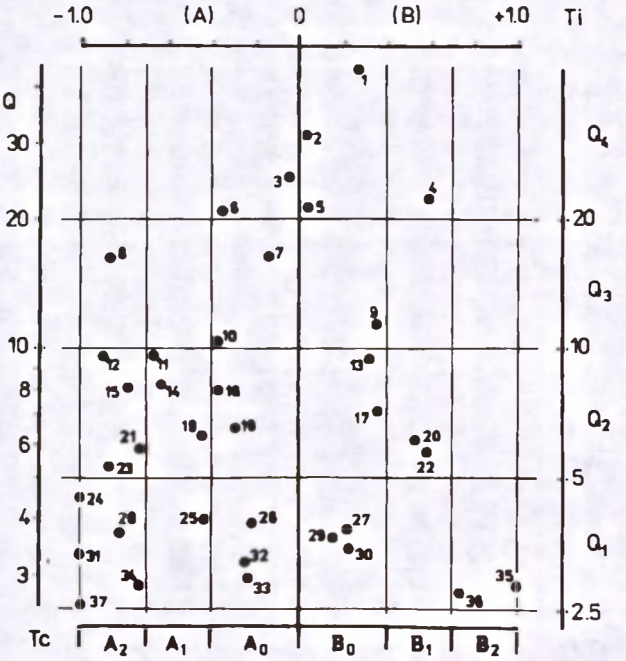


Fig. 4. Discrimination diagram of species characteristic of molluscan assemblages A and B. 1–37 – species of molluscs according to Tab. 1; Q – ordering index (geometrical mean of constancy and domination), Q_1–Q_4 – intervals of Q-index, T_i – values of discrimination formula, Tc – intervals of T_i (A_0–A_2, B_0–B_2); A_2, B_2 – species most typical of assemblages A and B; A_1, B_1 – species less typical of assemblages A and B; A_0, B_0 – species not distinctive of assemblages A and B

Ryc. 4. Diagram dyskryminacyjny gatunków charakteryzujących zespoły A i B. 1–37 – gatunki mięczaków wg tab. 1; Q – wskaźnik porządkujący (średnia geometryczna stałości i dominancji), Q_1–Q_4 – przedziały wskaźnika Q, T – wartości formuły dyskryminacyjnej, Tc – przedziały T_i (A_0–A_2, B_0–B_2); A_2, B_2 – gatunki typowe dla zespołów A i B; A_1, B_1 – gatunki mniej typowe dla zespołów A i B; A_0, B_0 – gatunki nie wyróżniające

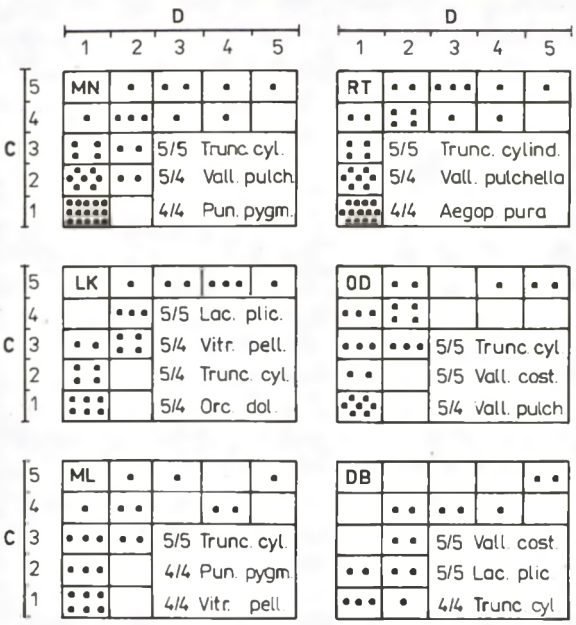
–0.75). All of them are ordered according to Q values in intervals Q_1–Q_4 (Fig. 4). The T_i index is somewhat similar to the fidelity index used in phytosociology and hydrobiology.

The first group of localities (A) is characterized by 8 taxa reaching values exceeding Q = 5 (Q_2 – Q_4) (columns A_2 and A_1). Five species reaching these values represent the interval A_2. The most typical one is *Aegopinella pura* found in almost all localities of this group (Q_3), while *Vitrea diaphana*, *Orcula doliolum*, *Vitrea crystallina* and *Carychium tridentatum* belong to the interval Q_2 and they occur less common. Three other species (*Discus rotundatus*, *Perforatella incarnata*, *Anacthinula aculeata*) are placed in the field A_1 – Q_2. All of them, except for *Carychium tridentatum*, are snails of ecological groups EG-1, or EG-2 living in shady and partly shady habitats. Characteristic of the second group of localities (B) is *Vallonia costata* reaching high values of T_I and Q (B_1–Q_4). Two other species: *Cochlicopa lubricella* and *Nesovitrea hammonis* are situated in the field B_1–Q_2. Snails reaching the highest Q values (Q_4, Q_3) belong to intervals A_0 and B_0 and they occur in localities of both groups (Fig. 4).

