SNAIL ASSEMBLAGES OF GALLERY FORESTS BETWEEN LIPPA (LIPOVA) AND MAKÓ

K. BÁBA and P. KONDOROSSY

Introduction

This study deals with the snail assemblages of gallery forests along the Hungarian section of the Maros River. These forests have been little investigated for snail assemblages.

In the Hungarian section of the Great Plain, several new records of Chilostoma banatica have been reported, either in recent or near recent state. This species is distributed from the southern Carpathians to the Bihar (Bihor) Mts. and Máramaros (Maramureş) and has been known since the Miocene (Soós 1943) as the leading species of interglacials (Lozek 1964). The species is distributed along the rivers in Hungary (Bába 1979). In the plain the first record was taken in the Csála forest in 1915 at Nagyvárad (Oradea) by Soós. In Hungary, the first occurrence was reported by Bába (1979) from Bagiszeg at the Upper Tisza River. Only shells were found in the alluvial deposits of the Maros and Tisza rivers by Czógler and Rotarides in 1938. A. Horváth found a single living specimen in the drift at the confluence of the Tisza and Maros rivers, Szeged.

Before river regulations, the species was native to the Fekete and Fehér Körös area. Shells were found in ploughed land in sites formerly covered by gallery forests. Living specimens were found by Domokos (1992) near Gyulavári, in the Sitkei forest. At the Maros River near Makó-Landor, a population was discovered which was subsequently analyzed by Bába and Domokos (1992). Bagiszeg and Landor are now nature reserves.

This study will also compare the associated species of Chilostoma banatica with snail assemblages in Romania.

Material and methods

Quadrat sampling was performed in the locations of Chilostoma banatica by Bába at Bagiszeg between 1967 and 1985, at Makó-Landor (Maros) between 1986 and 1991 and in the Csála forest, Romania, in 1973. Between Lippa and Bezdin, Romania, P. Kondorossy made collections at three locations. Quadrat size was 25 by 25 cm, 10 quadrats were taken in each site. Seasonal investigations were performed at Bagiszeg for 10 years, and at Landor for two years (three times a year). In the Landor site soil samples were also collected to measure soil humidity. At the Maros River canopy closure and percentage cover of herbs were recorded at each site. For a biometric study of Chilostoma banatica, 50-50 individuals were collected by Domokos, and the shell breadth data were compared with climatic data (temperature and precipitation) as averaged for the two previous years. The figures were prepared using the data of the National Meteorological Service, and are reproduced from Bába and Domokos (1992).

The data were evaluated by clustering and ordination methods. Shannon-Wiener diversity index was also calculated. Species associations were identified using regional grassland and forest studies from the plain (Podani 1991). Block clustering, as followed by Feoli-Orlóci's (1979) evaluation procedure, allowed determination of ecological species groups, whereas nutritional types were defined according to Frömming (1954). The habitat typology developed by Lozek (1964) was also used in the analysis of community structure. The percentage distribution of habitat types was used to detect structural changes caused by external factors (floods, sylviculture). The results are generalized to characterize the current environmental status of forests along the Maros River. The forests were evaluated by clustering, based on the Czekanowski Index, and by principal component analysis (Podani 1991).

The ecological species groups are as follows:

A. hygrophilous, mezohygrophilous, shade species
B. photophilous species of swamps and marshes
C. photophilous mezohygrophilous and mesophilous species
D. xerophilous and xeromesophilous species of open habitats
E. hygrophilous ubiquists along lakes and watercourses

The nutritional types are:

1. O. Omnivorous
2. H. Herbivorous
3. Sz. Saprophagous.

We made four groups out of Lozek's habitat types. These are: 1. Forest dwellers (Lozek's W, Wh, Wm), bush forest dwellers (Lozek's Sw, Ow, Ws, Wm, m, Wf). Riparian species (H, P) and steppe species (o, x, sf).

Macroclimatic differences were evaluated after Kakas (1960) and Andó (1992). Nomenclature of plant communities follows Soó (1980).

Locations

The study sites are as follows:

Salicetum albae-fragilis (Soó 1933) Issler 1926

1. Lippa,1992.08.25., Salicetum albae-fragilis,15-20 km from the water.
2. Bezdin, 1992.08.26. at a swamp on the floodplain, 200 m from the river. The understorey is Xanthium and Urtica.
3. Bezdin,1992.08.28. Urtica stand at the same site as 2.

