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CONSIDERATIONS REGARDING THE FOREST LANDSNAIL FAUNA OF THE CIUCAŞ MOUNTAINS

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SUMMARY. Part of the southern branch of Eastern Carpathians, the Ciucaş Mountains have a substratum of Cretaceous limestones, gravel and rounded blocks of crystalline schists, gneiss, limestone, sandstone, caught in a limestone matrix. This paper analyses the land snail fauna of deciduous and mixed forests, a habitat type where the geological substrate is completed with favourable humidity conditions that allow the development of specific land snail communities. In the research area a 55 species of terrestrial gastropods were identified. *Zonitoides nitidus, Mastus venerabilis, Faustina faustina, Balea fallax* and *Bulgarica cana* prevail in the communities, being abundant in most sampling sites. Other species such as *Balea stabilis* and *Monachoides incarnatus* develop large populations and reach high values of relative abundances in spite of their low frequency. The European interest species *Drobacia banatica* was identified in five of the ten sampling sites. This species is in the Ciucaş Mountains at the eastern limit of its distribution. One of the two species of the genus *Alopia* known as being present in the area was also found, represented by two subspecies, *Alopia nefasta nefasta* and *Alopia nefasta helenae.*

Keywords: biodiversity, the Ciucaş Mountains**,** communities, limestone, snails.

Introduction

Part of the decomposition biota in most terrestrial ecosystems, land snails are also preyed upon by many vertebrates and invertebrates, having therefore a central position in many food chains.

Several studies have documented the importance of edafic factors in land snail distribution. Traditionally the pH and calcium level are considered limiting factors (Agócsy, 1967; Cameron, 1973; Radea and Mylonas, 1992). Land-snails have high calcium requirements for the production of both their eggs and their shells, hence lime-rich substrates generally support abundant and diverse land-snail communities (Kerney and Cameron, 1979; Gärdenfors, 1992; Nekola, 1999).

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Several studies have demonstrated the strong positive correlation between individual abundance, species richness and the pH of the organic litter and soil (Wäreborn, 1969, 1970; Waldén, 1981; Nekola, 1999; Nekola and Smith, 1999; Pokryszko and Cameron, 2005).

Part of the southern branch of Eastern Carpathians, the Ciucaș Mountains have a development of the relief on three levels, with Cretaceous limestones, but also with gravel and rounded blocks of crystalline schists, gneiss, limestone, sandstone etc., cemented in a limestone matrix. These geological conditions allow the development of a rich land snail fauna. Our research aims to analyze the terrestrial snail communities inhabiting deciduous and mixed forests, habitats which combine the presence of soil calcium with favourable humidity conditions.

Materials and methods

Samples were taken from 10 sampling sites located in deciduous and mixed forests of Ciucaş Mountains as presented in Fig. 1 and described below.

S 1 10 km to Săcele, 45.32592 N, 25.49398 E, altitude: 843 m.
S 2 Cheia – Văleni, 45.2488 N, 25.56673 E, 791m altitude.
S 3 Valea Stânei: 45.2520 N, 25.57590 E, 885 m altitude.
S 4 one km upstream Valea Stânei Gorges: 45.2998 N, 26.0370 E, 1273 m altitude.
S 5 Muntele Roşu: 45.30110 N, 25.5690 E, 1336 m altitude.
S 6 Pârâul Berii: 45.3004 N, 25.5625 E, 1219 m altitude.
S 7 A tributary of Cheiţa River: 45.2853 N 25.5480 E, 1057 m altitude.
S 8 Babarunca: 45.3074 N, 25.5125 E, 952 m altitude
S 9 Dălghiu, near the forest range, 45.5366 N, 25.9049 E, 905 m altitude.
S10 Dălghiu, 45.5492 N, 25.9127 E, 932 m altitude.

