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# Malacofaunistical investigation of the Esztramos Hill (NE Hungary)

T. Deli–V. Tukarcs–
P. Sólymos

**Abstract** We started surveying the mollusc fauna of the Esztramos Hill (Aggtelek National Park, N Hungary) in 1997. Our preliminary investigation pointed out the sympartic occurrence of *Vertigo alpestris* and *Pupilla triplicata*, which was a curiosity. Consequently we went on surveying the mollusc fauna in 1998-1999 during which we identified 10545 specimens of 44 species from 38 soil samples taken from 10 different habitat types. We used multivariate analyses to assess to species composition of the different habitats of the hill. Our results show that the vegetation structure has major effect on the snail assemblages. We also investigated the different habitat preference of the two sympatric *Truncatellina* of the hill. The *Truncatellina cylindrica* prefers open, while *T. claustralis* prefers closed vegetation structure. In the transitional areas these two species coexist due to the small scale patchiness of the habitats. In a historical point of view, the Esztramos presents island effect. Since also glacial and postglacial relicts are preserved in a relatively small area. This refuge is one of the most valuable parts of the Aggtelek National Park despite of its serious exploitation during the antecedent mining period.
**Key words:** Mollusca, faunistics, biogeography, island effect, nature couservation.

## Introduction

The malacofaunistical research in the Aggtelek Karst Area has been largely neglected (Pintér et al. 1979) until the last few years. Some sporadic data were available, but many areas with great botanical significance are white spots on the map even today. One of these spots is the Esztramos Hill with its unique botanical and geological value. The once intensely mined Esztramos Hill is now protected part of the Aggtelek National Park.

During the surveys our aim was to compare the snail assemblages living in the different biotopes of the hill. The relative closeness of the Carpathians and the significant Szádelő Creek few kilometres away excited us to do faunistical work here.

## Material and methods

### *Sampling*

The sampling sites are close to each other (Fig. 1). These sites differ primarily in cover and exposure. Main characteristics are summarised in Table 1. Site 1. The sampling procedure was carried out on 29. 10. 1998 and 18. 3. 1999. Three 25 cm × 25 cm × 5 cm quadrates were taken from each sampling sites except site 1 and 2 with six quadrates (3 plus 3 samples from identical habitat types indicated as 1A, 1B, 2A and 2B in Fig. 1) and site 7 with 5 quadrates. In rocky environments, where taking quadrates were not possible, we took 1.5 l volume soil samples. Besides the quantitative malacological sampling we also picked up single individuals, which is necessary in faunistical works and com-

Table 1. Main characteristics of the sampling areas. Fig. 1 shows the location of the sites.

| Site | Vegetation | Cover | Exposure |
|---|---|---|---|
| 1 | Submontane beech forest | Closed | NW |
| 2 | Linden-ash forest on rocky bed | Closed | NW |
| 3 | Acacia forest | Closed | SE |
| 4 | Spruce forest | Closed | S |
| 5 | Spirea shrub | Transitional | NW |
| 6 | Filbert shrub | Transitional | NW |
| 7 | Rock cavity | Open | NW |
| 8 | Rocky grassland | Open | NW |
| 9 | Steppe grassland | Open | W |
| 10 | Steppe grassland | Open | S |