Fraxino pannonicae-Ulmetum (Zólyomi 1934) Soó 1960.

4. Upper Tisza, Bagiszeg,1967.07.28. caricetosum subassociation.
5. Bagiszeg,1969.07.28. convallarietosum subassoc., the willows surrounding the forest will be cut.
6. Bagiszeg,1971.07.28. asperuletosum subass. Covered by water for two weeks during the 1970 flood.

7. Bagiszeg,1972.07.22. asperuletosum.
8. Bagiszeg,1974.06.6. asperuletosum, canopy only one-fourth of the original due to Lymantra gradation.
9. Bagiszeg,1975.08.22. asperuletosum.
10. Bagiszeg,1978.07.15. asperuletosum.
11. Bagiszeg,1985.06.13. asperuletosum. The forest was thinned in 1984 to promote faster reproduction. Due to cutting, the canopy cover has decreased considerably.
12. Csála forest,1973.08.15. brachypodietosum, treated by sylviculture.
13. Csála forest,1973.08.15, asperuletosum, treated by sylviculture
14. Csála forest,1992.07.28, with shrubs (Crataegus monogyna)
15. Csála forest,1992.07.28, Urtica - Rubus facies, treated by sylviculture
I 6. Pécska,1991. 08.20. Rubus - Urtica (brachypodietosum), treated by sylviculture, 50 m from the river.
17. Csála forest,1992.07.28. Poor understorey. Forests 14-15 lie 3-400 m from the river
18. Bezdin,1992.08.26. 200 m from water, only shells.
19. Landor 1987.09.26.
20. Landor 1988.06.07.
21. Landor 1989.09.26.
22. Landor 1990.05.11.
23. Landor 1990.07.10.
24. Landor 1990.09.18.
25. Landor 1991.05.08.
26. Landor 1991.07.12.
27. Landor 1991.09.04.
28. Makó, strand forest,1986.10.12. 50 m from water.

The Landor site belongs to the brachypodietosum subassociation, 100-150 m from the river.

Species recorded

From the sites at Upper Tisza and Maros,1871 specimens belonging to 35 species were collected. Along the Upper Tisza (Bagiszeg) 483 were found,1388 at the Maros River. The species composition of the two sites is different, but both include Chilostoma banatica. Carychium tridentatum, Oxyloma elegans, Columella edentula, Arion hortensis and Vitrina pellucida were not found at the Maros River, whereas Vitrea subrimata, Nesovitrea hammonis, Deroceras laeve, D. agreste, Clausilia pumila, Balea biplicata, Hygromia transsylvanica, and three - probably drifted species (Vitrea transsylvanica, Euconulus fulvus and Trichia hispida) are absent from Bagiszeg. Of the species found at Bagiszeg, 85.7% also occur at the Maros River, whereas 71.4% of species at the Maros River occur also at the Upper Tisza. There are probably two factors responsible for the differences. Based on Kakas' (1960) climatic classification, Bagiszeg has a climate with an oceanic character, with moderately warm summer (type B4), whereas most of the Great

Hungarian Plain belongs to the continental type with moderately dry climate (A3). The Romanian section is more humid, because the area is open towards the northwest. Due to impermeable layers and slope, the Maros River has a considerable gradient. Its watershed includes 18 mountainous regions and covers twice as much area as the Tisza River. It floods very rapidly (Andó 1992) facilitating transportation of the fauna. The number of species per forest ranges between 6 and 14. The Balea, Clausilia and Hygromia species and Vitrea transsylvanica and Trichia hispida were found at the Romanian section.