The samping points were selected in forests with different microhabitat conditions considering the humidity level, the vegetation and the presence of limestones:

- sampling points with swampy areas near the river: S9,
- mixed forests: S1, S 5, S10,
- moderately humid areas: S2, S3, S7, S8,
- sampling points with limestone and limestone-cimented blocks: S 4, S 6,

Samples were collected from plots of 100 m^2, by four people for about an hour. All the living snails and freshly empty shells from vegetation, litter and decomposing wood were collected. The visual searching was quantified in effort. The same amount of time (one hour) was used to collect samples in all the sites. In order to collect the small species living in the litter, one 20 l sample of litter was sieved in every site (Cameron and Pokryszko, 2005). Standardisation of the collecting methods is necessary in order to perform an analysis of the land snail communities in terms of relative abundance.

The snails or empty shells found in the samples were identified using Grossu (1981, 1983, 1987, 1993) and Kerney and Cameron (1979). The classification follows Fauna Europaea (Bank, 2011).

The frequency, and the relative abundance were calculated and used in Table 1. The relative abundance was also used to build the affinity diagram of the sampling stations (single linkage method, Euclidean distance).

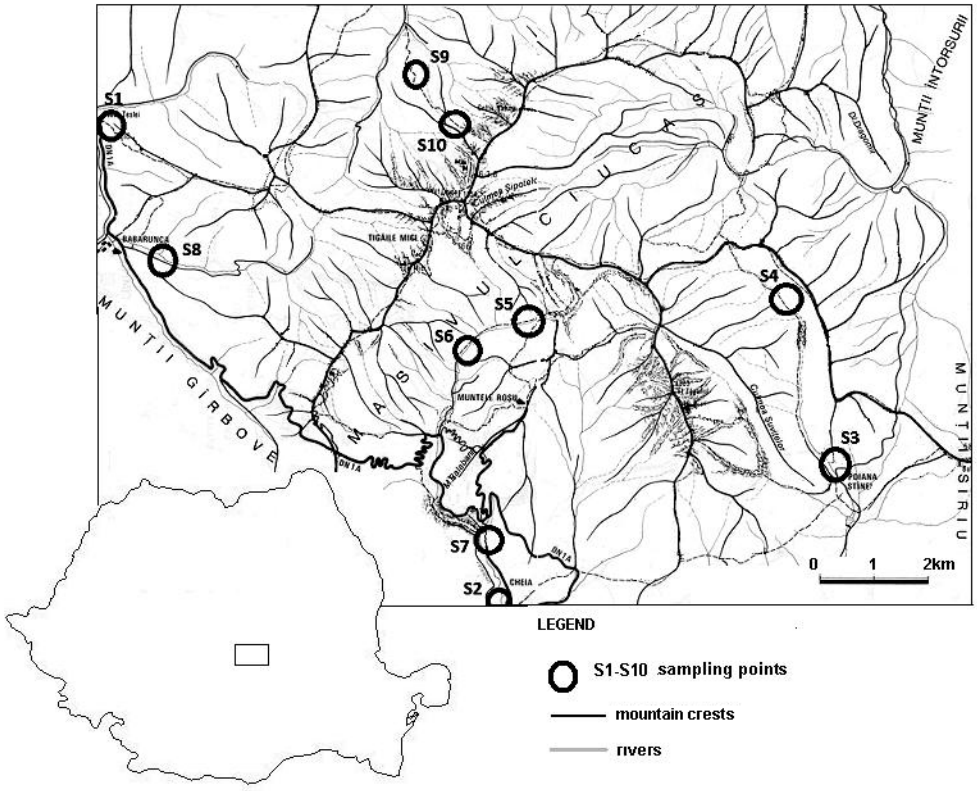

Figure 1. Location of the 10 sampling sites

Results and discussion

54 species of land snails were found in the sampling sites. The systematic list is presented below.

The systematic list of terrestrial gastropod species from deciduous and mixed forests of the Ciucaș Mountains

Carychiidae Jeffreys, 1830

Carychium tridentatum (Risso, 1826) - S1: 10 km to Săcele, S3: Valea Stânei, S4: Valea Stânei Gorges, S7: tributary of Cheiţa, S8: Babarunca, S9: Dălghiu.

Succineidae H. Beck, 1837

Succinea putris (Linnaeus, 1758) - S9: Dălghiu.

Cochlicopidae Pilsbry, 1900 (1879)

Cochlicopa lubrica (O.F. Müller, 1774) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei tributary of Cheiţa, S8: Babarunca, S9: Dălghiu.