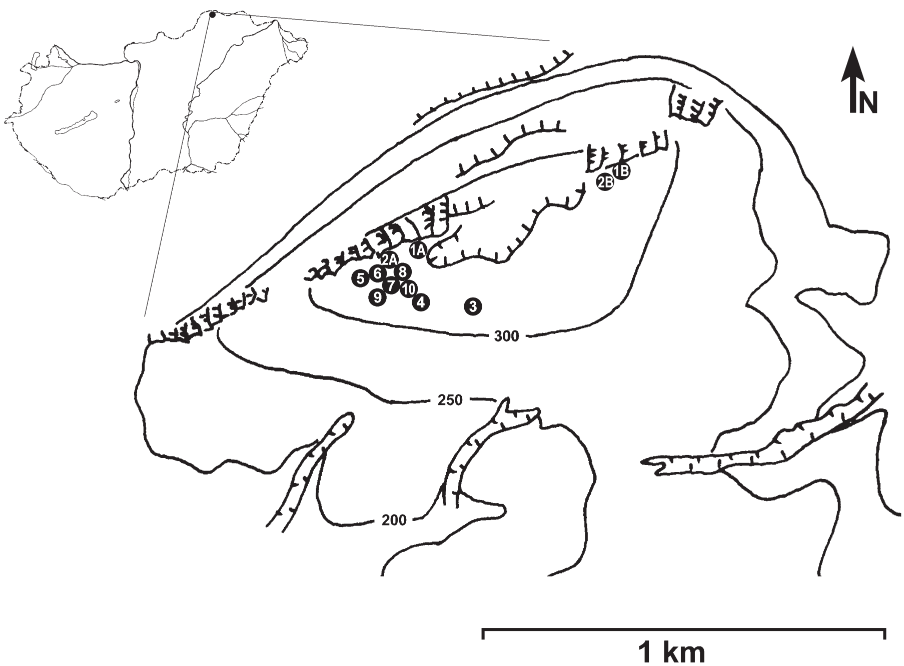


Fig. 1. Map of the Esztramos with the location of the sampling sites.

plements quantitative sampling especially in the case of large bodied species with relatively low population density.

*Data analyses*

Similarity of the species composition was calculated by the Matusita quantitative dissimilarity index, and the similarity structure was analysed by hierarchical cluster analysis with using of the Ward-Orlóci fusion method and nonmetric multidimensional scaling. The NuCoSA package (Tóthmérész, B. 1993) was used for these computations.

To find character species of the cluster hierarchy the IndVal method (Dufrêne, M. – Legendre, P. 1997) was used. This method combines the mean number of species individuals with its relative frequency of occurrence in the various groups of sites in the cluster hierarchy. The index is maximum when all individuals of a species are found in a single group of sites and when the species occurs in all sites of that group, it is a symmetrical indicator (its presence contributes to the habitat specificity and its presence can be predicted in all sites of the group, IndVal >55%). Other species must be considered as accidental ones, these are asymmetrical indicators (their presence cannot be predicted in all samples of one habitat, but contributes to the habitat specificity, IndVal <55%). The index for a given species is independent of the other species relative abundances (Dufrêne, M. – Legendre, P. 1997). The statistical significance of the species indicator values is evaluated using a randomisation procedure by 1000 random permutations. The IndVal2 package (Dufrêne, M. – Legendre, M. 1997) was used for the computations.

## Results

The preliminary field surveys were carried out in 1997. The *Verigo alpestris* species was found only in these samplings. In 1998 and 1999 we went on the investigation. We identified 10545 specimens of 44 species listed below in taxonomic order (*V. alpestris* preliminarily found is signed with an asterisk):

*Carychium tridentatum* (Risso, 1826)
*Succinea oblonga* (Draparnaud, 1801)
*Cochlicopa lubrica* (O. F. Müller, 1774)
*Cochlicopa lubricella* (Porro, 1838)
*Pyramidula rupestris* (Draparnaud, 1801)
*Columella edentula* (Draparnaud, 1805)
*Truncatellina cylindrica* (Férussac, 1807)
*Truncatellina claustralis* (Gredler, 1856)
*Vertigo pusilla (*O. F. Müller, 1774)
*Vertigo pygmaea* (Draparnaud, 1801)
**Vertigo alpestris (*Alder, 1838)
*Chondrina clienta* (Westerlund, 1883)
*Granaria frumentum* (Draparnaud, 1801)
*Pupilla triplicata* (Studer, 1820)
*Vallonia costata* (O. F. Müller, 1774)
*Vallonia pulchella* (O. F. Müller, 1774)