Shannon-Weaver's diversity index (H') related to Pielou's equitability index (J) (Dyduch-Falniowska 1988), as well as the Simpson index (ADI) redefined by S. W. Alexandrowicz (1987) were used in the present analysis (Fig. 5). No significant correlation between indices H' and J' was found (r = 0.32). Three sets of samples can be distinguished on the diagram (Fig. 5–I). The first one is connected with habitats favourable for molluscs (a), the second (b) with places influenced by human activity, while the third (C) with environments inhabited by rich (H' = 3.2–3.6) and fairly rich assemblages (H' = 2.8–3.2). Index ADI and the number of taxa (N_t) are not significantly correlated (r = 0.12). Two jointed assemblages (8 and 9 – set a) are the most rich ones, containing more than thirty species each. The largest set (b) encloses differentiated but not very rich assemblages (high values of ADI and low values of Nt, while the remaining one (c), assemblages characterized by relatively low values of ADI index (Fig. 5–II).

The two groups of snail assemblages (A and B) are distinguishable by both pairs of indices. Assemblages with a considerable share of woodland species (group A) are clearly more differentiated than assemblages dominated by open-country species (group B). Thus, species diversity seems to be governed mainly by geobotanical conditions and human impact. Similar differentiation was observed by Dyduch-Falniowska (1991) in the Tatra Mountains.

Snail assemblages living in the described localities have a different structure of constancy and domination (C–D). Six of them can be taken as examples (Fig. 6). A few species usually reach high classes of C and D (5–5, 5–4, 4–4) in the whole material. Such taxa as *Truncatellina cylindrica*, *Laciniaria plicata*, *Vallonia pulchella* and *Vallonia costata* can be pointed out as species characteristic of particular assemblages. These species can be accompanied by *Vitrina pellucida*, *Punctum pygmaeum*, *Aegopinella pura*, *Orcula doliolum* and *Alinda biplicata* reaching also high values of these indices. A large number of species assigned to class 1–1



Ryc. 5. Diagramy wskaźników różnorodności fauny. I – wskaźnik Shannona-Weavera (H') w stosunku do wskaźnika Pielou (J'), II - zmodyfikowany wskaźnik Simpsona (ADI) w stosunku do ilości gatunków (N_t), a–c – grupy zespołów, 1–20 – numer stanowisk (jak na ryc. 1)

Fig. 5. Diagrams of differentiation indices. I – index of Shannon-Weaver (H') versus Pielou's index (J'), II – Simpson's modified taxon diversity index (ADI) versus the number of taxa (N_t), a–c – groups of assemblages, 1–20 – numbers of localities (as in Fig. 1)

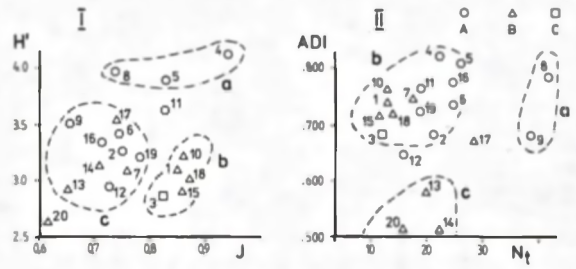


Fig. 6. Diagrams of constancy and domination of species in selected localities. C1–C5 – classes of constancy, D1–D5 – classes of domination; symbols of ruins as in Tab. 1

Ryc. 6. Diagramy stałości i dominacji gatunków w zespołach z wybranych stanowisk. C1–C5 – klasy stałości, D1–D5 – klasy dominacji, symbole stanowisk jak na tab. 1

occur in rich assemblages characterized by high values of diversity indices (Fig 6–MN, –RT).

The *Truncatellina-Vallonia*, *Truncatellina-Punctum*, and the *Laciniaria-Truncatellina-Vitrina* faunas are distinguished as the most typical ones (Fig. 6). In a few localities assemblages dominated by *Alinda* (*Alinda biplicata*) or *Perforatella* (*Perforatella incarnata*, *Perforatella bidentata*) occur. They have been distinguished as *Alinda-Vallonia* and *Perforatella-Succinea* faunas. The distribution of these types of snail assemblages depends mainly on geobotanical and ecological conditions among ruins and around them.

Frequencies of species constancy and domination in snail assemblages usually change exponentially (Dyduch-Falniowska 1991). In the whole analyzed material only the domination index clearly corresponds with this model, while the index of constancy declines nearly linearly (Fig. 7–II). This means that the distribution of particular taxa is relatively uniform, while the number of specimens remains more variable. These indices calculated as general constancy and general domination point out to the most important components of snail assemblages inhabiting ruins (Fig. 7–I).

The domination of six species exceeds 5% (D3–D5) and eleven species belong to the two highest classes of constancy (C4, C5). *Truncatellina cylindrica* is clearly the most common one. It is a palearctic (west-palearctic) taxon widespread in the whole Europe, except for its northern part. Dry sunny places with soil enriched with calcium carbonate, rocky background and rocky detritus covered with xerothermic grasslands are habitats particularly favourable for this snail. The species occurs in most regions of Poland, mainly in the Sudety Mountains and the Małopolska Upland (Riedel 1988; Pokryszko 1990).