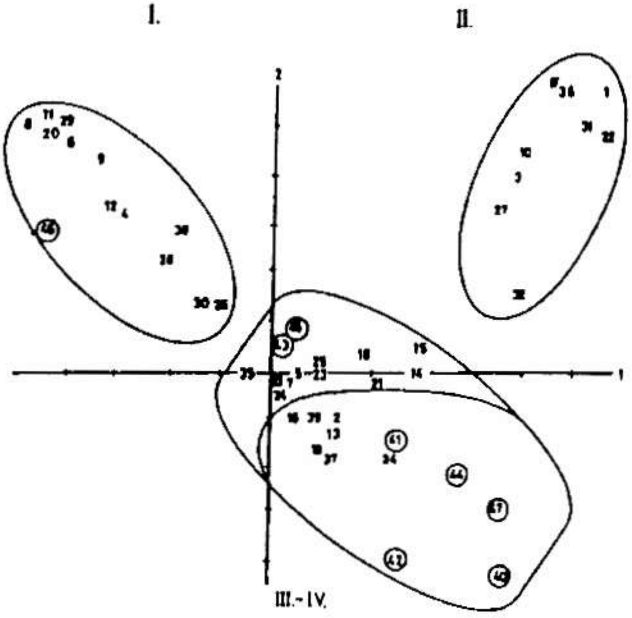


Figure 1. Principal components ordination of species and abiotic factors.
Numbers of groups: I. species of open areas: 4. Cochlicopa lubricella; 6. Truncatellina cylindrica; 8. Granaria frumentum; 9. Pupilla muscorum; 11. Vallonia costata; 12. Chondrula tridens; 20. Vitrina pellucida; 26. Euconulus fulvus; 28. Helicella obvia; 29. Helicopsis striata; 30. Monacha carthusiana; 38. Cepaea vindobonensis; II. riparian Ubiquists: 1. Carychium minimum;3. Cochlicopa lubrica; 10. Vallonia pulchella; 17. Punctum pygmeum; 22. Vitrea crystallina; 27. Bradybena fruticum; 31. Perforatella bidentata; 32. Perforatella rubiginosa; III. subhygrophylous and hygrophylous species: 5. Columella edentula; 7. Vertigo antivertigo; 14. Succinea putris; 15. Succinea oblonga; 18. Aryon sylvaticus; 21. Zonitoides nitidus; 23. Aegopinella minor; 24. Nesovitrea hammonis; 25. Deroceras agreste; 33. Perforatella incarnata; 35. Hygromia kovácsi; 2. Carychium tridentatum; 13. Cochlodina tridentata; 16. Oxyloma elegans; 19. Arion subfuscus; 34. Perforatella vicina; 37. Chilostoma banaticum; 39. Helix pomatia. Habitat parameters: 40. humidity; 41. hydrology; 42. forest age; 44. canopy closure; 46. pH; 47. climatic district.

Associated species

The gallery forests of the Upper Tisza and the Maros have a species group in common. For the Great Hungarian Plain as a whole, based on the abundance data of 39 species and 6 environmental variables, principal coordinates analysis indicates four main groups (Bába 1992, Fig.1). I. Species of open areas (xeromesophilous and xerophilous species affected by pH). II. Riparian ubiquists, III-IV. subhygrophilous and hygrophilous species, influenced by hydrological conditions, forest age, canopy closure, physical soil type and climate. Of group IV, the presence of Chilostoma is maintained by the large water production of rivers coming from Transylvania and the constant humidity of the habitats. Group IV is characterized by the Dacic Chilostoma banatica and the Carpathian Perforatella vicina. The gallery forests described in terms of group IV are separated from other gallery forests of Hungary, perhaps because of the heavy sylvicultural impact and dry continental climate.

Coenological characteristic species of group IV in gallery forests

The coenological character species in the gallery forest, considering the constancy (percentage) and total dominance percentages, can be divided into three groups: constant (51-100% constancy), subconstant (20-50% constancy) and co-occurring species (1-19%). The dominance values strongly vary in the first two groups. Of the constant species, Chilostoma, Cochlodina, Perforatella, Helix and of the subconstant species Arion subfuscus belong to group IV (Fig. 1). Bradybaena, a riparian ubiquist, also belongs to the group of constant species. Most of the constant species in other parts of the Great Hungarian Plain are forest dwellers (group III) and riparian ubiquists (group II). Perforatella vicina, and its substitute P. incarnata, Helix pomatia, Bradybaena and occasionally Cochlodina remain constant in the gallery forests of the Upper Tisza and the Danube. Chilostoma banatica, coming from Transylvania via the rivers Fehér- and Fekete Körös, and Szamos before water regulations, is now characteristic in the gallery forests along the left tributary of the Tisza.

Similarity between the gallery forests of the Upper Tisza and the Maros

These similarities were evaluated via cluster analysis using the Czekanowski Index as applied to the Makó, Landor and Bagiszeg data (Table 1). Note that numbering in the figure differs from the list of locations. Bagiszeg is now 1-8, Makó is 9, and Landor is 10-18. The snail assemblages of the three forests form three cluster seeds, connected through locations 4, 9 and 10. The locations 11-18 from Landor are separated for two reasons. They belong to a different humidity type (Kakas 1960): Bagiszeg has an oceanic character, whereas Makó-Landor are more continental. The other reason is the intensive thinning performed in Landor in 1989.