*Acanthinula aculeata* (O. F. Müller, 1774)
*Chondrula tridens* (O. F. Müller, 1774)
*Ena obscura* (O. F. Müller, 1774)
*Punctum pygmaeum* (Draparnaud, 1801)
*Vitrina pellucida* (O. F. Müller, 1774)
*Vitrea diaphana* (Studer, 1820)
*Vitrea contracta* (Westerlund, 1871)
*Aegopinella minor* (Stabile, 1864)
*Oxychilus draparnaudi* (Beck, 1837)
*Oxychilus glaber* (Rossmässler, 1835)
*Oxychilus inopinatus* (Ulicny, 1887)
*Daudebardia rufa* (Draparnaud, 1805)
*Daudebardia brevipes* (Draparnaud, 1805)
*Euconulus fulvus* (O. F. Müller, 1774)
*Cecilioides acicula* (O. F. Müller, 1774)
*Cochlodina laminata* (Montagu, 1803)
*Cochlodina orthostoma* (Menke, 1830)
*Cochlodina cerata*(Rossmässler, 1836)
*Balea biplicata* (Montagu, 1803)
*Laciniaria plicata* (Draparnaud, 1801)
*Helicella obvia* (Menke, 1828)
*Perforatella incarnata* (O. F. Müller, 1774)
*Perforatella vicina* (Rossmässler, 1842)
*Euomphalia strigella* (Draparnaud, 1801)
*Helicodonta obvoluta* (O. F. Müller, 1774)
*Chilostoma faustinum* (Rossmässler, 1835)
*Isognomostoma isognomostoma* (Schröter, 1784)
*Cepaea vindobonensis* (Férrusac, 1821)
*Helix pomatia* (Linneaus, 1758)

## Discussion

*Statistical evaluation*

The multivariate analysis of our data is presented in Figs. 2 and 3. The ordination (Fig. 2) is based on the soil samples. The samples taken from the same site are close to each other. In Fig. 2 we can differentiate between tree more or less distinct group. The first group consists of the closed areas (site 1–3) except for the spruce plantation (site 4) which is well separated. The second group is more compact and consists of the areas with transitional and closed vegetation (site 5–10). The sampling sites are arranged along a “horseshoe” which represents a forest-field gradient (Fig. 2).

Because samples taken from the same site form coherent groups, we used the average number of individuals per site (the total number of individuals was divided by the number of samples). Fig. 3 shows the result of the cluster analysis, where site 4 is placed into the same group with the site1–3 group. The other cluster group consists of site 5–10. This clas-

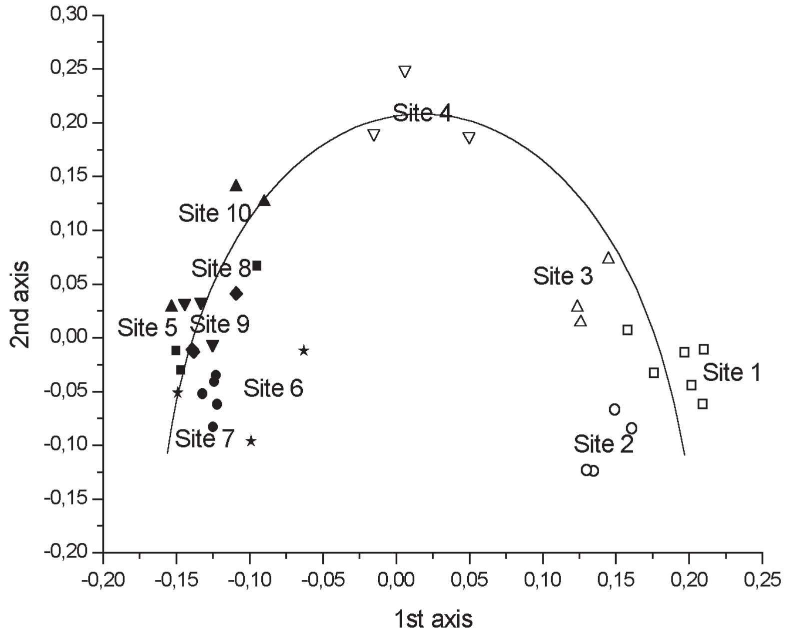


Fig. 2. Ordination of the soil samples with nonmetric multidimensional scaling (stress = 0.0819776). The Bray-Curtis dissimilarity index was used.

