Terrestrial snail fauna in the Someş/Szamos[1] River Valley from the spring region to the inflow into the river Tisza

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Abstract

The sampling sites included montane and lowland riparian plant communities of early or advanced successional stages as well as forests of hilly region, which often extend_to riverbanks. The plant communities differ from each other by the composition of their snail assemblages, as it is proved by the results of cluster and principal component analyses. It was concluded, that ubiquitous and continental species (*Bradybaena, Deroceras rodnae, Succinea putris, Helix lutescens*) dominate among snails transported by the Someş/Szamos over long distances. Species of narrow ecological tolerance range can be found in the riparian vegetation of the Someş/Szamos Valley and also of minor watercourses arriving from neighbouring hills and mountains. The fauna dispersal from the spring region is hampered by water reservoirs, shrinkage of forest habitats to single row of trees along the river and the lack of riparian gallery forests in the flood area. The biotopes are subjected to the strongest human impact resulted from the forest management, or logging the flood plain into agricultural fields. The garbage disposal in/or near the riparian vegetation also cause major disturbances for the snail assemblages.

Keywords: Gastropoda, human impact, Someş/Szamos River Valley

Introduction

A scientific expedition was organised in the valley of river Someş/Szamos between 1-18. 06. 1992 with the aim of assessing the current biotic status of the river. During the field investigations special attention was paid to the influence of human activities on the microflora and invertebrate fauna of the river, and on its natural self-purification. It was also followed how the prevailing water quality and the environmental conditions affects the capacity of the river for transporting fauna elements along its course. This process is decisive in settling of montane invertebrates (e.g. snails) of more or less narrow ecological tolerance range in plant communities on the Great Hungarian Plain, even far beyond the borders of Romania. The invertebrate fauna populating the environs of the river Szamos were studied by Erdős (1935) and by Bába (1968-69, 1970, 1972, 1973, 1974, 1975, 1977, 1978, 1979, 1980-81, 1983 a, b, 1986, 1991, 1992 a), studying beetles and snails respectively.

[1] The first name is Romanian, and the second Hungarian

Materials and methods

Sixteen major sampling sites were appointed for the expedition, but not all of them were appropriate for collecting snails. Snail data were gathered from further localities (1b, 16, 1a, 19-25) during rest periods. Mostly the quadrate method (with plots of 10x25x25 cm) was used for sampling snail assemblages, but on sites 19-25 snails were collected by thinning. For comparison, two additional localities (17-18 quadrates) situated close to the country borders were also analysed. The sampling sites, the snail species found and several calculated parameters are listed in Table. The field data (from both quadrates and thinning) were analysed by ecological and zoogeographical techniques.

During the data analysis we focused on two main points, namely on the dispersal ability of species and on the ecological status of snail assemblages in plant communities studied by the quadrate method.

An area-analytical zoogeographical technique (Bába, 1982) was used to study the dispersal characteristics of snail species.

The following fauna groups were distinguished: climatically continental groups: 1. Siberian-Asian (1.1. East Siberian, 1.2. West Siberian, 1.3 Euro-Siberian, 1.4. Holarctic), 3. Kaspi-Sarmatian, 4. Ponto-Pannonic, 9.5. Daco-Podolian, 10.1. Boreo-alpine; climatically subatlantic groups: 2.1. Central Asian xeromontane, 5. Ponto-Mediterranean (5.2.1. *Quercion frainetto,* 5.2.2. *Fagion illyricum-moesiacum*), 6. Adriato-Mediterranean, 7. Atlanto-Mediterranean, 8. Holomediterranean, 9. Central European montane (9.1. Carpathian, 9.2. Carpatho-Sudetian, 9.3. Carpatho-Baltic, 9.4. Alpo-Carpathian), 10.2. Boreo-montane.

The species distribution data reported by Grossu (1981, 1983, 1987), Soós (1943) and Lozek (1964) were also considered in *Argna bielzi, Carpathica calophana, Cochlodina marisi, Balea stabilis, Vestia elata, Vestia gulo* and *Trichia bielzi* in groups 9.1. or 9.2.. The occurrence of *Vitrea transsylvanica* and *Balea fallax* in Bulgaria (Serafim-Liharev, 1975) justified to put them into the group 5.2.2.

In order to observe changes in the structural composition of snail assemblages the following variables were used: abundance (A/m^2), species density (mean number of species in ten quadrates), percentage proportion of juvenile individuals, percentage of mortality, Shannon-Wiener diversity (H') and the habitat typology system of Lozek (1964-65) and Lisicky (1991). Following the notation of Lozek, four major groups were distinguished, namely the forest dwellers (W, amalgamating Lozek's W, Wh and Wm groups), bush forest dwellers (BW, comprising Lozek's SW, OW, WS, WM, M and Wf groups), riparian species (RU, including Lozek's H and P groups), and steppe dwellers (S, created from the groups of O, X, Sf and S).

The ecological groups obtained by the block clustering method of Feoli & Orlóczi (1979) (Bába & Podani, 1992b) were used in accordance with the data of Grossu (1981, 1983, 1987), Soós (1943), Lisicky (1991) and Kerney et al. (1983) for the zoogeographical group assignments of species listed before. Five categories were recognised: 1. hydrophilous montane-submontane species, 2. subhydrophilous species, 3. riparian hydrophilous species, 4. mesophilous-mesoxerophilous elements, 5. ubiquitarian components.

The relationships among snail assemblages were analysed by the Sokal-Michener group average clustering method and by Principal Coordinates Analysis (PRINCOOR, Podani 1988).

The characteristics used for the analysis of structural composition of snail assemblages are listed in Table.

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Sampling sites and plant communities

The sampling sites listed in Table 1. are of two types depending on the sampling technique used (thinning or quadrate method), which is reflected also in their numbering. For each plant community the altitude above sea-level, annual precipitation (Tufescu, 1965) and magnitude of river fall (m/km) are given in this order. The numbers signing sites were inappropriate for snail collection are omitted.