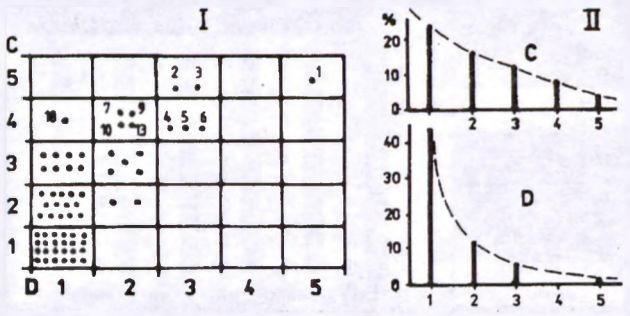


Fig. 7. Indices of species constancy and domination in the whole analysed material. I – values of indices for particular species, 1–18 – numbers of species (according to Table 1), C1–C5 – classes of constancy, D1–D5 – classes of domination; II – distribution of values of constancy indices (C) and of domination indices (D)

Ryc. 7. Wskaźniki stałości i dominacji gatunków w całym analizowanym materiale. I – wartości wskaźników poszczególnych gatunków, 1–18 – numery gatunków (według tabeli 1), C1–C5 – klasy stałości, D1–D5 – klasy dominacji; II – rozkłady wskaźników stałości (C) i dominacji (D)

In the Beskidy Mountains and in the Carpathian Foothills it was noted only in a few localities, especially along outcrops of limestone and marl of the Silesian and Skole Nappes (W. P. Alexandrowicz 1994). Ruins of old castles seem to be particularly suitable for the development of rich populations of *Truncatellina cylindrica*.

Vallonia pulchella and *Vitrina pellucida* are next to *Truncatellina cylindrica* significant components of this fauna reaching indices C5–D3 (Fig. 7–I). They are holarctic species widespread in the whole Europe, living in open or partly shady habitats such as grasslands, loose forests and bushes, in moderately dry habitats and in sunny, dry places. In the Polish Outer Carpathians these two taxa were noted in several localities (Riedel 1988), whereas assemblages collected between ruins are particularly rich in these snails. Three other species: *Vallonia costata*, *Laciniaria plicata* and *Punctum pygmaeum* (C4–D3) form strong populations in some described ruins (Fig. 7–I).

The group of 24 species encloses subrecedents and accidents (C1–D1). These molluscs have been found only in one or in a few localities. These are taxa connected with specific habitats (xerophilous or higrophilous snails), as well as snails included in the red list (ed. Głowaciński 1992). These species classified as endangered (E) or vulnerable (V) are of special interest:

Balea perversa (E) – a west-european species known also from the Middle Europe (Germany, Czech Republic and Western Slovakia). In Poland it was found in a few places in the Sudety Mountains and in one isolated locality in Odrzykoń near Krosno (Bąkowski, Łomnicki 1892; Riedel 1988).

Trichia lubomirskii (V) – a species living in Western Carpathians as well as in Silesia and Małopolska Upland.

Trichia bielzi (V) inhabits mainly Eastern Carpathians. In Poland it is known only from the Bieszczady Mountains, Beskid Niski Range and from the eastern part of the Carpathian Foothills.

Perforatella dibotryon (V) is a species distributed similarly to *T. bielzi* but it occurs also in the Beskid Sądecki and Beskid Wyspowy Ranges, reaching as far as the Raba River Valley.

Discus perspectivus (V) – a snail living in Balkans, Carpathians and Eastern Alps, noted in southern Poland but much rarer in present malacocoenoses than in holocene sediments.

Ten species reckoned among rare (R) on the list of threatened snails were found in ruins of Carpathian castles. Two of them: *Oxychilus glaber* and *Orcula doliolum* have indices of constancy and domination C4–D1 and C2–D2, while the others only C1–D1 (*Semilimax semilimax*, *Eucobresia nivalis*, *Cecilioides acicula*, *Oxychilus orientalis*, *Daudebardia brevipes*, *Acicula parcelineata*, *Perforatella umbrosa* and *Aegopinella nitens*).

Two species: *Oxychilus draparnaudi* and *Helicella obvia* are connected in Central Europe with areas

influenced by human activity. The first of them is noted mainly in towns, while the second in waste land and degraded habitats. Both came from the south during the Late Holocene or even in the historical times (S. W. Alexandrowicz, W. P. Alexandrowicz 1995).

BIOMETRY OF POPULATIONS OF SELECTED SPECIES

Some populations were analyzed using biometrical methods described by the author (S. W. Alexandrowicz 1987). Measured were the following dimensions of shells: H – height of shell, B – breadth of shell, h – height of aperture, b – breadth of aperture, L – height of the last whorl, D – diameter of shell (the largest diameter). Additionally, indices of shape (H/B, L/H, h/b) were calculated. Values of arithmetic mean, standard deviation and standard error of selected features are presented on the diagram (Fig. 8 – x, s, b). Nearly all sets of data have the normal distribution verified with the Kolmogorov test.

Truncatellina cylindrica. Populations from Muszyna, Rytro, Czchów, Melsztyn and Odrzykoń containing about 100 specimens each are characterized below. Mean values of shell size (H) range from 1.73 mm to 1.82 mm. They are greater then those given by Pokryszko (1990) from the Sudety Mountains. Values H and B are significantly correlated in each population but their differentiation is relatively low (c_V = 4.40–5.60). The height of shells is twice their breadth – indices of elongation H/B usually reach about 2.1, while indices of L/H are the same in the whole material. The population from Melsztyn encloses specimens significantly larger then the populations from Rytro, Odrzykoń and Muszyna, and somewhat larger then the population from Czchów (Fig. 8).

Laciniaria plicata. The populations from Lanckorona, Myślenice, Muszyna and Odrzykoń (45–70 specimens each) are characterized by shells of a different size (mean H values are 14.80–16.30 mm). The specimens from Odrzykoń are significantly larger then the specimens from the Wieliczka Foothills, particularly from Dobczyce, living in a habitat strongly influenced by human activity. The main indices of shape (H/B, L/H, h/b) are less differentiated (Fig. 8).