Orculidae Pilsbry, 1918

Sphyradium doliolum (Bruguière, 1792) : S1 10 km to Săcele.

Valloniidae Morse, 1864

Vallonia costata (O.F. Müller, 1774) : S3: Pritvale - Valea Stânei.

Acanthinula aculeata (O.F. Müller 1774): S1: 10 km to Săcele.

Enidae B.B. Woodward, 1903 (1880)

Ena montana (Draparnaud, 1801) - S4: la one km upstream Valea Stânei Gorges , S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S9: Dălghiu.

Merdigera obscura (O.F. Müller, 1774) - S3: Pritvale – Valea Stânei.

Mastus venerabilis (L. Pfeiffer) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km ustream Valea Stânei Gorges, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S8: Babarunca, S10: Dălghiu.

Clausiliidae J.E. Gray, 1855

Alopia nefasta helenae (R. Kimakowicz): S4: one km upsream Valea Stânei Gorges.

Alopia nefasta nefasta (M. Kimakowicz): S5: Muntele Roşu to Pârâul Berii.

Cochlodina (*Cochlodina*) *laminata* (Montagu, 1803) : S2: Cheia – Văleni tributary of Teleajen.

Cochlodina (*Paracochlodina*) *orthostoma* (Menke, 1828): S4: la one km upsream Valea Stânei Gorges, S6: Pârâul Berii.

Ruthenica filograna filograna (Rossmässler, 1836). Original data: S5: Muntele Roşu to Pârâul Berii.

Macrogastra (*Pyrostoma*) *plicatula* (Held, 1836): S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S10: Dălghiu.

Clausilia cruciata (Studer, 1820) - S2: Cheia – Văleni tributary of Teleajen, S4: la one km upstream Valea Stânei Gorges, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii.

Clausilia dubia A. Schmidt, 1856 - S6: Pârâul Berii.

Laciniaria plicata (Draparnaud, 1801) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S8: Babarunca.

Balea fallax (Rossmässler, 1836): S2, Cheia; S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges , S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Balea (*Pseudalinda*) *stabilis* (L. Pfeiffer, 1847) - S3: Pritvale – Valea Stânei.

Vestia (*Vestia*) *turgida* (Rossmässler, 1836) - S3: Pritvale – Valea Stânei.

Vestia (Vestia) elata (Rossmässler, 1836) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S13 : Babarunca, S15: Dălghiu.

Bulgarica (*Strigilecula*) *vetusta* (Rossmässler, 1836) - S5: Muntele Roşu to Pârâul Berii.

Bulgarica (*Strigilecula*) *cana* (Held, 1836) - S1: 10 km to Săcele, S2: Cheia – Văleni triutary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca.

Punctidae Morse, 1864

Punctum (*Punctum*) *pygmaeum* (Draparnaud, 1801).

Original data: S4: one km upstream Valea Stânei Gorges, S7: tributary of Cheiţa, S8: Babarunca.

Pristilomatidae T. Cockerell, 1891

Vitrea diaphana (S. Studer, 1820) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale- Valea Stânei, S4: one km upstream Valea Stânei Gorges , S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Vitrea transsylvanica (Clessin, 1877) - S3: Pritvale – Valea Stânei, S6: Pârâul Berii, S8: Babarunca, S9, S10: Dălghiu.

Vitrea crystallina (O.F. Müller, 1774) - S7: tributary of Cheiţa.

Euconulidae H.B. Baker, 1928

Euconulus (*Euconulus*) *fulvus* (O.F. Müller, 1774) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S7: tributary of Cheiţa.

Gastrodontidae Tryon, 1866

Zonitoides (*Zonitoides*) *nitidus* (O.F. Müller, 1774) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Oxychilidae P. Hesse, 1927 (1879)

Daudebardia transsylvanica (Draparnaud, 1805) - S1: 10 km to Săcele, S3: Pritvale – Valea Stânei, S8: Babarunca, S10: Dălghiu.

Oxychilus depressus (Sterki, 1880) - S8: Babarunca.