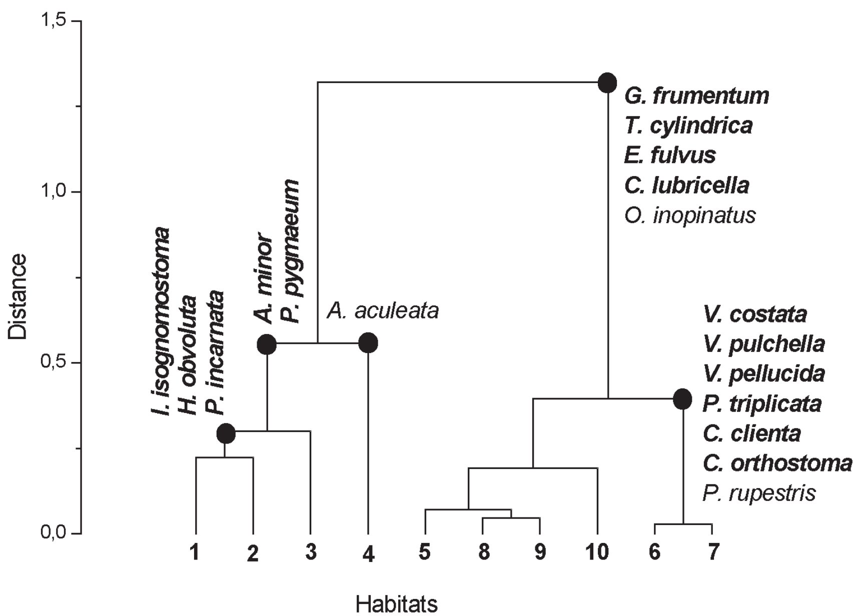


Fig. 3. Cluster analysis of the sampling sites (1–10) and the character species of the main cluster hierarchy. The Bray-Curtis dissimilarity index and Ward-Orlóci fusion method was applied. Symmetrical indicators are typed with boldfaced letters.

Table 2. Two-way indicator table with the distribution of individuals among the sampling sites. Second numbers show the fidelity of the species in a given site (presence per the soil samples taken). The ranks of the column headings correspond to those of Fig. 3. The IndVal column indicates the maximum species indicator value observed in the clustering hierarchy represented by boldfaced numbers in the site columns. + = specimens collected besides the soil sampling, * = p<0.05 level, ns = no significance, ? = insufficient data to test the significance.