Alinda biplicata. The populations from Muszyna and Krajowice (52 and 64 specimens, respectively) comprise shells nearly the same in size. They differ in the shape of aperture, which is significantly less elongated than in the first mentioned population (Fig. 8). Populations characterized by similar features were described from Wawel Hill in Cracow (S. W. Alexandrowicz 1988).

Balea perversa. The population from Odrzykoń, one and the only in the Polish Carpathians, is characterized by relatively small specimens. The mean value of shell height (H) is 7.64 mm, and that of shell breadth (B), 1.33 mm. Shells in the control population from the Sudety Mountais are significantly larger; they reach H – 8.32 mm and B – 1.53 mm (Fig. 8). They are also more elongated then specimens from Odrzykoń, but indices L/H and h/b are nearly the same in both populations.

Other species. The relatively rich population of *Ruthenica filograna* occurs in Krajowice. The mean value of shell height (H) is 7.90 ±0.14 mm; the range of this feature is 7.32–9.22 mm. Specimens living in the Cracow Upland are somewhat larger, just as shells found in Holocene sediments in this region.

Interesting populations of two species inhabit Kamieniec Hill in Odrzykoń. The first of them – *Chilostoma faustinum* – contains relatively small specimens with the

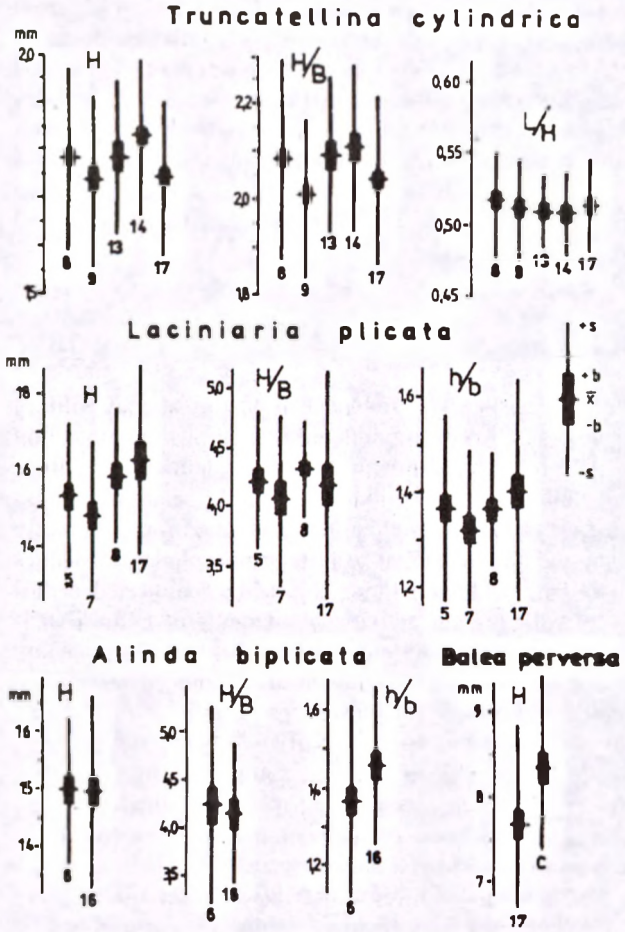


Fig. 8. Biometrical features of selected populations. H – shell height, h – height of aperture, H/B – index of elongation, L/H – index of the shape of a last whorl, h/b – index of aperture shape, 5–17 – numbers of localities (as in Fig. 1), x̄ – arithmetic mean, b – interval of standard error, s – interval of standard deviation (both on the confidence level ,05)

Ryc. 8. Cechy biometryczne wybranych populacji. H – wysokość skorupki, h – wysokość ujścia, H/B – wskaźnik wydłużenia skorupki, L/H – wskaźnik kształtu ostatniego skrętu, h/b – wskaźnik kształtu ujścia, 5–17 – numery stanowisk (jak na ryc. 1), x̄ – średnia arytmetyczna, b – przedział błędu standardowego, s – przedział odchylenia standardowego (oba na poziomie ufności ,05)

mean diameter of 15.4 ±0.3 mm. Populations of this species living in the Tatra Mountains, Pieniny Mountains and the Cracow Upland are composed of larger specimens exceeding 15–20 mm in diameter, with the mean value of 16–17 mm at least. The other population from Odrzykoń encloses specimens of *Pupilla muscorum*, their mean height (H) is 2.96 ±0.08 mm and the range of this feature 2.74–3.16 mm These are relatively small specimens as compared with those described from many other localities where shells are to 0.5 mm larger. Specimens collected on dumps of the soda factory in Cracow – a typical anthropogenic and polluted habitat – reach the mean height (H) 3.35 ±0.08 mm with the range 2.38–3.98 mm (S. W. Alexandrowicz 1990).

The strong populations of *Vallonia pulchella* from Rytro, Melsztyn and Odrzykoń, as well as those of *Vallonia costata* from Odrzykoń and Zagórze resemble many others measured and described from several localities (a.o. from the soda dumps in Cracow). The mean value of shell diameter in *Vallonia pulchella* is 2.37–2.42 mm, and in *Vallonia costata* 2.30–2.32 mm with relatively low values of the differentiation index (c) in all populations in question (3.60–5.85).

RUINS OF CASTLES AND NATURE CONSERVATION

Ruins of castles are protected as historical and cultural monuments. According to legal regulations the protection of such objects is limited to walls, remains of buildings and ancient fortifications without special regard to animate and inanimate nature inside and around them (to plant and animal life, as well as geomorphological values of the site). Though these objects are connected exclusively with human activity as elements of cultural landscape, most of them, abandoned for a few centuries, are places of more or less advanced ecological succession. Snail communities inhabiting these sites, as well as populations of selected species, particularly threatened ones, should be also objects of conservation. In some localities other values such as sandstone tors, geological outcrops, interesting plants or animals communities are additional reasons to protect these sites.