The climatic differences in the two forests are indicated by the mean shell breadth values of Chilostoma. The data were obtained between 1968 and 1991 in Landor,1979-1985 in Bagiszeg (Bába & Domokos 1992).

Table 1. Coenological character species of forests from the Upper Tisza and Maros forests.

	C%	D%
Chilostoma banatica	96	13.140
Bradybachia futicum	88	10.956
Helix pomatia	80	2.832
Perforatella vicina	76	12.613
Cochlodina laminata	68	6.467
Carychium minimum	48	8.551
Succinea oblonga	44	3.580
Cochlicopa lubricata	44	7.322
Cepaea vindobonensis	44	1.015
Vallonia pulchella	36	21.165
Arion subfuscus	36	1.122
Zonitoides nitidus	32	0.801
Limax cinereoniger	28	0.748
Euomphalia strigella	24	1.656
Arion sylvaticus	20	1.175
Deroceras agreste	16	1.122
Succinea putris	16	0.320
Helix lutescens	16	0.587
Perforatella rubiginosa	12	0.213
Carychium tridentatum	8	3.687
Clausilia pumila	8	0.106
Aegopinella minor	8	0.106
Punctum pygmeum	8	0.106
Deroceras laeve	8	0.106
Oxyloma elegans	4	0.160
Columella edentula	4	0.106
Vitrina pellucida	4	0.053
Balea piplicata	4	0.374
Hygromia transsylvanica	4	0.213
Vitrea subrimata	4	0.053
Nesovitrea hammonis	4	0.053
Vitreea transsylvanica	(4)	0.053
Arion hortensis	4	0.053
Trichia hispida	(4)	0.053

Fluctuation and oscillation

The forests in Bagiszeg and Landor were influenced by natural and anthropogenic effects during the study years. These include: cut of the willow grove in Bagiszeg in 1969 so that the agricultural land gets close to the forest (50% decrease in abundance); flood in 1970 (20% decrease); Lymantria dispar gradation in 1974 (63% decrease); forest thinning to enhance growth of young trees in 1984 (18% decrease). In 1989 in Landor selective thinning (77-38% decrease). Figure 4 shows the A/m^2 changes. The proportion of living and dead specimens and the density data illustrate that the proportion of dead animals steadily increases after sylvicultural intervention in Landor. In the forest at Makó, the permanent anthropogenic effects contribute to the increased proportion of dead animals.

In the figure, arrows indicate the time of impact. Fig. 6 shows the changes of species number, species density (mean species number per quadrat) and diversity.

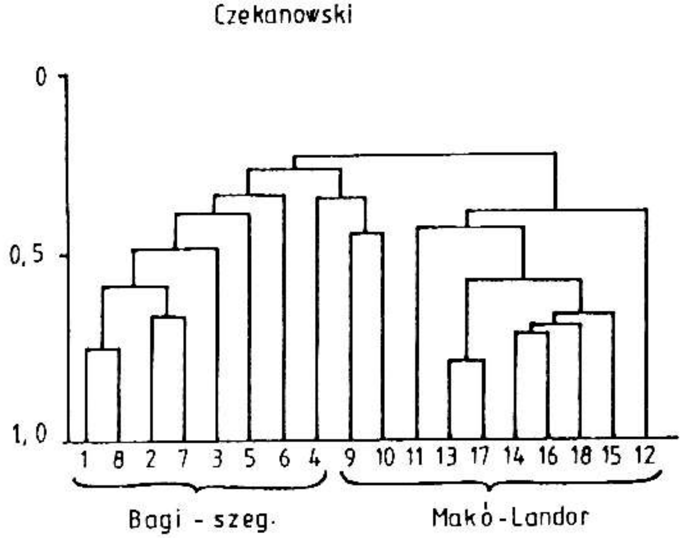


Figure 2. Cluster analysis by the group average method using the Czekanowski Index.