| Species | IndVal (%) | Sampling sites | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | **1** | **2** | **3** | **4** | **5** | **8** | **9** | **10** | **6** | **7** |
| Ena obscura | 50.00 * | **14/3** | – | – | – | – | – | – | – | – | – |
| Columella edentula | 44.12 * | **15/3** | – | 1/1 | – | – | – | – | – | – | – |
| Daudebardia brevipes | 16.67 ns | 1/1 | – | – | – | – | – | – | – | – | – |
| Cochlodina laminata | 16.67 ns | 1/1 | – | – | – | – | – | – | – | + | – |
| Isognomostoma isognomostoma | 100.00 * | **10/6** | **78/6** | – | – | – | – | – | – | – | – |
| Helicodonta obvoluta | 88.58 * | **17/5** | **26/6** | – | – | – | – | – | – | – | 1/1 |
| Perforatella incarnata | 66.67 * | **18/4** | **6/4** | – | – | – | – | – | – | – | – |
| Vitrea diaphana | 95.59 * | 12/4 | **260/6** | – | – | – | – | – | – | – | – |
| Chilostoma faustinum | 90.32 * | + | **14/6** | – | – | 2/2 | – | 1/1 | – | – | – |
| Vertigo pusilla | 83.28 * | 3/2 | **66/6** | 4/1 | – | – | – | – | – | 1/1 | 2/1 |
| Daudebardia rufa | 81.48 * | 5/3 | **22/6** | – | – | – | – | – | – | – | – |
| Truncatellina claustralis | 79.05 * | 23/3 | **602/6** | 5/2 | – | – | – | 1/1 | – | 137/2 | 31/5 |
| Perforatella vicina | 66.67 * | – | **8/4** | – | – | – | – | – | – | – | – |
| Oxychilus draparnaudi | 61.11 * | 2/2 | **22/4** | – | – | – | – | – | – | – | – |
| Laciniaria plicata | 33.33 ? | + | 2/2 | – | – | – | – | – | – | – | – |
| Aegopinella minor | 100.00 * | **222/6** | **224/6** | **54/3** | – | – | – | – | – | – | – |
| Punctum pygmaeum | 88.70 * | **263/6** | **28/6** | **6/2** | 1/1 | – | – | – | – | 9/1 | 5/1 |
| Carychium tridentatum | 98.82 * | – | 1/1 | **21/3** | – | – | – | – | – | – | – |
| Euomphalia strigella | 90.91 * | 2/1 | – | **5/3** | – | – | – | – | – | – | – |
| Vitrea contracta | 75.00 * | 4/2 | – | **3/3** | – | – | – | – | – | – | – |
| Succinea oblonga | 33.33 ? | – | – | 1/1 | – | – | – | – | – | – | – |
| Cochlicopa lubrica | 33.33 ? | – | – | 2/1 | – | – | – | – | – | – | – |
| Cecilioides acicula | 33.33 ? | – | – | 1/1 | – | – | – | – | – | – | – |
| Limacidae | 22.22 ns | – | 2/2 | 1/1 | – | – | – | – | – | – | – |
| Acanthinula aculeata | 49.38 * | 1/1 | 4/4 | 2/2 | **7/2** | – | 7/2 | – | – | – | – |
| Helix pomatia | 33.33 ? | + | – | + | 1/1 | – | – | – | – | – | – |
| Chondrula tridens | 82.46 * | – | – | 3/2 | – | – | 2/1 | – | **19/3** | – | 1/1 |
| Helicella obvia | 33.33 ? | – | – | – | – | – | – | – | 2/1 | – | – |
| Cepaea vindobonensis | 31.86 ns | – | – | 2/2 | 2/1 | 1/1 | 2/1 | 2/1 | 3/3 | 2/2 | – |
| Granaria frumentum | 99.66 * | – | – | 1/1 | 7/3 | **451/3** | **320/3** | **302/3** | **233/3** | **327/3** | **937/5** |
| Truncatellina cylindrica | 89.69 * | – | – | 5/2 | 2/1 | **224/3** | **151/2** | **199/3** | **11/2** | **771/3** | **924/5** |
| Euconulus fulvus | 88.09 * | 2/2 | 4/4 | – | 7/2 | **79/3** | **17/3** | **6/2** | **3/2** | **174/3** | **388/5** |
| Cochlicopa lubricella | 74.36 * | – | 1/1 | 4/2 | – | **164/3** | **66/3** | **11/1** | + | **161/3** | **247/5** |
| Oxychilus inopinatus | 50.00 * | – | – | – | – | **4/2** | **3/2** | **2/1** | **3/1** | **3/1** | **19/3** |
| Vallonia costata | 94.36 * | – | 2/2 | – | – | 7/3 | 68/2 | 33/1 | – | **518/3** | **704/5** |
| Vallonia pulchella | 84.74 * | – | – | 2/1 | – | 7/3 | 40/3 | 13/3 | – | **57/3** | **171/5** |
| Vitrina pellucida | 84.27 * | 1/1 | 4/2 | 6/3 | – | 18/3 | 7/2 | 4/3 | – | **66/3** | **69/5** |
| Pupilla triplicata | 80.92 * | – | – | – | – | – | 6/2 | 4/1 | – | **45/3** | **37/4** |
| Chondrina clienta | 76.72 * | – | 2/2 | – | 2/1 | 8/2 | 315/2 | 36/1 | – | **100/3** | **710/5** |
| Cochlodina orthostoma | 56.98 * | – | 4/2 | – | – | – | – | – | – | **8/2** | **14/3** |
| Pyramidula rupestris | 50.00 * | – | – | – | – | – | – | – | – | **86/2** | **113/2** |
| Balea biplicata | 36.18 ? | – | 30/2 | – | – | – | – | – | – | 5/2 | 17/3 |
| Oxychilus glaber | 40.00 ns | – | – | – | – | – | – | – | – | – | 21/2 |
| Vertigo pygmaea | 20.00 ns | – | – | – | – | – | – | – | – | – | 1/1 |
| Cochlodina cerata | 14.12 ns | 1/1 | – | – | – | – | – | + | – | – | 2/1 |
| Clausiliidae indet. | | 31/6 | 392/6 | – | – | 2/1 | – | 4/2 | – | 46/3 | 360/3 |
| Total | | 617/6 | 1412/6 | 129/3 | 29/3 | 965/3 | 1004/3 | 614/3 | 274/3 | 2470/3 | 4414/5 |