Gilău Mountains; Someşul Cald

1.a. Cliffs above the spring Bazarul-Someşului, 03. 06. 1992 (thinning) by Gheoca V., 1250-1300 m a.s.l. 1.b. Ic Ponor, 150 m downstream of the spring, a *Petasitetum albae* (Klika, 1954) stand of about 20 cm height (1200 m a.s.l., limestone bedrock, 1500 mm, 5 m/km). 19/1. On site 1.b. thinning from rocks along a path escorting the creek. 20/1. In the creek wave area in the neighbourhood of the „Rumen Ars" forester's lodge. 1.c.2,5 km downstream of 1.b., in a primordial stand of *Alnetum incanae-Petasitetum albae* (*Rumex obtusifolius, Caltha pelta, Salix eleagnos, Salix caprea*; about 1100 m a.s.l., metamorphic rocks, biotitic paragneis, 1500 mm, 5 m/km).

Muntele Mare: Someşul Rece

2. Blăjoaia, 04. 06. 1992. Due to deforestation and heavy grazing by sheep, the soil is substantially acidified, on which peat bogs and swamps of *Sphagnetalia Pawlowski, 1928*, and *Nardetalia Passarage, 1949* plant communities developed. Especially the *Polytrichum juncetum* plant community forms large stands (1350 m a.s.l., granite, 1200 mm). According to measurements on the site, the soil pH was 5,5 on the bank of the stream. 21/2: Near the water reservoir at the confluence of the two Someş/Szamos branches upstream Gilău. 05. 06. 1992. On the bank in a *Querco petreae Carpinetum* stand.

Someşul Mic.

3. Upstream Cluj, 07. 06. 1992. *Salicetum albae fragilis* Isser 1926 (*Galium aparine, Urtica dioica, Rubus sp.,* some *Agrostis stolonifera, Aegopodium podagraria*; disturbed site, 350 m a.s.l., sand, silt, Eocene marl and sandstone, 700 mm, 3m/km).

4. Downstream Cluj, 07. 06. 1992. *Salicetum albae fragilis* Isser 1926 (*Galium aparine, Rubus sp., Urtica dioica,* some *Aegopodium podagraria*; disturbed site, 330 m a.s.l., sand on Sarmatian marl, silt, 700 mm, 1,7 m/km).

5. Downstream Gherla, 22/5 upstream the village Nima, 08. 06. 1992. Thinning in tall vegetation along the stream.

Rodna Mountains: Someşul Mare River

6.a. 500 m downstream of the spring, upstream Valea Mare, 08. 06. 1992, initial phase of *Petasitetum kablikiana* Paul et. Wales (1936) 1946 (Coldea 1990), 900 m a.s.l., gneiss, 1400 mm, 5 m/km.

6.b. Downstream of Valea Mare, before Arieş. 09. 06. 1992, *Petasitetum kablikiana* Paul et. Wales (1936) 1946 (Coldea, 1990) (*Athyrium filix-femina, Rumex obtusus, Abieto-Fagetum* zone, 700 m a.s.l., gneiss, 1400 mm, 5 m/km).

7. Downstream Sângeorgi Băi, 09. 06. 1992. Primordial stand of *Telekio-Alnetum incanae* Coldea, 1990, with *Aegopodium podagraria, Mentha aquatica, Athyrium filix-femina.* In a narrow strip along the bank of the stream close to a plough-land, 480 m a.s.l., sandy silt, 1000 mm, 4,5 m/km.

Someş/Szamos

9. Downstream Beclean, 10. 06. 1992. *Salicetum albae-fragilis* Isser 1926. Single row of trees on a steep bank (*Galium aparine, Rubus sp., Scrophularia nodosa*), near a cornfield, 250 m a.s.l., clay on volcanic bedrock, 800 mm, 2 m/km. 23/9 Downstream Beclean, 10. 06. 1992.

10. Căşeiu, 10. 06. 1992. *Salicetum albae-fragilis* Isser, 1926, consotiation *Populus nigra / Urtica dioica*, mass occurrence of the adventive *Helianthetum decapitatus.* Single row of trees among agricultural fields, 225 m a.s.l., marl and clay on sandstone bedrock, 700 mm, 1,5 m/km.

12. Sălsig. 24/12 Benesat, 11. 06. 1992. Upstream of Sălsig at a railway viaduct, 70 m away from the river on the edge of a *Querco petreae-Carpinetum* Soó 1957 stand. Thinning, 164 m a.s.l., gravely soil, 700 mm, 1 m/km.

13. Pomi, 11. 06. 1992. *Quercetum petreae-Carpinetum* Soó 1957 stand extending down to the riverbank. Hilly region in the environs of Gutin Mountains. A small creek reaches the Someş/Szamos in the neighbourhood of the sampling site at Pomi (*Lamium galeobdolon, Chrysantemum corymbosum, Echinocystis echinata*). 142 m a.s.l., sandy clay on andesite bedrock, 800 mm, 1 m/km. 25/12. A forest stand owned by the village Agrişu de Jos in the environs of Fersig-Mireşu-Mare. Canals go through and around the oak forest. Collection by thinning.

14. Upstream Satu Mare, 12. 06. 1992. *Salicetum albae-fragilis* Isser 1926. On a high bank of 50-100 m width, some 30 m away from the river in a much thinned vegetation

(*Rubus sp., Aristolochia clematitis, Agrostis stolonifera*). 115 m a.s.l., alluvial sand and clay, 700 mm, 1 m/km.

15. Downstream Satu Mare, 12. 06. 1992. *Salicetum triandrae* Müller-Görs 1958 on a flat river bank (*Phragmites australis, Lycopus exaltatus, Agrostis stolonifera*). 115 m a.s.l., alluvial sand, 700 mm, 1 m/km.

16. The confluence with river Tisza, at Vásárosnamény. *Salicetum triandrae* Müller-Görs 1958 on a steep bank (*Rubus sp., Calystegia sepium,* 100 m a.s.l., alluvial sand, 700 mm, 1 m/km).

17. Sárkánykert at the Szamos/Someş confluence with river Tisza, 30. 08. 1966. *Salicetum albae-fragilis* Isser 1926. *Rubus sp., Echinocystis lobata,* alluvial sand.

18. Vásárosnamény, steep bank of the Tisza, 31. 07. 1967. *Salicetum triandrae* Müller-Görs 1958, alluvial sand.

The geographical location of each sampling site is shown in Figure 1.