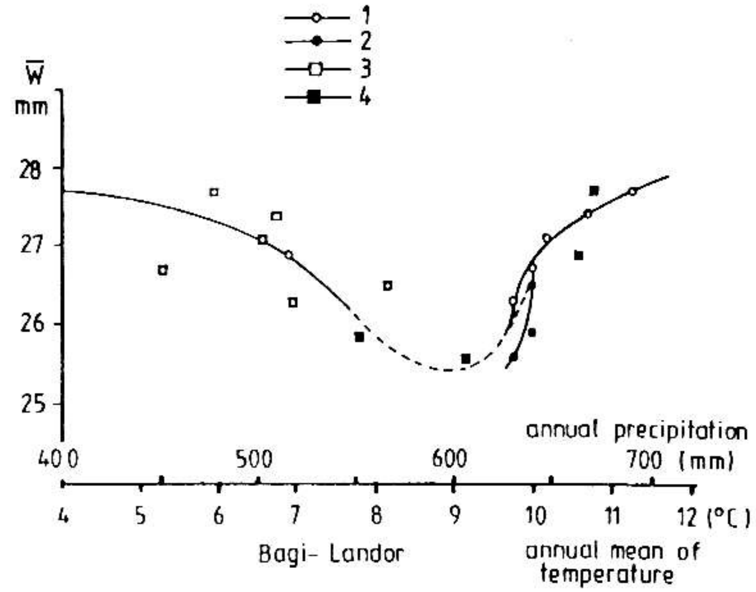


Figure 3. The dependence of average shell breadth (W) from temperatures measured in the previous year (1. Landor, Makó; 2. Bagiszeg) and from precipitation of the previous year (3. Landor, Makó; 4. Bagiszeg).