sification reflects the differences in the plant cover rather than the differences in the exposures. Site 1–4 are characterised by closed vegetation, while site 5-10 are characterised by open (site 8–10) or transitional (site 6–7) vegetation.

The closed cluster group has no own character species due to the differences between site 1–3 and the spruce forest (site 4). The individual and species numbers of the not native spruce forest are extremely low (Table 2). *Acanthinula aculeata* (IndVal = 49.38%) is a significant but not true indicator of this area.

The group of site 1–3 has its own true character species: *Aegopinella minor* (IndVal = 100.00%) and *Punctum pygmaeum* (IndVal = 88.70%). These species and the *A. aculeata* are characteristic to the dry forests of Hungary.

Out of the non-native spruce and acacia forests, the remaining native beech and linden-ash forests (site 1–2) has their own true indicator species, which are montane elements: *Isognomostoma isognomostoma* (IndVal = 100.00%), *Helicodonta obvoluta* (IndVal = 88.58%), *Perforatella incarnata* (IndVal = 66.67%). All the sites of this closed cluster group has several character species (Table 2).

The second main cluster group, the open and transitional group has four true and one asymmetrical character species: *Granaria frumentum* (IndVal = 99.66%), *Truncatellina cylindrica* (IndVal = 89.69%), *Euconulus fulvus* (IndVal = 88.09%), *Cochlicopa lubricella* (IndVal = 74.36%) and *Oxychilus inopinatus* (IndVal = 50.00%).

The separation of the transitional areas is interesting. The *Spirea* shrub was placed nto the group of the open habitat. The *Spirea* shrub serves light conditions similar to the dense grasslands since its height is more similar to the tall grasses than to the filbert plants.

The filbert shrub (site 6) was joined with the adjacent rock cavities (site 7). Site 6 and 7 have six true and one asymmetrical indicator species: *Vallonia costata* (IndVal = 94.36%), *Vallonia pulchella* (IndVal = 84.74%), *Vitrina pellucida* (IndVal = 84.27%), *Pupilla triplicata* (IndVal = 80.92%), *Chondrina clienta* (IndVal = 76.72%), *Cochlodina orthostoma* (IndVal = 56.98%) and *Pyramidula rupestris* (IndVal = 50.00%).

These results support the belief, that cover plays essential role in the organisation of the snail assemblages, while exposure has relatively minor importance compared to cover.