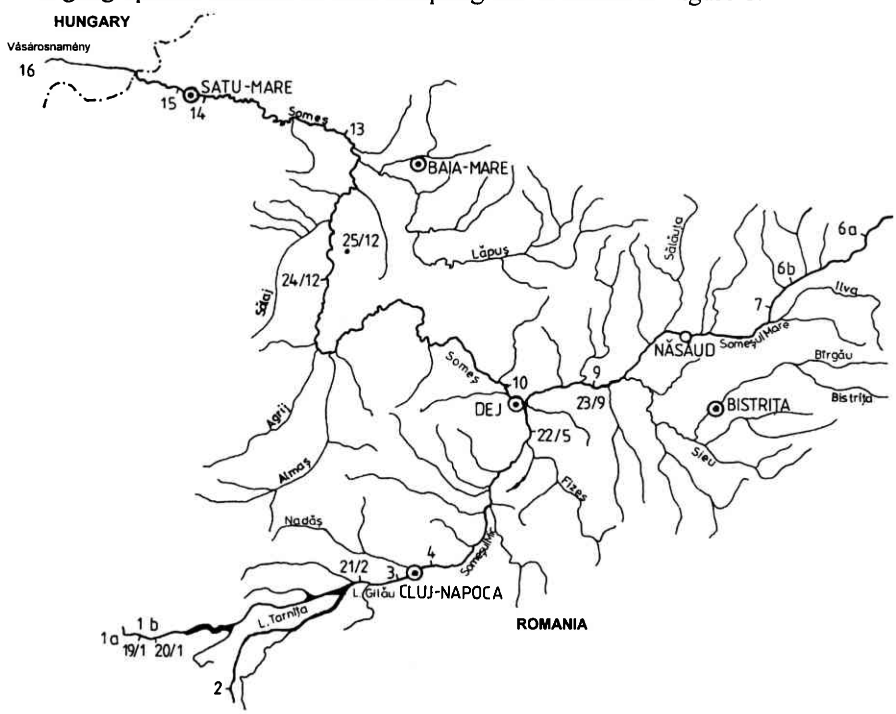


Figure 1. Map of the geographical distribution of sampling sites along the Someş/Szamos river

Environmental status of sampling sites

Under given climatic conditions the animals (snails inclusively) will develop a homogenous zoocoenotic character within a geographic region with free migration. The forests (Bába 1992 a) and running waters serve as routes for fauna dispersal, provided that these ecological corridors are undisturbed (Erdősi, 1935; Bába, 1978, 1979; Bába et al. 1982-83; Bába, 1992 a). Examining the entire length of the river Someş/Szamos in this respect, we found everywhere evidences of inhibition of fauna migration and biodiversity development by human activities. The fauna movements generally start from the direction of mountains. The human effects hindering fauna dispersal occur up to the montane zone of all three mountains considered. These effects are of various kind. In order to slow water running people often build wood weirs in streambeds, which lead to the death of riparian tall communities (at Munţii Gilău and Rodna). The *Petasitetum* stand emerging after the disturbance are not taller than 20 cm. The cover of riparian vegetation is disrupted by man-made constructions, supporting roads along the watercourse. The reservoirs (at Munţii Gilăului) or local water barriers hamper the continuous fauna movement and with high precipitation lead to soil acidification and degradation over large areas. The intensive deforestation and grazing, both retarding the regeneration of the original vegetation (Muntele Mare) further amplify this latter process. In this mountain only one specimen of *Arion subfuscus* was found after several kilometres of thorough investigation.

At lower altitudes the crop production and animal husbandry confines the natural riparian vegetation to a narrow band (sampling sites 9 and 10). The plastic and metal wastes thrown away by the local population along the river are carried over several tens of kilometres when the water level is high (site 7). A municipal dumping ground has been settled near the sampling site 14. On the lowland, the river flood plain is completely treeless, thus there are no refugees for the fauna, which existed in the previous century to control the Someş/Szamos waterway.

In contrast with these impediments on the lowland (Great Hungarian Plain), the fauna migration is facilitated by numerous smaller watercourses coming from the neighbouring mountains and hilly regions and reaching the Szamos/Someş (sampling sites 10 and 13).

Results and discussions

1. Species recorded and their distribution

The expedition in the Someş/Szamos Valley resulted in a collection of 763 living individuals and 168 shells belonging to 58 species (data of sites 17 and 18 are not included). Some species are montane forest dwellers requiring high moisture content in biotopes (ecological species group 1). Zoogeographically these are (East) Carpathian (9.1), *Fagion illyricum-moesiacum* (5.2.2.) or xeromontane (2.1.) elements. Their distribution to lowland till the river could not be proved. This is not probable for the xeromontane rock dwellers (Table ; species 4, 5, 14), the Boreo-montane species (10.2.; *Ena montana*) and the Carpathian and Balkan montane species (*Argna, Semilimax, Vitrea transylvanica, V. diaphana, Carpathica, Cochlodina marisi, Balea fallax, B. stabilis, Vestia, Bulgarica, Trichia bielzi*).

The large water surface of the reservoir at Gilăului markedly reduces the temperature fluctuations in its environs. This altered mesoclimate promotes settling of the

Carpathica species of high moisture requirements even at the foothills. The occurrence of *Ruthenica filograna* and *Trichia hispida* at the edge of a *Querco p. Carpinetum* forest stand is due to the close proximity of a hilly region and the fauna transportation by countless unnamed minor watercourses. These two species turn up in the flood plain of the Someş/Szamos, as *Querco petreae-Carpinetum* stands proceeding down to the riverbank (site 15).

Similar factors promote *Cochlodina laminata* and *Perforatella vicina* to reach lowland areas with annual precipitation above 600 mm (sampling sites 13 and 17). These two species are widespread on the northern part of the Great Hungarian Plane in Hungary, where large forested areas were and still are. Hungarian researches (Bába 1977, 1983a, 1986) showed that the riparian forests (*Fraxino-Ulmetum*) enable the establishment of river-carried montane snail species need high moisture. There are not such forest types in the flood area on the Romanian part of the Someş/Szamos Valley. Data from sites 22/9 and 24/2 show that *Perforatella vicina* is able to inhabit thickets growing on the riverbank.