Oxychilus glaber (Rossmässler, 1835) - S1: 10 km to Săcele; S8-Babarunca.

Cellariopsis deubeli (Wagner, 1914) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges, S7: tributary of Cheiţa.

Aegopinella pura (Alder, 1830) - S1: 10 km to Săcele, S9: Dălghiu.

Aegopinella minor (Stabile, 1864) - S6: Pârâului Berii, S7: tributary of Cheiţa.

Aegopinella epipedostoma (Fagot, 1879) - S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges, S6: Pârâul Berii, S7: tributary of Cheiţa, S10: Dălghiu.

Nesovitrea petronella (Pfeiffer, 1853) - S3: Pritvale – Valea Stânei, S6: Pârâul Berii, S7: tributary of Cheiţa.

Vitrinidae Fitzinger, 1833

Semilimax semilimax (J. Férussac, 1802) - S7: tributary of Cheiţa, S8: Babarunca.

Oligolimax annularis (S. Studer, 1820) - S7: tributary of Cheiţa.

Vitrina pellucida (Clessin, 1877) - S2: Cheia – Văleni tributary of Teleajen, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S7: tributary of Cheiţa.

Limacidae Lamarck, 1801

Limax cinereoniger (Wolf, 1803) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S6: Pârâul Berii, S8: Babarunca.

Lehmannia marginata (O.F. Müller, 1774) - S2: Cheia – Văleni tributary of Teleajen.

Arionidae J.E. Gray, 1840

Arion subfuscus (Draparnaud, 1805) - S4: one km upstream Valea Stânei Gorges, S8: Babarunca, S9: Dălghiu.

Arion (*Carinarion*) *circumscriptus* (Johnston, 1828) – S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S10: Dălghiu.

Bradybaenidae Pilsbry, 1934 (1898)

Fruticicola fruticum (O.F. Müller, 1774) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S9: Dălghiu.

Hygromiidae Tryon, 1866

Euomphalia strigella (Draparnaud, 1801) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S8: Babarunca.

Monachoides incarnatus (O.F. Müller, 1774) - S4: one km upstream Valea Stânei Gorges, S9, S10: Dălghiu.

Monachoides vicinus (Rossmässler, 1842) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca.

Helicidae Rafinesque, 1815

Arianta arbustorum arbustorum (Linnaeus, 1758) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S5: Muntele Roşu traseu Pârâul Berii – izvor, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Drobacia banatica (Rossmässler, 1838) S1: 10 km to Săcele, S2: Pritvale – Văleni tributary of Teleajen, S8: Babarunca, S9, S10: Dălghiu.

Faustina (faustina) faustina (Rossmässler, 1835) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km upstream Valea

Stânei Gorges, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Isognomostoma isognomostomos (Schröter, 1784) - S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4:one km upstream Valea Stânei Gorges, S5: Muntele Roşu to Pârâul Berii, S6: Pârâul Berii, S7: tributary of Cheiţa, S8: Babarunca, S9, S10: Dălghiu.

Helix (*Helix*) *pomatia* (Linnaeus, 1758) - S1: 10 km to Săcele, S2: Cheia – Văleni tributary of Teleajen, S3: Pritvale – Valea Stânei, S4: one km upstream Valea Stânei Gorges, S6: Pârâul Berii, S7: tributary of Cheiţa.

The number of species and specimens for each sampling station is represented in Figure 2. The presence of limestones and lime-cimented blocks in a sampling site is associated with the decrease in humidity, hence there is a reduced diversity, as it is the case of S4, S5 and S6, while an increased diversity is found in sampling points with higher humidity level. The highest diversity and also the highest number of specimens were recorded in S3 - Pritvale-Valea Stânii, S8 - Babarunca and S9 - Dălghiu. The calcareous nature of the substratum is underlined by the presence of species characteristic for open calcareous habitats like *Mastus venerabilis*, which is one of the most abundant species in the analyzed area (A%=10.038, Table 1), and species of *Alopia* genus - *Alopia nefasta nefasta* and *Alopia nefasta helenae.* Analysing the land snail communities in term of relative abundance of individual species differences in habitat conditions are evident. The tree diagramm performed on relative abundance (Fig. 3) reveal a first group of stations located in mixed forests, were the lowest diversity was recorded (S1, S5, S10). A second group includes stations with limestone and limestone-cemented blocks (S4 and S6), while the most humid station (S9) and the one with the highest diversity (S3) are independent, joining the group at a great distance.