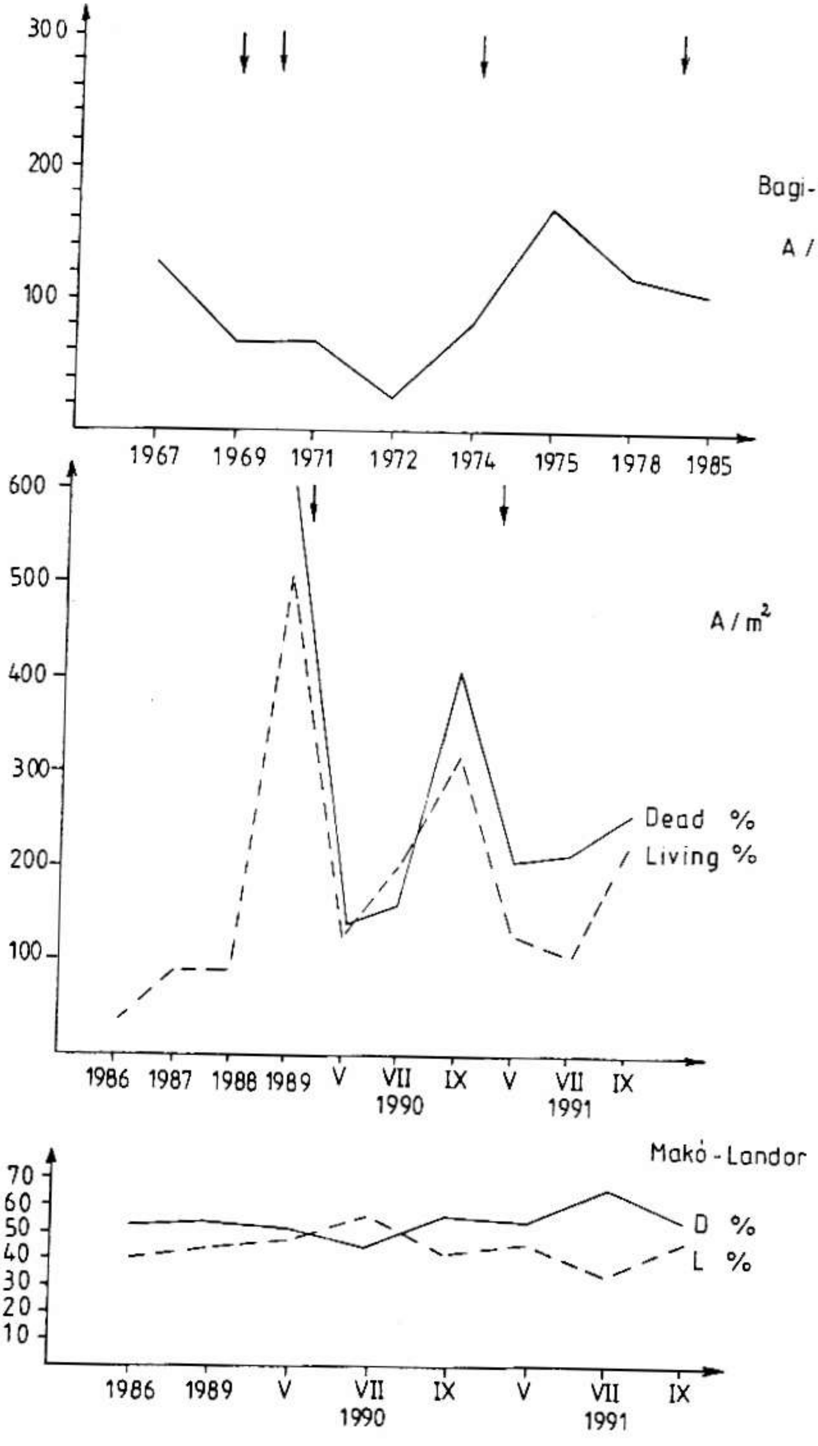


Figure 4. Abundance changes and the proportion of dead/live specimens in Bagiszeg and Makó-Landor

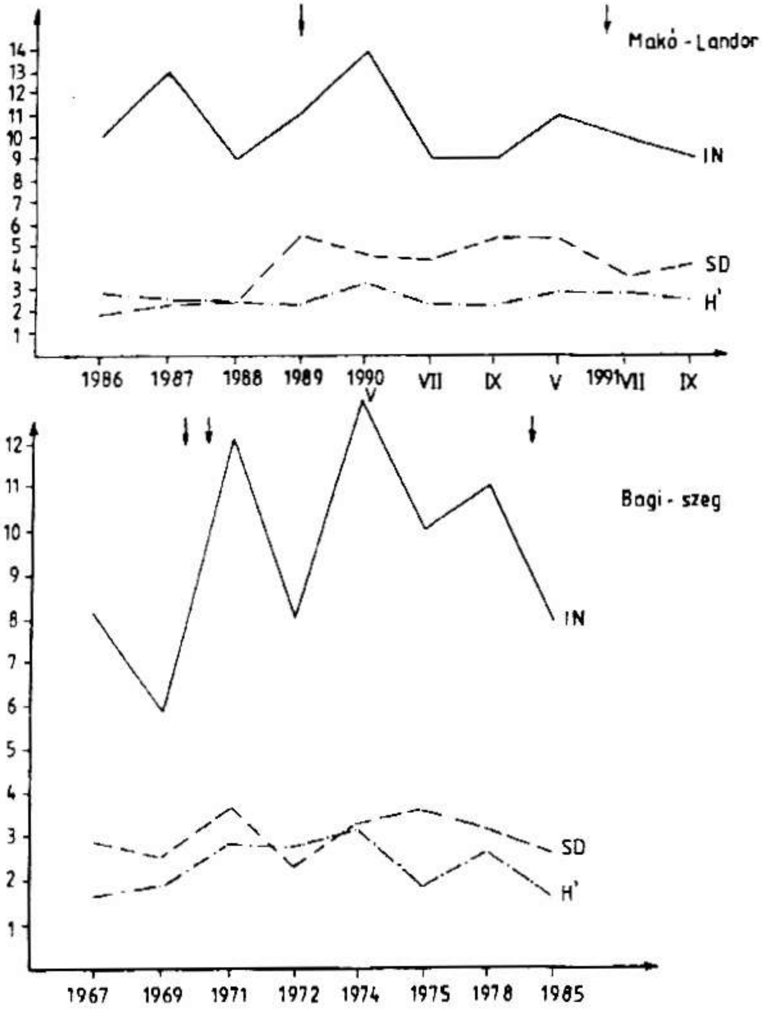


Figure 5. Species number, species density and diversity changes in Landor and Bagiszeg (IN=species number, SD=species density, H=diversity).

In Bagiszeg, the species number, species density and diversity decreased upon the natural and anthropogenic effects. The total number of species decreased from 10-13 to 6-8. The same holds true for the Landor forest after the sylvicultural intervention in 1989. The reason for the flattened curves for the Landor data is the decrease of canopy closure, which in turn led to decreased soil humidity (Fig. 6). Consequently, the dominance of major species steadily decreases between 1990-1991. Of the three dominant species, Vallonia suffered the least changes although its tolerance limits are the narrowest.