The absence of the Daco-Podolian *Hygromeria transsylvanica* and *Chilostoma banaticum* - both requiring continental climatic conditions - is due to the lack of gallery forests along the lowland reaches of the Someş/Szamos. This is in contrast with the pattern found earlier in the flood area of the river Mureş (Soós, 1943), where these two species coexisted with *Arianta arbustorum* in extensive gallery forests. Their occurrence in the Hungarian part of the Mureş was proved by the author's own collection in 1972. *Cochlodina laminata* was found to be associated with *Perforatella vicina* at several localities near Vásárosnamény downstream the confluence of the Someş/Szamos and Tisza rivers (Bába, 1992 d).

The co-occurrence of *Chilostoma* and *Hygromia* at Benesat in a thicket growing underneath a railway viaduct (site 24/12) is supposedly due to the fauna distribution by waterways from the nearby Ţibleş Mountains, whence both snail groups have been reported earlier (Grossu 1983). Probably the same is true for *Trichia bielzi*. The water reservoirs and the treeless conditions of the flood areas at foothills might hamper their further dispersal downstream of Gilau Mountains and Rodna Mountains. The appearance of *Chilostoma* in the high flood area on site 3 may be the remnant of a former population.

In three snail species an unhindered distribution was observed in the riparian zone along the Someş/Szamos. *Bradybaena fruticum* is a continental ubiquitous species living in riparian tall communities, thickets and grassy places influenced by human activities along the watercourse. *Helix lutescens* is a Ponto-Pannonian species with continental climatic preferences, which inhabits tree rows and banks and narrow places between these and adjoining agricultural fields. Its distribution along the river has also been observed earlier (Soós, 1943). Both species were also found at Vásárosnamény even in sites not listed in Table Numerous individuals of the amphibian (continental) *Succinea putris* were observed downstream Beclean on rocks emerging from the water of Someş/Szamos.

The third freely distributed species is the ubiquitous *Deroceras rodnae* with an Alpino-Carpathian area. Due to its high moisture requirements this species follows rivers closely.

Analysing the distribution patterns of 48 montane snail species, it has been established that the migration along the rivers is hindered not only by the treelessness of the flood area, but also by water pollution. Thus, among the rivers entering Hungary from Transylvania, Crişul Repede does not carry any montane species because of its heavily polluted water (Bába, 1992 d).

2. Study of species distribution by zoogeographical methods

By the applied zoogeographical methods it was possible to follow geographically the distribution of fauna group elements. In Figure 2. the distribution of the four most important fauna groups distinguishing montane and lowland areas are shown. The Central Asian xeromontane, petrophilous elements (2.1) occur only at the upper reaches of the Someş/Szamos. Having high moisture requirements, the Boreo-alpine (10.1) and Boreo-montane (10.2) species occur in the montane zone or occasionally at lower places in humid gorges and river valleys. This is also true for *Arianta arbustorum*, which is similarly spread in gallery forests of the Danube Valley. The European montane elements (9.1, 9.2, 9.3, 9.4, 9.5), some continental (*Hygromia, Chilostoma*) and hydrophilous species of wide ecological tolerance range can also populate river valleys (e.g. *Perforatella bidentata*). The members of the Siberian-Asian fauna groups (1.1, 1.2, 1.3, 1.4) typically inhabit areas of lower altitude, although exceptionally they may occur in montane alder forests or in forests and grasslands underwent to human disturbances, where their proportion increases (Bába, 1992 c, e). They can also be considered as representatives of lowland fauna in contrast with the rest of the groups in Figure 2. having a montane character.

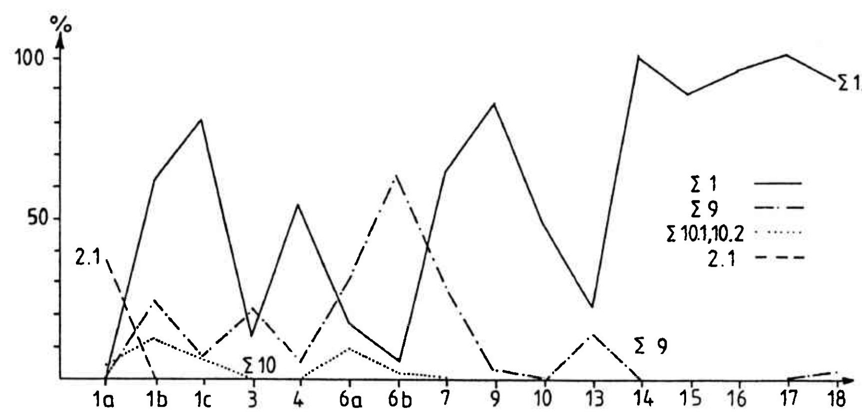


Figure 2. Percentage proportion of Siberian-Asian (1: 1.1, 1.2, 1.3, 1.4), Central European montane (9: 9.1, 9.2, 9.3, 9.4, 9.5), xeromontane (2.1), and Boreo-alpine / Boreo-montane (10: 10.1, 10.2) fauna groups of each sampling site

The fauna groups 2.1, 10/10.1 and 10.2 do not extend beyond the altitude of 400-600 m a.s.l. (Figure 2., *Pyramidula, Sphyradium, Arianta, Ena*: Table 1.). Among the European montane group, the hydrophilous Carpathian species of narrow tolerance range (*Cochlodina marisi, Balea stabilis, Vestia elata, Argna, Oxychilus orientalis, Trichia bielzi*) are similarly confined to the montane localities (the occurrence of *Trichia bielzi* at Benesat may results from immigration from neighbouring mountains).

The Carpatho-Sudetian (9.2) *Vestia gulo* and the East Baltic (9.3) *Ruthenica filograna* found in sampling site 13 is probably due to the influence of a local oak forest and creek. The same can be true for the snail assemblage on site 24/12.

The Alpo-Carpathian ubiquitous *Deroceras rodnae* (sites 15 and 16) and the Carpatho-Sudetian (9.2) *Perforatella vicina* (sites 22/5, 25, 12 and 17) species may extend their area much further. The high proportion of Siberian-Asian fauna groups on sites 1b, 1c, 4, 9, and 10 indicate human disturbances, while on sites 14, 16 and 18 it reflects the continental character of snail assemblages in primordial *Salicetum triandrae* stands (Bába, 1980 - 81).