Three forms of protection can be used to preserve malacocoenoses and biotopes connected with relics of Carpathian castles: nature reserve, area of ecological interest and nature-landscape group. This last form seems to be the most appropriate. Among the surveyed ruins two are in the existing nature reserves, and two in areas of projected and well documented nature reserves. Four ruins are situated in towns in the area of public parks. All others are not protected as yet. Ten of them, as shown below, are quite important and interesting sites of natural history, deserving legal protection.

Molluscan assemblages described from the existing and proposed nature reserves, enclosing ruins of castles, supplement the knowledge of the fauna inhabiting these areas. They can be regarded as additional elements justifying protection of these sites.

The snail community from the Zamczysko nad Rabą nature reserve in Myślenice contains a rich population of *Alinda biplicata*. Snails of shady, partly shady and open habitats, forming this assemblage, occur in nearly equal proportions. They are connected with plant communities characterized in detail by Jędrzejko and Stebel (1994). No threatened snail species have been found in this locality.

The assemblage found in the Góra Sobień nature reserve in Monasterzec comprises three taxa included in the red list: *Trichia bielzi*, *Oxychilus orientalis* and *Orcula doliolum*. The two first occur in the eastern part of Carpathians, while the last one, as a meridional element, is known from a few localities in the Polish Carpathians, as well as from the Sudety Mountains and Małopolska Upland (Riedel 1988; Pokryszko 1990). The snail community composed of shade-loving species with a considerable admixture of open-country and mesophilous species corresponds with vegetation described by Dzwonko and Zemanek (1976).

Relics of the medieval Golesz castle in Krajowice are situated inside the projected nature reserve (Z. Alexandrowicz 1987a). A spectacular rocky labyrinth with sandstone tors and walls connected with a large structural landslide, described by S. W. Alexandrowicz and Z. Alexandrowicz (1988), is a chief reason to protect the site. The snail community is rich and contains three threatened species. Two of them: *Perforatella dibotryon* and *Trichia bielzi* represent the East-Carpathian element, while the third *Daudebardia brevipes* is distributed in Poland both in the Carpathians and in the Sudety Mountains (Riedel 1988). A fairly rich population of *Ruthenica filograna* is another noteworthy feature of this assemblage.

The projected nature reserve in Odrzykoń encloses Kamieniec Hill crowned with ruins. Three groups of sandstone tors are the most interesting objects of inanimate nature (Z. Alexandrowicz 1987a, b). The molluscan fauna inhabiting this area contains four threatened taxa. One of them – *Balea perversa* – signalized as endangered species is particularly worthy of notice. Found in this place more then 100 years ago (Bąkowski, Łomnicki 1892) it is still living there. The occurrence of the population of *Balea perversa*, characterized by relatively small specimens, can be an important reason to create a nature reserve in Odrzykoń. Rich populations of a few other species live in the described ruins. Beside species analyzed by biometrical methods (*Laciniaria plicata*, *Truncatellina cylindrica*, *Vallonia pulchella*, *Vallonia costata*), there are *Cochlodina orthostoma*, *Pupilla muscorum* and *Cochlicopa lubrica*.

Ruins of castles situated in towns are usually enclosed in public parks. Grassland with clumps of trees and bushes, more or less cultivated, surround fragments of walls and old buildings. Snail assemblages living in such habitats, created, cultivated and strongly influenced by

man are relatively poor and unsufficiently known. In the four described localities (Cieszyn, Dobczyce, Nowy Sącz, Tarnów) snail assemblages are similar. They are composed mainly of *Vallonia pulchella*, *Vallonia costata*, *Truncatellina cylindrica* and *Helix pomatia*. Fairly rich populations of *Alinda biplicata* or *Laciniaria plicata* can be found too, while threatened taxa are nearly completely absent. The same type of the fauna was formerly described from Wawel Castle Hill in Cracow (S. W. Alexandrowicz 1988). These localities are protected by local regulations, which guarantee a certain degree of stability for the habitats. Protection of snail assemblages is not necessary in this case. The same refers to the poor malacocoenoses from Ślemień and Dąbrówka Starzeńska.

Proposals to protect ten areas containing ruins of old castles and fortifications will be presented with regard to their natural values. There are projects to create one nature reserve and five nature-landscape groups, supported by malacological, geomorphological and geological values of these objects, as well as four areas of ecological interest (for environmentally responsible use), described as places inhabited by interesting snail communities.