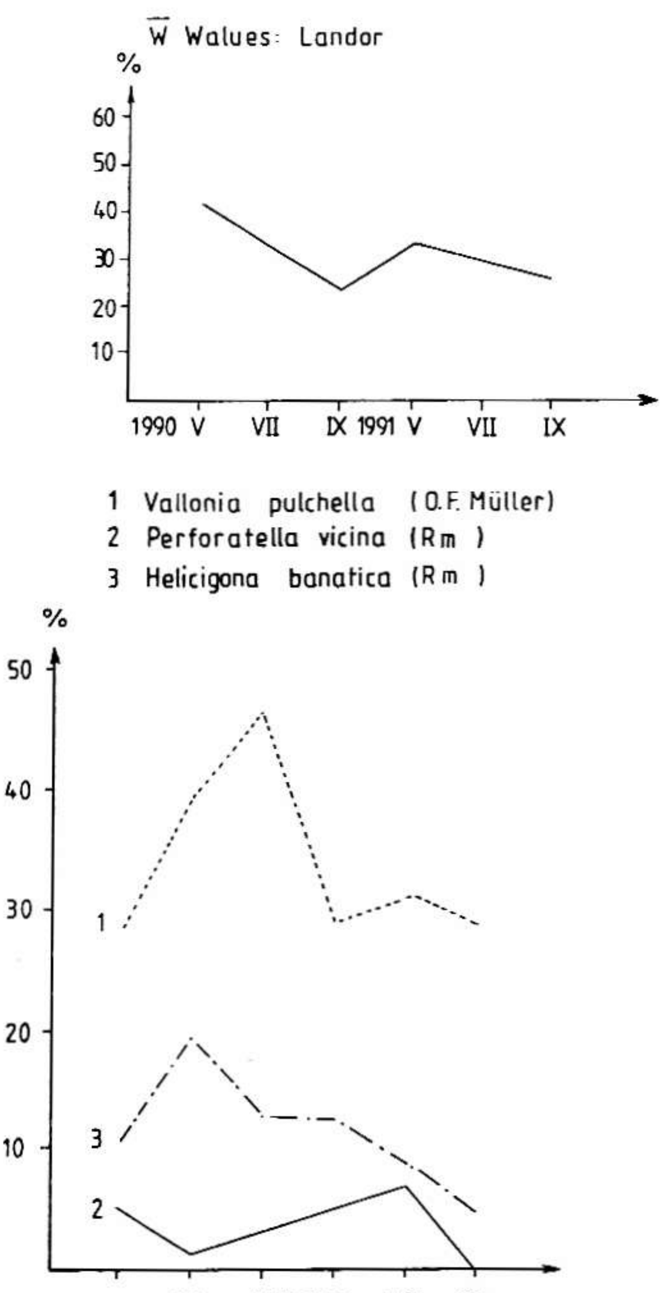


Figure 6. Changes of dominance of characteristic species and of soil humidity in the gallery forest at Landor.

Structural changes during fluctuation and oscillation

Structural changes in the two forests are different. Of the ecological species groups, complement changes of the C-A group dominate (Fig. 7). Following the renewal of shrubs after the Lymantra gradation, the shade species (group A) increase. At Landor, sylvicultural intervention is followed by the increased dominance of riparian ubiquists (E). Group E is a complement of groups A-C. Group E becomes dominant in the forest of the floodplain after disturbance, as earlier investigations suggest.

The nutritional types in the two forests also differ. In Bagiszeg, the omnivorous (O) and saprophagous (S) types are complementing, with the dominance of the first. After the Lymantria gradation, the saprophagous type becomes dominant, however (Fig. 7). At Landor, increased amounts of forest litter and debris, produced by sylvilcultural intervention, lead to the permanent dominance of the saprophagous type (Cochlodina, Vallonia, Carychium), similarly to the mown pastures, indicating terrestrial eutrophication (Fig. 8).

Table 2 shows structural changes in terms of constancy and dominance relations of the species assemblages. At Bagiszeg, Perforatella vicina and Chilostoma are constant-dominant, and Arion subfuscus is temporarily subconstant after floods. After the Lymantria gradation, when the canopy has regenerated, the increased soil moisture led to the constant-dominance of Carychium tridentatum. The sylvicultural treatment at Landor, and the steady decrease of soil moisture (Fig. 6) were favorable for mesophilous species with relatively wide tolerance ranges (Vallonia pulchella, Cochlicopa lubrica). The subconstant-dominants (Carychium minimum) and the hygrophilous species (Bradybaena, Cochlodina, Perforatella) become temporarily characteristic in the spring and autumn reproductive periods.