Explantation of Table :

Sampling sites (sampled by the quadrate method) (1b, 1c), number of individuals, species diversity, abundance and diversity data, and abbreviations of zoogeographical (I) and ecological (II) species groups, and of Lozek's habitat types (III). Sites 17 and 18 are located in the Hungarian section of the rivers Someş/Szamos and Tisza, and serve as controls of collection during this expedition. Sites 19-25/1-12 are additional localities for snail collection, which were pointed out in the vicinity of major sites (19-25) and were sampled by thinning. The cross sign indicates species represented by shells on a given site.

Environmental status of sampling sites

1. Zoogeographical approach

The collective values of continental and subatlantic fauna groups - based on percentage abundance data - indicate the predominance of continental climate in lowlands, and subatlantic climate in the mountains (Bába, 1982, 1983, 1992 c, Bába et al. 1982 -83).

The ratio of continental fauna groups increases significantly as altitude and precipitation (Tufescu, 1965) simultaneously decrease (Figure 3.). The sampling sites at Gilău Mountains (1a), Rodna Mountains (6a, 6b) and those of hilly regions covered by typical forests (13) are dominated by subatlantic fauna elements. Lacking of continental patterns reflects human disturbances (sites 1b, 1c, 3, 4 and 10).

Species	I	II	III	1a	1b	1c	3	4	6a	6b	7	9	10	13	14	15	16	17	18	19/1	20/1	21/2	22/5	23/9	24/12	25/12	Σ
1 Succinea oblonga Draparnaud, 18	1.2	3	RU	-	-	-	-	-	-	-	+	-	-	-	1	-	1	5	-	-	-	-	-	-	-	-	7
2 Succinea putris Linné, 1758	1.1	3	RU	-	-	-	-	-	-	-	18	-	5	-	7	1	7	21	10	-	-	-	-	20	-	-	89
3 Succinea elegans Risso, 1826	8	3	RU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	2
4 Cochlicopa lubrica O.F. Muller, 1774	1.4	3	BW	-	-	2	-	-	1	-	2	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	10
5 Pyramidula rupestris Draparnaud, 1801	2.1	4	S	16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	16
6 Sphyradium doliolum Bruguière, 1792	2.1	2	W	-	-	-	-	-	-	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	+
7 Argna bielzi Rossmässler, 1859	9.1	1	W	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
8 Vallonia pulchella O.F. Müller, 1774	1.4	3	S	-	-	-	-	-	-	-	-	-	1	+	-	-	-	34	-	-	-	-	-	-	-	-	35
9 Ena montana Draparnaud, 1801	10.2	1	W	2	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
10 Discus ruderatus Ferussac, 1821	1.1	3	W	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
11 Arion subfuscus Draparnaud, 1805	1.1	2	W	-	2	1	1	-	2	1	1	6	2	1	-	9	1	-	-	4	-	-	-	2	-	-	30
12 Arion sylvaticus Lohmander, 1937	7	3	W	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	4
13 Vitrina pellucida O.F. Müller, 1774	1.4	4	BW	1	13	14	-	+	6	-	1	-	-	-	-	+	-	-	-	-	3	1	-	-	-	-	39
14 Semilimax semilimax Ferussac, 1802	7	1	W	-	-	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
15 Phenicolimax annularis Studer, 1820	2.1	4	S	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
16 Vitrea transsylvanica Clessin, 1877	5.2.2	1	W	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2
17 Vitrea diaphana Studer, 1820	5.2.2	2	W	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
18 Vitrea crystallina O.F.Müller, 1774	6	1	BW	-	-	-	-	-	-	-	-	-	-	1	-	-	-	3	-	-	-	-	-	-	-	-	4
19 Aegopinella pura Alder, 1830	1.2	5	W	-	2	1	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
20 Aegopinella epipedostoma Fagot, 1879	8	4	W	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
21 Nesovitrea hammonis Strom, 1765	1.1	3	BW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4
22 Oxychilus draparnaudi Beck, 1837	8	5	BW	-	-	-	+	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
23 Oxychilus orientalis Clessin, 1887	9.1	3	W	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
24 Carpathica calophana Westerlund, 1881	9.1	1	W	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	1
25 Zonitoides nitidus O.F.Müller, 1774	1.4	3	RU	-	-	-	-	-	-	-	2	-	-	1	-	-	5	9	13	-	-	-	-	-	-	-	30
26 Limax cinereoniger Wolf, 1803	6	1	BW	-	-	-	-	-	1	3	-	-	-	1	-	-	-	-	-	3	-	1	-	-	-	-	10
27 Limax maximus Linné, 1758	8	5	BW	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
28 Bielzia coerulans M. Bielz, 1851	9.2	1	W	-	-	-	-	-	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
29 Deroceras laeve O.F.Müller, 1774	1.3	3	RU	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	4
30 Deroceras reticulatum O.F. Müller, 1774	1.3	4	BW	-	-	-	-	-	-	-	-	-	-	-	3	1	-	5	1	-	-	-	-	1	-	-	11
31 Deroceras rodnae Grossu et Lupu, 1965	9.4	2	BW	-	3	-	-	-	4	2	1	1	-	-	-	2	1	-	-	-	-	1	-	-	-	1	16
32 Euconulus fulvus O.F. Müller, 1774	1.4	5	BW	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
33 Cochlodina laminata Montagu, 1803	6	2	W	-	-	-	1	-	-	-	-	1	-	7	-	-	-	-	-	-	-	-	-	-	-	-	9
34 Cochlodina marisi A. Schmidt, 1857	9.1	2	BW	19	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	19
35 Ruthenica filograna Rossmässler, 1836	9.3	4	W	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	1
36 Macrogastra latestriata A. Schmidt, 1857	9.3	1	E	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
37 Laciniaria plicata Draparnaud, 1801	5.2.2	2	W	1	-	-	-	-	-	-	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	4
38 Balea biplicata Montagu, 1803	5.2.2	2	BW	-	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
39 Balea fallax Rossmässler, 1836	5.2.2	1	W	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
40 Balea stabilis L. Pfeiffer, 1847	9.1	2	W	1	-	-	-	-	1	4	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	7
41 Vestia elata Rossmässler, 1836	9.1	1	W	-	-	-	-	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
42 Vestia gulo E. A. Bielz, 1859	9.2	1	W	-	-	-	-	-	1	12	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	15
43 Bulgarica vetusta Rossmässler, 1836	5.2.1	2	BW	24	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24
44 Bulgarica cana Held, 1836	9.3	1	W	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
45 Bradybaena fruticum O.F.Müller, 1774	1.1	5	BW	-	-	-	1	19	-	-	7	15	1	1	-	1	-	-	-	3	-	-	-	25	2	-	75
46 Monarcha casthusiana O.F Müller, 1774	8	4	S	-	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	-	-	-	-	9
47 Perforatella bidentata Gmelin, 1788	9.3	3	W	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
48 Perforatella vicina Rossmässler, 1842	9.2	2	W	-	-	1	+	+	-	-	12	-	-	1	-	-	-	2	-	2	3	-	1	1	-	1	24
49 Perforatella rubiginosa A. Schmidt, 1853	1.1	3	RU	-	-	-	+	1	-	-	1	3	1	2	5	25	12	17	12	-	-	-	-	-	-	-	79
50 Hygromia transsylvanica Westerlund, 1876	9.5	1	W	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	3
51 Trichia hispida Linné, 1758	5.2.2	2	BW	-	-	-	+	4	-	-	4	-	3	4	-	6	-	-	-	1	-	-	-	-	-	-	22
52 Trichia bielzi A. Schmidt, 1860	9.1	1	W	-	-	-	-	-	4	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	6
53 Euomphalia strigella Draparnaud, 1801	3	5	BW	-	-	-	-	+	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	+
54 Arianta arbustorum Linné, 1758	10.1	3	BW	-	4	2	-	-	3	1	-	-	-	-	-	-	-	-	-	25	2	-	-	-	-	-	37
55 Chilostoma faustinum Rossmässler, 1838	9.5	2	W	-	-	-	-	-	1	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
56 Chilostoma banaticum Rossmässler, 1838	9.5	2	W	-	8	1	2	-	-	-	-	-	-	-	-	-	-	-	-	8	2	-	-	-	2	-	23
57 Isognomostoma isognomostoma Schröter, 1784	9.4	2	W	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
58 Cepaea vindobonensis Ferussac, 1821	3	4	BW	-	-	-	-	1	-	-	-	-	1	1	-	-	-	-	-	-	-	-	1	1	-	-	5
59 Helix pomatia Linné, 1758	5.3	4	BW	-	-	-	1	1	-	1	-	-	2	-	-	-	-	-	-	-	-	-	1	3	-	-	9
60 Helix lutescens Rossmässler, 1837	5.3	4	S	-	-	-	+	4	-	1	-	1	1	-	-	-	-	-	-	-	-	1	3	9	-	-	20
Σ No of species				66	33	27	14	37	45	38	50	29	31	23	16	51	27	102	36	47	10	6	5	62	6	4	765
Abundance A/m²				-	52,8	43,2	22,4	59,2	7,2	60,8	80,0	46,4	49,6	36,8	25,6	81,6	43,2	163,2	57,6	-	-	-	-	-	-	-	
Species density (average)				-	2,0	2,0	1,2	2,5	2,3	2,7	3,0	1,8	2,4	1,8	1,2	2,7	1,9	4,7	2,1	-	-	-	-	-	-	-	
Diversity				-	2,35	2,55	2,83	2,32	3,7	3,41	2,64	2,06	3,00	3,11	1,75	2,23	2,00	2,719	1,716	-	-	-	-	-	-	-	
Percentage of juvenile				-	42,4	25,9	28,5	51,3	13,07	35,1	66,0	37,9	67,7	45,5	68,75	9,80	14,8	-	-	-	-	-	-	-	-	-	
Mortality				-	17,5	48,07	66,6	41,2	0	8,10	13,8	0	8,8	21,4	5,88	54,46	0	-	-	-	-	-	-	-	-	-	