Góra Lanckorońska Hill – a proposed nature reserve (Fig. 1–5). It is a lofty hill dominating the landscape of the western part of the Wieliczka Foothills. Its narrow ridge crest and steep slope falling about 150 m to the north are covered with a mixed forest. A pretty village with a center established as a monument of traditional architecture extends at the foot of the low, southern slope of the hill. There are two main reasons to conserve this small range. The snail assemblage living in ruins at the top of the hill is rich and differentiated. It contains four threatened species: *Orcula doliolum*, *Oxychilus glaber*, *Semilimax semilimax* and *Eucobresia nivalis*, as well as numerous important taxa, such as *Acicula polita* and *Laciniaria plicata*. The population of this last species seems to be one of the richest and strongest in the Polish Carpathians. Moreover, Lanckorona is a famous geological locality. An instructive profile of the Cretaceous flysch of the Silesian Nappe is accessible along a narrow gorge crossing the northern slope of the hill. There are red shales, radiolarites and the whole sequence of the Lgota Beds forming the limb of inversed antycline. The Subsilesian Nappe crop out in the tectonic window described from the area around the village, mainly from its eastern part. Beside gaize-type sandstone (unique in Carpathians) and fossiliferous sandstone with Ostrea, a small intrusion of porphyrite and a block of gneiss can be pointed out as geological objects worthy of notice (Książkiewicz 1951). A scientific and educational path, very instructive for both tourists and students, should be traced there. To determine precisely the boundaries of the proposed nature reserve supplementary studies are needed.

Baszta Hill in Muszyna – a proposed nature-landscape group (Fig. 1–8). A narrow ridge crest surrounded with steep slopes rises about fifty meters above the Krynica-czanka, Poprad and Szczawnik River Valleys. Outcrops of sandstone and conglomerate typical of the Piwniczna Sandstone Member (the Magura Formation of the Magura Nappe) run along this ridge forming a rocky wall at the southern tip of the hill. The snail assemblage living on the ridge crest in ruins is rich and interesting. It encloses seven threatened species, two of them noted as vulnerable (*Trichia lubomirskii* and *Perforatella dibotryon*) and five, as rare (*Orcula doliolum*, *Semilimax semilimax*, *Eucobresia nivalis*, *Oxychilus glaber*, *Perforatella umbrosa*). The strong populations of *Laciniaria plicata* and *Truncatellina cylindrica*, as well as the populations of two species characterized by relatively small specimens (*Chilostoma faustinum* and *Pupilla muscorum*) are components of this assemblage. Great values of both animate and inanimate nature are main reasons to conserve Baszta Hill. It is attractive for tourists and can be included in the educational trail passing through the nature reserve Obrożyska at the other side of the Szczawnik River Valley. Important geological sites in Zlockie, proposed for conservation, should also be included in this educational trail.

Castle Hill in Rytro – a proposed nature-landscape group (Fig. 1–9). The hill surrounded with steep, partly forested slopes rises about 120 m above the bottom of the Poprad River Valley, as a distinct component of the landscape. Outcrops of coarse-grained sandstone (the Piwniczna Sandstone Member of the Magura Formation) are visible on these slopes, as well as along the crest of the narrow ridge running south-east on the right side of the valley. The molluscan assemblage living among the ruins at the top of the hill comprises 7 threatened species: *Discus perspectivus*, *Trichia lubomirskii*, *Perforatella dibotryon*, *Orcula doliolum*, *Semilimax semilimax*, *Eucobresia nivalis* and *Oxychilus glaber*. The first three species are noted as vulnerable (ed. Głowaciński 1992a). The strong populations of *Truncatellina cylindrica* and *Vallonia pulchella* occur in this place. This relatively rich snail assemblages should be protected together with its habitat. The described locality can be also included into the educational path popularizing a few interesting geological sites together with the rocky range.

Zamczysko Hill in Rożnów – a proposed nature-landscape group (Fig. 1–11). It is a narrow ridge surrounded by the meander of the Dunajec River, deeply incised. Molluscan fauna with the threatened *Oxychilus glaber* and a few other interesting taxa (*Euomphalia strigella*, *Cochlodina orthostoma*, *Chilostoma faustinum*) inhabiting partly shadowed ruins is noteworthy. It accounts for the protection of this locality, situated within a characteristic element of the landscape close to a large dam reservoir.

The hill in Wytrzyszczka – a proposed nature-landscape group (Fig. 1–12). A snail community with *Oxychilus glaber* and rich populations of *Truncatellina cylindrica* and *Laciniaria plicata* inhabits the rocky headland protruding into a dam reservoir at its western shore. Both

landscape and malacological values justify protection of this locality.

Castle Hill in Melsztyn – a proposed nature-landscape group (Fig. 1–14). The narrow ridge crest of a hill dominating the Dunajec River Valley at its left bank has steep, partly rocky slopes, forming an interesting component of the landscape, typical of the Rożnów Foothills built of the Istebna and Ciężkowice Sandstone. Outcrops of coarse-grained sandstone of the Istebna Beds are visible in a few places. A rich molluscan assemblage living among ruins contains 3 threatened species (*Trichia lubomirski*, *Oxychilus glaber*, *Cecilioides acicula*), as well as the particularly strong population of *Truncatellina cylindrica* accompanied by populations of *Vallonia pulchella*, *Acanthinula aculeata*, *Vitrina pellucida* and *Punctum pygmaeum*. This fauna and the values of inanimate nature account for the conservation of this area either as a nature-landscape group (proposed here) or even as a nature reserve, according to the proposal by Denisiuk (1993).

The four localities: **Kobiernice, Barwald, Czchów** and **Zagórze** are proposed as areas of ecological interest for environmentally responsible use. Two types of snail assemblages should be protected in these areas. The first of them includes shadow-loving and mesophilous snails with a few threatened species (*Acicula parcelineata*, *Discus perspectivus*, *Oxychilus glaber*). It occurs at the top of Walisko Hill in Kobiernice and Żarek Range in Barwald near Kalwaria Zebrzydowska (Fig. 1–2, 1–4). The other type of assemblage, dominated by open-country snails is connected with the ruins in Czchów and Zagórze (Fig. 1–13, 1–20). Beside the strong populations of *Truncatellina cylindrica* and specimens of *Oxychilus glaber*, it contains such taxa as *Trichia lubomirskii*, *Cecilioides acicula* and *Helicella obvia* (Czchow), or *Oxychilus orientalis* and *Daudebardia brevipes* (Zagórze). All these molluscan assemblages are not very rich but typical of these habitats.