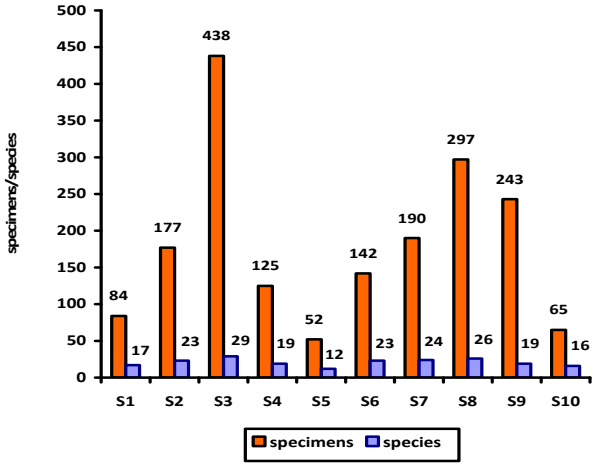

Figure 2. The number of specimens and species identified in each sampling site.

Table 1.

The identified species: zoogeographical elements (Hol. - Holarctic; Eur. - European; E-Sib.- Euro-Siberian; C-Eur. - Central-European; C-N Eur, – Central-North European; C-S Eur. – Central-South European; C-E Eur. – Central-East European; Balc. - Balcanic; Carp. – Carpathic; End. - endemic), their demands towards humidity (H – hygrophylous; MH mesohygrophylous; M – mesophylous; MX - mesoxerophylous), number of individuals, frequency (F%) and relative abundance (A%).

species	Zoogeo-graphy	Humidity	no. ind.	F%	A%
Carychium tridentatum	Eur.	H	32	70	1.765
Succinea putris	E-Sib.	H	1	10	0.005
Cochlicopa lubrica	Hol	H	12	60	0.661
Sphyradium doliolum	C-S Eur.	M	4	10	0.220
Vallonia costata	Hol.	MH	2	10	0.110
Acanthinula aculeata	Eur.	M	5	20	0.275
Mastus venerabilis	Balc.	MH	182	**80**	**10.038**
Ena montana	Eur.	MH	13	40	0.717
Merdigera obscura	Eur.	MH	3	10	0.165
Alopia nefasta helenae	End.	M	2	10	0.110
Alopia nefasta nefasta	End.	M	8	10	0.450
Cochlodina laminata	Eur.	MH	18	60	0.450
Cochlodina orthostoma	Eur.	MH	13	40	1.020
Ruthenica filograna	C. Eur.	M	3	10	0.165
Macrogastra plicatula	Carp.	M	41	40	2.261
Clausilia cruciata	C-N Eur.	M	23	10	1.875
Clausilia dubia	Eur.	MH	1	40	0.005
Laciniaria plicata	Eur.	MH	17	10	0.937
Balea fallax	Carp.	MH	74	**80**	**4.081**
Balea stabilis	Carp.	MH	215	**10**	**11.858**
Vestia elata	Carp.	M	11	40	0.606
Vestia turgida	Carp.	M	49	10	2.702
Bulgarica cana	C-N Eur.	M	66	80	3.640
Bulgarica vetusta	C-SE Eur	M	48	10	2.647
Punctum pygmaeum	Eur.	M	4	30	0.220
Vitrina pellucida	Hol.	M	8	40	0.441
Semilimax semilimax	Eur.	H	6	30	0.330
Phenacolimax annularis	Eur	MH	1	10	0.005
Vitrea diaphana	Eur.	MH	99	**80**	**5.460**
Vitrea transsylvanica	C-E Eur.	MH	21	50	1.158
Vitrea crystallina	Eur.	MH	1	10	0.005
Euconulus fulvus	Hol.	MH	3	30	0.165
Daudebardia transsylvanica	Carp.	MH	5	40	0.275
Cellariopsis deubeli	Carp.	MH	14	40	0.772
Oxychilus glaber	Eur.	MH	18	10	0.992
Oxychilus depressus	C-S Eur.	MH	5	10	0.275