Table 1.

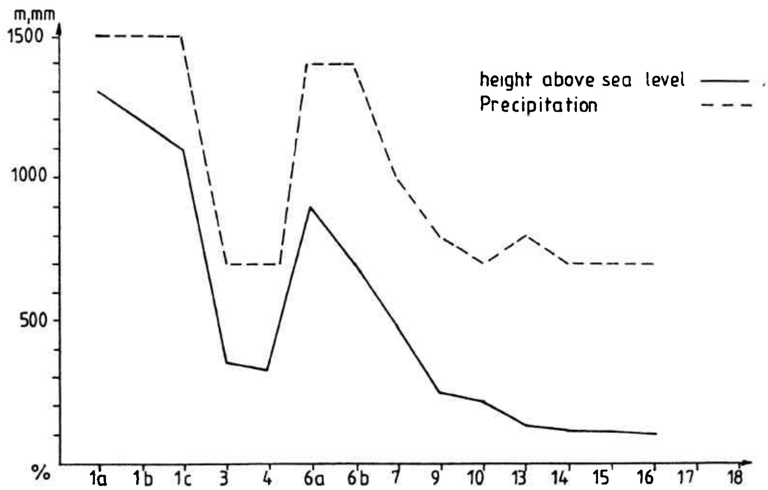
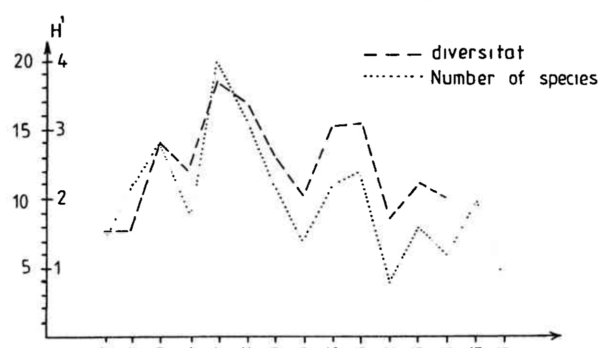


Figure 3.

2. Ecological approach; the characteristics of snail assemblages

The structural characteristics of snail assemblages may also reflect their environmental status. The variation in diversity and species number of the assemblages studied are shown in Figure 4. These values depend on many factors, such as the position of the assemblage in a successional series. The number of species and diversity are generally low in an initial successional stage (*Petasitetum, Salicetum triandrae*). These parameters were indeed low on sites 1b, 1c (both are at Gilău Mountains), 4 and 9.