### *Habitat preferences of the two Truncatellina species*

Three *Truncatellina* species occur in the Hungarian land snail fauna. These are sympatric only in some areas, e.g. on some hills in the Buda Mts. and on the Szársomlyó (Sólymos, P. 2000, 2001). Here two of them are sympatric. The abundances are very different as it is shown in Table 2 and in Fig. 4. This difference is caused by the ecological tolerance of the species. Both species occur in the S and the NW part of the hill, but they prefer different vegetation structures. *Truncatellina cylindrica* is more dominant in open (steppe and rocky grasslands) and transitional (shrub) vegetation, and this is the character species of the not-open cluster part (IndVal = 89.69%). *T. claustralis* came out from the closed forest vegetation and less frequently from transitional shrub areas. It is the character species of site 2 (linden-ash forest, IndVal = 79.05%).

We can see that in the open and closed vegetation the two species are allopatric. The most interesting areas are the transitional areas where these are sympatric (site 3, 6–7). These areas are mixed mosaics of different habitats, and the coexistence is due to the small scale patch-

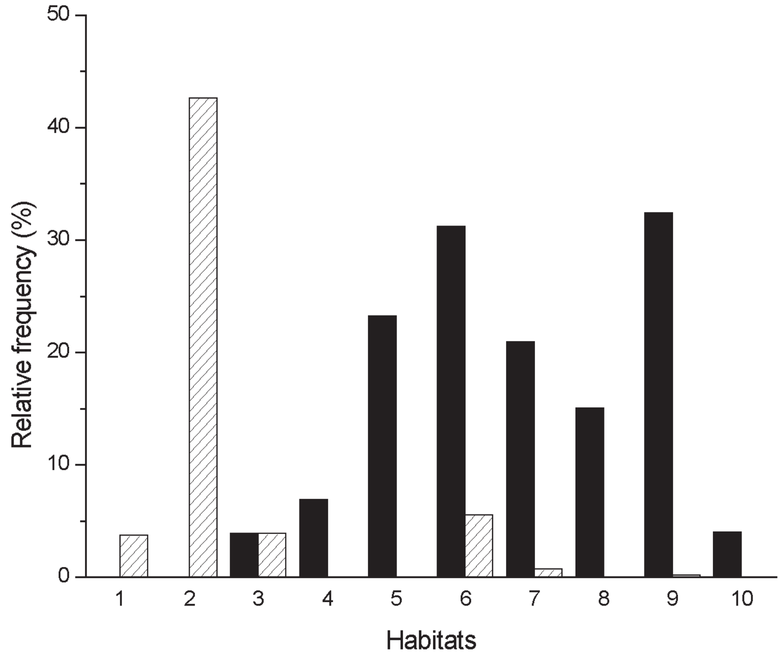


Fig. 4. Relative frequency values of the two *Truncatellina* species in the different habitats. Filled columns = *Truncatellina cylindrica*, shaded columns = *Truncatellina claustralis*.

iness of the habitats. Probably these are not the optimal habitats for the two *Truncatellina* species although these can serve tolerable conditions for several coexisting species with different ecological demands. Similar results were detected on the Szársomlyó (Sólymos, P. 2001)

*Island effect in the malacofauna*

The sympatric occurrence of the *Verigo alpestris* and *Pupilla triplicata* raises up an interesting question about the faunal history of the Esztramos. Both species was more prevalent in the Carpathian Basin during the last glacial (Würm III.) than it is today (Krolopp, E. – Sümegi, P. 1992). The *P. triplicata* is characteristic to the extremely xeric periods of the glacials, and this is supported by the composition of the accompanying species. Recent distribution data seems to be in contrast with the Quaternary data. This species is absent from the xeric S habitats of the Esztramos, but it occurs on the steep NW slope where the vegetation, the exposure and some other species all indicates milder microclimate. The picture is similar on our southernmost and so called submediterranean island hill, the Szársomlyó. Here the *P. triplicata* was found in rock cavities and under moss on the ridge region of the hill (Sólymos, P. 2000). But the air temperature reach extremes in these shaded environments as well.