Table 1 continued

Aegopinella pura	Eur.	M	5	20	0.275
Aegopinella minor	C-S Eur.	MX	10	20	0.551
Aegopinella epipedostoma	C Eur.	MH	40	50	2.206
Nesovitrea petronella	Eur.	M	7	30	0.386
Zonitoides nitidus	Hol.	H	206	**80**	**11.362**
Arion circumscriptus	Eur.	MH	100	**90**	**5.514**
Arion subfuscus	Eur.	MH	4	10	0.220
Limax cinereoniger	Eur.	MH	8	10	0.441
Lehmania marginata	Eur.	H	18	20	0.992
Bradybaena fruticum	Pal.	MH	48	30	2.647
Monachoides incarnatus	Eur.	M	127	**30**	**7.004**
Monachoides vicinus	C Eur.	M	23	60	1.268
Euomphalia strigella	Eur.	M	59	30	3.254
Arianta arbustorum	Eur.	M	14	80	0.772
Faustina faustina	C-E Eur.	M	130	**90**	**6.40**
Drobacia banatica	C-E Eur.	M	23	50	1.13
Isognomostoma isognomostomos	Eur.	M	59	90	2.90
Helix pomatia	Eur.	M	14	60	0.689

In five of the ten sampling points *Drobacia banatica* was present. *Drobacia banatica* is a species of European interest which reaches here the eastern limit of its distribution. The species is present both on the northern and southern part of Ciucaș Mountains.

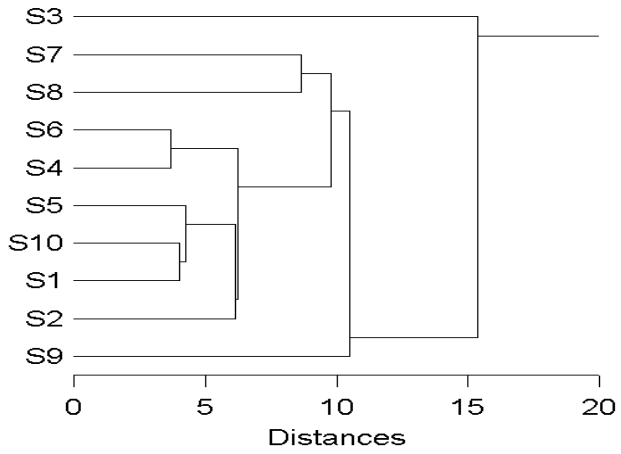

Figure 3. Cluster dendrogram of sampling sites based on species relative abundance (single linkage, Euclidean distance).

Of special interest are the species of the endemic genus *Alopia* H&A. (Adams, 1855). Except for one subspecies occurring in Slovakia, the genus *Alopia* is entirely endemic to Romania. It is a strongly calciphilous genus with the center of diversity in the eastern limestone-rich area of the Southern Carpathians, where endemic species have evolved within the major mountain ranges (Soós, 1943). Most of the taxa have a limited distribution and their conservation is important both at national and European level.

This genus is present mostly on limestone rocks in open habitats. This is the reason why in our samples only a few specimens belonging to a single species with two subspecies *Alopia nefasta nefasta* and *Alopia nefasta helene*, previously considered *Alopia helenae helenae* (Grossu, 1981), were present. A recent molecular study of the genus *Alopia* (Fehér et al., 2013) made some changes in its taxonomy. Consequently *Alopia helenae helenae* (Grosu, 1981; Nordsieck, 2008) was found to be a subspecies of *Alopia nefasta.*

Conclusions

The forests of Ciucaș Mountains show favourable conditions both of substratum and humidity and therefore shelter a rich land snail fauna. In that area both calciphilous and hygrophilous and mesohygrophilous snails are present. Species like *Zonitoides nitidus, Mastus venerabilis, Faustina faustina, Balea fallax, Bulgarica cana,* are present in most sampling points having high values of relative abundance. Other species such as *Balea stabilis* and *Monachoides incarnatus* develop large populations and reach high values of relative abundances in spite of their reduced frequency.