The abundance and mortality percentage is compared in Figure 5. In contrast with the very high abundance value of an undisturbed willow-poplar forest on site 17 (the confluence of the Someş/Szamos and Tisza rivers), rather low values were found in the same forest type on sites 3, 4, 9, 10 and 15. This is most probably because of a gradual shrink of trees or bushes of the wooded habitat to a sing



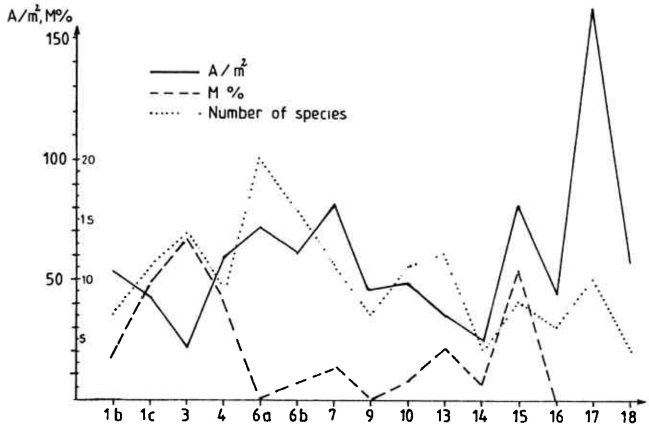


Figure 5. Variation in abundance, mortality percentage and species number among sampling sites

The high proportion of dead individuals on sites 1c, 3, 4 and 15 indicate an increased human impact. Indeed it could be seen during our expedition upstream and downstream Cluj, and in a heavily thinned forest in the vicinity of a dumping ground upstream Satu Mare.

The distribution frequency in Lozek's habitat types shows the following trend (Fig. 6). The riparian species predominate mostly on the lowland sites. The steppe dwellers (*Phenicolimax, Pyramidula*) are dominant components on rocks near the spring (site 1a). The occurrence of steppe dwellers (*Vallonia, Monacha, Helix lutescens*) in willow-poplar forests on sites 3 and 4 indicates human impact.

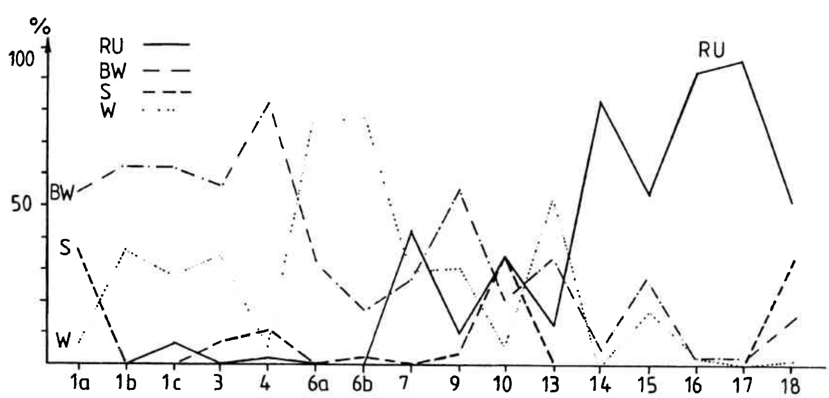


Figure 6. Percentage proportions of Lozek's habitat types at the sampling sites
W: forest dwellers, BW: bush forest dwellers, RU: riparian hydrophilous elements, S: steppe dwellers.

The forest dweller species reach a dominant status in the montane zone (Rodna Mountains), in undisturbed initial communities and in oak-hornbeam forests (site 13). However, in disturbed primordial *Petasitetum* vegetation (1b and 1c) and in willow-poplar forests (9 and 15) bush forest dweller species are the most abundant.

In addition to riparian hydrophilous species, bush dwellers (and occasionally steppe dwellers) appear in initial *Salicetum triandrae* habitats (sites 14, 16 and 18).

The water conditions of sampling sites are compared to differences in the moisture requirements of snail assemblages and the amount of annual precipitation on each site in Figure 7. In accordance with Lozek's habitat types, subhydrophilous components (1-2) follow a trend similar to that of the riparian ubiquitous (RU) and forest dwellers (W). Xeromesophilous elements (4) reach high abundance on sampling sites 1b, 1c and 10, while moderately high on site 4. The ubiquitous elements (5) tend to increase, but still remain in relatively low values in sites 1b and 1c, whereas outstandingly high ones in sites 4 and 9.

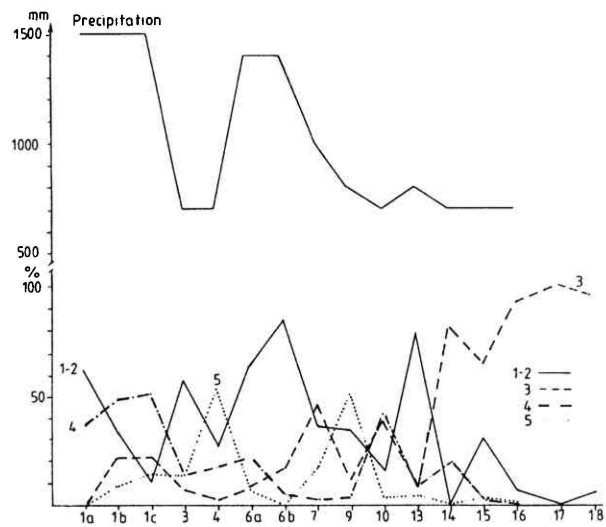


Figure 7. Percentage proportions of ecological species groups at the sampling sites
1: hydrophilous shade species, 2: subhydrophilous species, 3: riparian ubiquitous, 4: xero-mesophilous elements, 5: ubiquitous species

The characterisation revealed here indicates different aspects of structural changes in snail assemblages. A slight human influence is reflected in diversity and abundance figures in the low ratio of forest dweller species and in the ecological species group composition of the initial *Petasitetum* stands in sites 1b and 1c.

In sites 4, 9, 10 and 15 the number of species, diversity, low abundance and high mortality values, increasing ratio of bush forest dwellers, steppe dwellers, xeromesophilous and ubiquitous species indicate various degree of human impact. These characteristics are more homogenous on sampling sites with successionally initial

Salicetum triandrae vegetation, than those with more advanced willow-poplar forests. The background of this phenomenon must be a habitat reduction and harmful effects of agricultural practices on adjacent fields. We could not detect any direct influence of water pollution on the terrestrial snail assemblages of riparian vegetation.