CONCLUSIONS

The snail assemblages inhabiting the ruins of castles in the Polish Outer Carpathians are rich and diverse. The walls of old buildings and fortifications, as well as soil enriched with calcium carbonate, are the main factors favouring the occurrence of molluscs in these localities. Two types of assemblages have been distinguished: one connected with shady places, and the other with open ones. Both have developed in the course of plant succession within a few hundred years after the castles were destroyed. Threatened species of snails and strong populations of several interesting taxa living among the ruins are worthy of mention and can help justify protection of these sites. Also deserving protection are the elements of inanimate nature (geological profiles and outcrops, landscape values). In terms of these purposes the following proposals can be offered.

1. Localities with molluscan assemblages not supporting threatened species and not interesting as objects of inanimate nature should not be protected (Ślemień, Dąbrówka Starzeńska).

2. Ruins situated in towns, incorporated in newly arranged or reconstructed public parks, have been described from Cieszyn, Dobczyce, Nowy Sącz and Tarnów. Local regulations guarantee a certain degree of stability for these habitats, but they are not legally protected areas. The fauna living under very strong anthropopression should be periodically examined in such places.

3. Snail communities of ruins in nature reserves are protected and additional regulations are unnecesarry. Observations of changes in molluscan assemblages should be made once in a while.

4. Snail assemblages living in ruins in the proposed nature reserves are important components of the fauna of these areas and may constitute additional reasons for extending legal protection (Krajowice, Odrzykoń). This refers particularly to the population of *Balea perversa* living around the ancient castle crowning Kamieniec Hill.

5. Ruins of castles situated in places with particular natural values and inhabited by rich molluscan assemblages should be protected together with the surrounding areas. Elements of inanimate and animate nature as well as local conditions are the main factors in choosing the optimum status of conservation. Góra Lanckorońska Hill, a famous geological locality and a spectacular component of the landscape, is proposed as a nature reserve. The snail community living in partly reconstructed ruins at the top of this hill is of particular value. This area has not be taken under protection so far (Denisiuk 1993).

6. The nature-landscape group seems to be the most appropriate form of protection for areas containing ruins. These areas usually include objects interesting from the geological and geomorphological point of view, as well as rich and varied vegetation. Five fortified hills situated along the old trans-carpathian route in the Poprad and Dunajec River Valleys are proposed as nature-landscape groups (Muszyna, Rytro, Rożnów, Wytrzyszczka, Melsztyn). The snail communities as well as populations of selected species, particularly threatened ones, are important elements in justifying these proposals.

7. Areas of ecological interest are an adequate form of protection for the interesting molluscan assemblages found in ruins and recognized as the major natural values of these localities (Kobierniki, Barwald, Czchów, Zagórze).

Species of snails living in and around the ruins of Carpathian castles but noted only occasionally in the Beskidy Mountains and in the Carpathian Foothills enrich the fauna of this region. Some of them occur in strong populations connected mainly with the described

anthropogenic habitats. Following taxa can be mentioned as examples:

Truncatellina cylindrica – a species widespread in the Central Carpathians (Pieniny Mts, Tatra Mts), known from a few localities in the Carpathian Foothills (Riedel 1988; Pokryszko 1990),

Euomphalia strigella and *Cochlicopa lubricella* – two species not known from the Polish Western Carpathians until now (Riedel 1988),

Cecilioides acicula and *Helicella obvia* – two species found in Czchów and Melsztyn, the first in the Polish Carpathians.

Orcula dolium – a species known from the Carpathian Foothills, noted now in the Beskid Sądecki Range.

The ruins offer favourable habitat conditions for several threatened species of snails such as *Balea perversa*, *Trichia lubomirskii*, *Trichia bielzi*, *Perforatella dibotryon* and *Oxychilus orientalis*. The described localities can be regarded as refuges of these species, and of rich snail communities in general. Old castles situated along the main valleys are paths of migration of snails connected with sunny, dry habitats, as well as of calciphilous taxa. The ancient trans-carpathian route leading through the Poprad and Dunajec River Valleys, fortified with more than ten castles, is the best example of such a migration path.

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STRESZCZENIE

W Beskidach i na Pogórzu Karpackim zachowały się ruiny licznych zamków, usytuowane głównie na wzgórzach wzdłuż dolin głównych rzek (Marszałek 1993). Rozpadające się mury budynków i fortyfikacji wzbogacają glebę w węglan wapnia i stwarzają specyficzne warunki, wybitnie sprzyjające rozwojowi wielu gatunków ślimaków. Ruiny i ich najbliższe otoczenie od paru stuleci pozostają pod wpływem wtórnej sukcesji, prowadzącej do stopniowego różnicowania zespołów roślinnych oraz fauny. Miejsca takie są wprawdzie objęte ochroną jako zabytki historii i kultury materialnej (Ustawa o ochronie dóbr kultury i muzeach z 15-go lutego 1962), ale zarówno one same jak też ich otoczenie w większości przypadków zasługują także na ochronę jako obiekty przyrodnicze. Bogate zespoły mięczaków, jak też walory krajobrazowe i geologiczne powinny być brane pod uwagę jako motywy tworzenia rezerwatów przyrody, zespołów przyrodniczo-krajobrazowych i użytków ekologicznych.