For both *Drobacia banatica* and the endemic subspecies of *Alopia nefasta* it is important to describe the current distribution, in order to establish the appropriate management measures for these species' conservation.

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REFERENCES

Agócsy, P. (1968) Data on quantitative conditions in the mollusk faunas of two different substrates in central Hungary, *Acta Zoologica Academiae Scientarium Hungaricae,* **14**, 1–6

Bank, R.A. (2011) Fauna Europaea: Mollusca, Gastropoda. Fauna Europaea, Version 2.4, http://faunaeur.org (accessed 10.V.2013)

Cameron, R.A.D. (1973) Some woodland mollusc faunas from southern England, *Malacologia*, **14**, 355–370

Fehér, Z., Németh, L., Nicoară, A., Szekeres, M. (2013) Molecular phylogeny of the land snail genus Alopia (Gastropoda: Clausiliidae) reveals multiple inversions of chirality, *Zoological Journal of the Linnean Society*, **167**, 259–272

Gärdenfors, U. (1992) Effects of artificial liming on terrestrial gastropod populations, *Journal of Applied Ecology*, **29,** 50–54

Grossu, A.V. (1981) *Gastropoda Romaniae, Ordo Stylommatophora Vol. 3: Suprafamiliile Clausiliacea şi Achatinacea,* Ed. Litera Bucureşti

Grossu, A.V. (1983) *Gastropoda Romaniae. Ordo Stylommatophora, Vol.4, Suprafam. Arionacea, Zonitacea, Ariophantacea şi Helicacea,* Ed. Litera Bucureşti

Grossu, A.V. (1987) *Gastropoda Romaniae Vol.* 2, Subclasa Pulmonata, Ord. Basommatophora şi Ord. Stylommatophora: Suprafam. Succineacea, Cochlicopacea, Pupillacea, Edit. Litera (1987), Bucureşti

Grossu, A.V. (1993) The catalogue of the Molluscs from Romania. *Travaux du Muséum d'Histoire Naturelle" Grigore Antipa",* **23**, 291- 366

Kerney, M.P., Cameron, R.A.D. (1979) *A field guide to the Land Snails of Britain and North-West Europe*, Collins, London, pp 288

Nekola, J.C. (1999) Terrestrial gastropod richness of carbonate cliff and associated habitats in the GreatLakes region of North America, *Malacologia*, **41**, 231–252

Nekola, J.C., Smith, T.M. (1999) Terrestrial gastropod richness patterns in Wisconsin carbonate cliff communities, *Malacologia*, **41**, 253-269

Nordsieck, H. (2008) The system of the genus Alopia H. & A. Adams 1855 (Gastropoda: Stylommatophora: Clausiliidae), *Mitteilungen der Deutschen Malakozoologischen Gesellschaft*, **79/80**, 7–18

Pokryszko, B., Cameron, R.A.D. (2005) Geographical variation in the composition and richness of forest snail faunas in northern Europe, In: *Pattern and process in land mollusc diversity*, Cameron, R.A.D, Nekola, J.C., Pokryszko, B.M., Wells, F.E., (ed), Supplement No. 68 Perth, Western Australia: Records of the Western Australian Museum, pp 115-132

Radea, C., Mylonas, M. (1992) Landsnails in the organic horizon of a mediterranean coniferous forest, *Pedobiologia*, **36**, 187–192

Soós, L. (1943) *A Kárpát-medence Mollusca faunája*, Hungarian Academy of Sciences, Budapest

Waldén, H.W. (1981) Communities and diversity of land molluscs in Scandinavian woodlands. I. High diversity communities in taluses and boulder slopes in SW Sweden, *Journal of Conchology*, **30**, 351–372

Wäreborn, I. (1969) Land molluscs and their environments in an oligotrophic area in southern Sweden, *Oikos*, **20**, 461-479

Wäreborn, I. (1970) Environmental factors influencing the distribution of land molluscs of an oligotrophic area in southern Sweden, *Oikos*, **21**, 285-291