3. Relationships among snail assemblages

Four cluster cores emerge in the dendrogram in Figure 8. The first two include the rock dwellers collected by thinning in two mountains (Gilău and Rodna), and in *Petasitetum* communities (*Petasitetum albae, P. kabikliana*). The next cluster core contains snail assemblages occurring in *Salicetum albae-fragilis* stands that underwent to human influence on sites 3, 4, 9 and 10. The last core contains *Salicetum triandrae, Salicetum albae-fragilis* and *Telekio-Alnetum* stands. The *Querco petreae-Carpinetum* plant association differs from these four cluster cores.

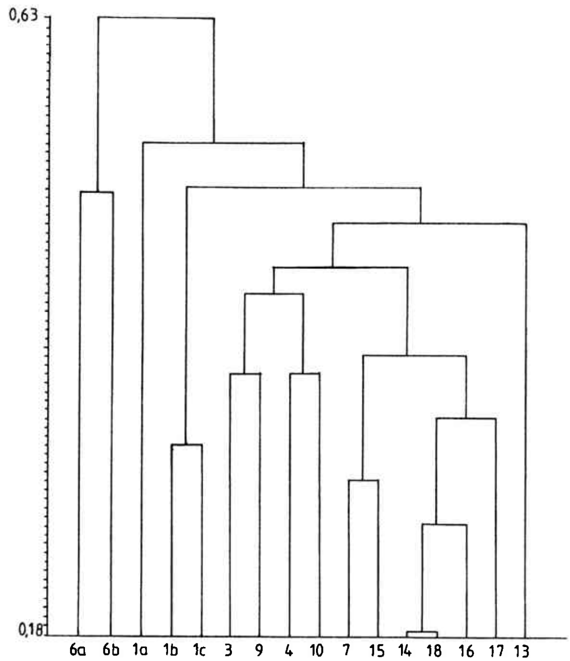


Figure 8. Dendrogram of the Sokal-Michener group average cluster analysis with the indication of sampling sites

The groups obtained by Principal Coordinates Analysis (Figure 9.) agree with the cluster cores detailed above. The snail assemblages in *Petasitetum* plant communities of the two mountains differ from those in *Telekio-Alnetum* (7) and *Querco-Carpinetum* (13) plant communities. Also, the snail assemblages of disturbed *Salicetum albae-fragilis* stands on sites 3, 4, 9 and 10 separate from those in seminatural *Salicetum albae-fragilis* forests occurring on sites 14-18.

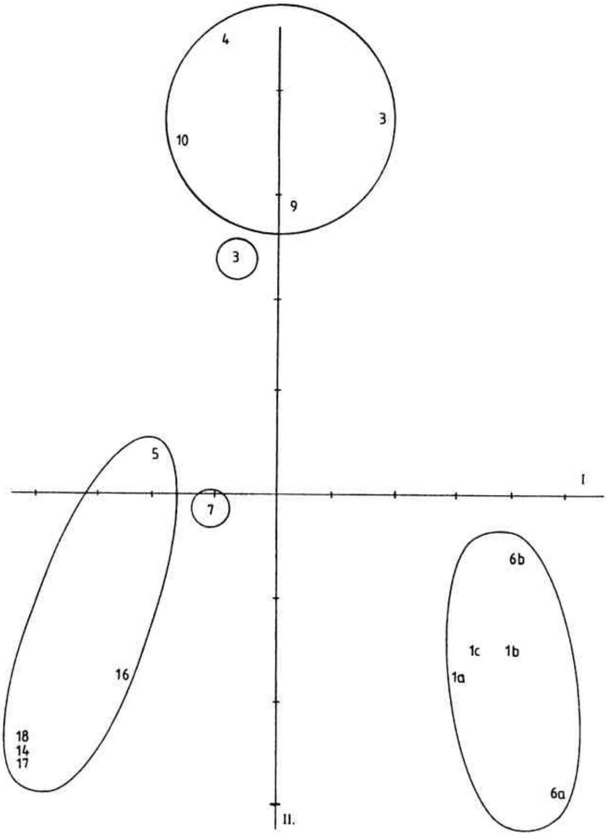


Figure 9. Results of Principal Coordinates Analysis (PRINCOOR). The various plant communities and the willow-poplar forest underwent human activities differ clearly from each other in the composition of their snail assemblages.

Conclusion

The expedition in the Someş/Szamos River Valley resulted the collection of 763 living and 168 shell snail individuals belonging to 58 species. The quadrate and thinning methods were used during collection. The vegetation in the sampling sites included montane and lowland riparian plant communities of early (*Petasitetum albae, P. kitaibeliana, Telekio-Alnetum* and *Salicetum triandrae*) or advanced (*Salicetum albae-fragilis*) successional stages, and *Querco p. Carpinetum* forests of hilly region often extending down to riverbanks (Soó 1964, Coldea 1990).

The plant communities differ from each other also in their snail assemblages composition, as it is shown by the results of cluster and principal component analyses (Figure 7. and 8.).

It was concluded, that ubiquitous and continental species (*Bradybaena, Deroceras rodnae, Succinea putris, Helix lutescens*) dominate among snails transported by the Someş/Szamos over long distances. Species of narrow ecological tolerance range can find their way to the riparian vegetation of the Someş/Szamos Valley through minor watercourses arriving from neighbouring hills and mountains. The fauna distribution from the spring region is hindered by water reservoirs, shrinkage of forest habitats to single row of trees along the river and the lack of riparian gallery forests in the flood area. In these extremely constrained forest habitats settling of snail individuals taking place during high water levels is not probable.

We could not detect any direct influence of water pollution on the terrestrial snail assemblages of the riparian vegetation. However, disturbance in the flood area was proved by changes in the zoogeographical and ecological characteristics of snail assemblages (Figures 2. - 8.). The biotopes are under the strongest human impact resulting from forest management (site 1b and 1c at Gilău mountains), or logging in the flood plain to convert these lands into agricultural fields. The garbage discharge in the neighbourhood of the riparian vegetation also causes major disturbances. These human interventions were seen upstream and downstream Cluj (sites 3 and 4), downstream Beclean (site 9), Căşeiu (10) and upstream Satu Mare (15).

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