Badania malakologiczne zostały przeprowadzone na 20 obiektach, wybranych spośród ponad 30 wstępnie wytypowanych (ryc. 1). Zgromadzona kolekcja obejmuje blisko 2,5 tysiąca okazów reprezentujących 64 gatunki ślimaków oskorupionych (tab. 1). Analiza taksonomiczna pozwoliła na wyróżnienie dwóch zespołów fauny (ryc. 2). Na spektrach malakologicznych można wykazać, że w pierwszym z nich znaczny udział mają gatunki cieniolubne z domieszką mezofilnych, natomiast drugi zespół odznacza się przewagą ślimaków preferujących środowisko otwarte (ryc. 3 – A, B). Odmienny typ fauny występuje jedynie w otoczeniu ruin w Ślemieniu, a odznacza się on obecnością gatunków wilgociolubnych (ryc. 3 – C).

Zastosowanie wskaźnika różnicującego (T_i) pozwoliło na wskazanie gatunków najbardziej charakterystycznych dla wspomnianych zespołów fauny. Są to: *Aegopinella pura*, *Vitrea diaphana*, *Vitrea crystallina*, *Orcula doliolum* i *Carychium tridentatum* dla zespołu A oraz *Cochlicopa lubricella* i *Nesovitrea hammonis* dla zespołu B (ryc. 4). Omawiane zespoły w pewnym stopniu wyodrębniają się także na wykresach ujmujących rozkład wskaźników różnorodności w dwóch wariantach. W obu wyodrębniają się po trzy grupy próbek, odróżniające się od siebie bogactwem i zróżnicowaniem fauny, odzwierciedlającym warunki siedliskowe i wpływ antropopresji (ryc. 5).

Wskaźniki stałości i dominacji gatunków na poszczególnych stanowiskach pozwalają na określenie poszczególnych zespołów według ich głównych składników. Są to fauny: *Truncatellina* – *Vallonia*, *Laciniaria* – *Truncatellina* – *Vitrina* oraz *Truncatellina* – *Punctum* (ryc. 6). Te same wskaźniki wyznaczone dla całego zbioru próbek umożliwiają wytypowanie gatunków, szczególnie charakterystycznych dla zespołów ślimaków żyjących wśród ruin (ryc. 7). Są to: *Truncatellina cylindrica*, *Vallonia pulchella* i *Vitrina pellucida* oraz *Vallonia costata*, *Laciniara plicata* i *Punctum pygmaeum*. Wśród taksonów rzadko reprezentowanych (akcesorycznych) znajdują się następujące gatunki, wyszczególnione na czerwonej liście zwierząt ginących i zagrożonych w Polsce (Głowaciński red. 1992): *Balea perversa* (gatunek wymierający) oraz *Trichia lubomirskii*, *Trichia bielzi*, *Perforatella dibotryon* i *Discus perspectivus* (gatunki narażone). Wykaz ten uzupełnia 10 gatunków zakwalifikowanych jako „rzadkie".

Analiza populacji objęła kilka wybranych gatunków, licznie reprezentowanych w niektórych stanowiskach. Są to takie taksony, jak *Truncatellina cylindrica*, *Laciniaria plicata* i *Alinda biplicata* oraz *Balea perversa*, *Ruthenica filograna*, *Chilostoma faustinum*, *Pupilla muscorum*, *Vallonia pulchella* i *Vallonia costata* (ryc. 8). W części badanych populacji okazy mają średnie wymiary mniejsze niż w populacjach z innych stanowisk.

Badania malakologiczne uzupełnione danymi z zakresu przyrody nieożywionej upoważniają do podjęcia starań o utworzenie jednego rezerwatu przyrody, pięciu zespołów przyrodniczo-krajobrazowych oraz czterech użytków ekologicznych. Ochroną rezerwatową należy objąć Górę Lanckorońską – obiekt szczególnie interesujący z naukowego i dydaktycznego punktu widzenia. Proponuje się utworzenie następujących zespołów przyrodniczo-krajobrazowych, rozmieszczonych wzdłuż starego, transkarpackiego szlaku komunikacyjnego, biegnącego dolinami Popradu i Dunajca: Wzgórze Baszta w Muszynie, Wzgórze Zamkowe w Rytrze, cypel wzgórza Zamczysko w Rożnowie, skalisty półwysep w Wytrzyszczce oraz wzgórze w Melsztynie. Za użytki ekologiczne winny być uznane: Wzgórze Wolek w Kobiernicach, szczytowa część wzgórza Żarek w Barwałdzie koło Kalwarii, wzgórze z basztą w Czchowie oraz ruiny w Zagórzu. Dwie ruiny zamków występują na obszarach istniejących rezerwatów (Myślenice – Zarabie oraz Góra Sobień koło Monastyrca), a dwie – na obszarach projektowanych rezerwatów przyrody (Golesz w Krajowicach i Kamieniec w Odrzykoniu).

Ruiny zamków usytuowane w miejscach o dużych wartościach naturalnych, a zarazem stwarzające szczególnie korzystne warunki dla rozwoju malakofauny, zasługują na ochronę zarówno jako dobra kultury narodowej, jak i – wraz ze swoim otoczeniem – obiekty przyrodnicze. Winny więc być powszechnie uwzględniane przy typowaniu, projektowaniu i dokumentowaniu nowych rezerwatów i innych form ochrony przyrody.