On the contrary the *Vertigo alpestris* is characteristic to the cooling periods of the glacials and this species is a rare arctic-alpine relict in Hungary (Krolopp, E.–Sümegi, P. 1993). The sympatric occurrence of this two species on the Esztramos reflects the double relict effect and can be explained by the several microclimatic nooks. These different microhabitats are close to each other so animals can move from one to another in a changing environment. *P. tiplicata* and *V. alpestris* are glacial relicts of the Esztramos.

The Carpathian Basin was ruled by forest dwelling snail species during the postglacial forest period (Deli et al. 1995, Deli, T. 1997). The earliest forest types of this period are no can be found as linden-ash rocky forest and ravine forests. Today the postglacial faunal elements occur in these forest types. So these are considered as postglacial relict habitats. These are now very fragmented on the Esztramos. *Ena obscura*, *Oxychilus glaber*, *Cochlodina orthostoma*, and *Vertigo pusilla* are characteristic to these habitats.

While the *Vertigo alpestris* lives in open rocky grasslands (in cavities and in the soil under *Saxifraga paniculata* polycormons and mosses), the *Vertigo pusilla* lives under the leaf litter of *Spirea media*, *Coryllus avellana* and *Sorbus* species.

## Összefoglalás

Az Aggteleki Nemzeti Park területén található Esztramos-hegy malakofaunisztikai vizsgálatát az 1997-es évben kezdtük el. Ekkor tájékozódó jelleggel egyeléses módszerrel gyűjtöttünk csigákat, illetve nagyjából kétszer 4 liter földminta kiválogatásával további apró fajokhoz jutottunk. A *Vertigo alpestris* és a *Pupilla triplicata* fajok együttes előfordulása igazi kuriózum. A megtalált fauna összetétele alapján szükségesnek látszott a módszeresebb faunisztikai vizsgálat.

Az 1998–99-es években az egyeléses gyűjtés mellett 12 mintavételi területet jelöltünk ki. A kijelölt élőhelyek mindegyikén 3–3db 25 cm x 25 cm x 5 cm-es földmintát gyűjtöttünk. A minták feldolgozása során 44 fajhoz tartozó 10 545 egyedet határoztunk meg.

Kiértékelés során statisztikai módszerekkel hasonlítottuk össze az egyes mintavételi területeket. Eredményeink azt mutatják, hogy az esztramosi csiga-együttesek a növényzeti struktúrára érzékenyebben reagálnak, mint a kitettségből adódó mikroklimatikus eltérésekre.

Megvizsgáltuk a területen élő két *Truncatellina* faj dominancia viszonyait is. Az eredményekből egyértelműen látható, hogy a *T. cylindrica* a nyílt vegetációhoz kötődik, a *T. claustralis* pedig a zárt erdei vegetációt követi. Az átmeneti növényzeti struktúrával rendelkező cserjésekben mindkét faj együttes előfordulása jelzi az élőhely átmeneti jellegét.

A faunisztikai eredmények alapján szigetfaunaként értelmeztük az Esztramos-hegy szárazföldi Mollusca faunáját. Itt ugyanis viszonylag szűk területen együtt fordulnak elő a jégkorszakok stadiálisaiból és interstadiálisaiból származó, valamint a pleisztocén végi beerdősülés során megjelenő reliktum fajok. Ez a kicsiny mozaikokból álló refúgiumterület természetvédelmi szempontból az Aggteleki Nemzeti Park egyik legértékesebb részét képezi.

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DELI, Tamás
TUKARCS, Veronika
SÓLYMOS, Péter
Department of Zoology
University of Debrecen
4010 DEBRECEN
P. O. Box 3
E-mail: tdobo@freemail.hu,
solymos@tigris.klte.hu