The results portrayed by diagrams discussed above suggest that regeneration of snail assemblages is more pronounced in moderately warm climates, both by seasons and months. In drier climates minor sylvicultural interventions (thinning) cause more changes leading to eutrophication. In more humid climates structural changes caused by external effects are more easily compensated thanks to the closeness of water in gallery forests.

Seasonal changes in Landor

Seasonal changes are depicted by cluster analysis and the mean shell breadth data of Chilostoma for 1991 (Fig. 9). After 1989, the seasonal changes are characterized by spring, summer and autmn periods. The spring aspects of different years are closer to one another than different aspects of the same year. Compared to previous investigations, such seasonal relationships develop in strongly desiccated forests and dry pastures (Bába 1993).

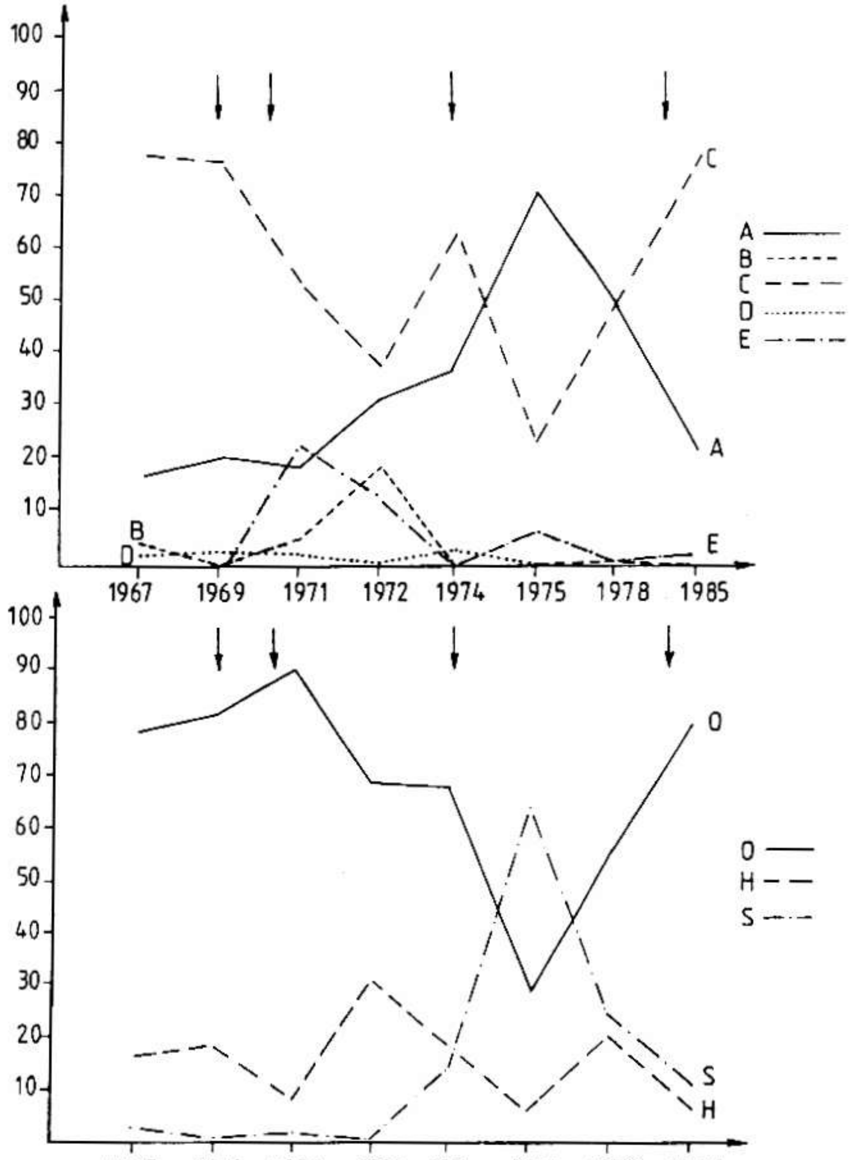


Figure 7. Percentage distribution of ecological species groups and nutritional types in Bagiszeg.

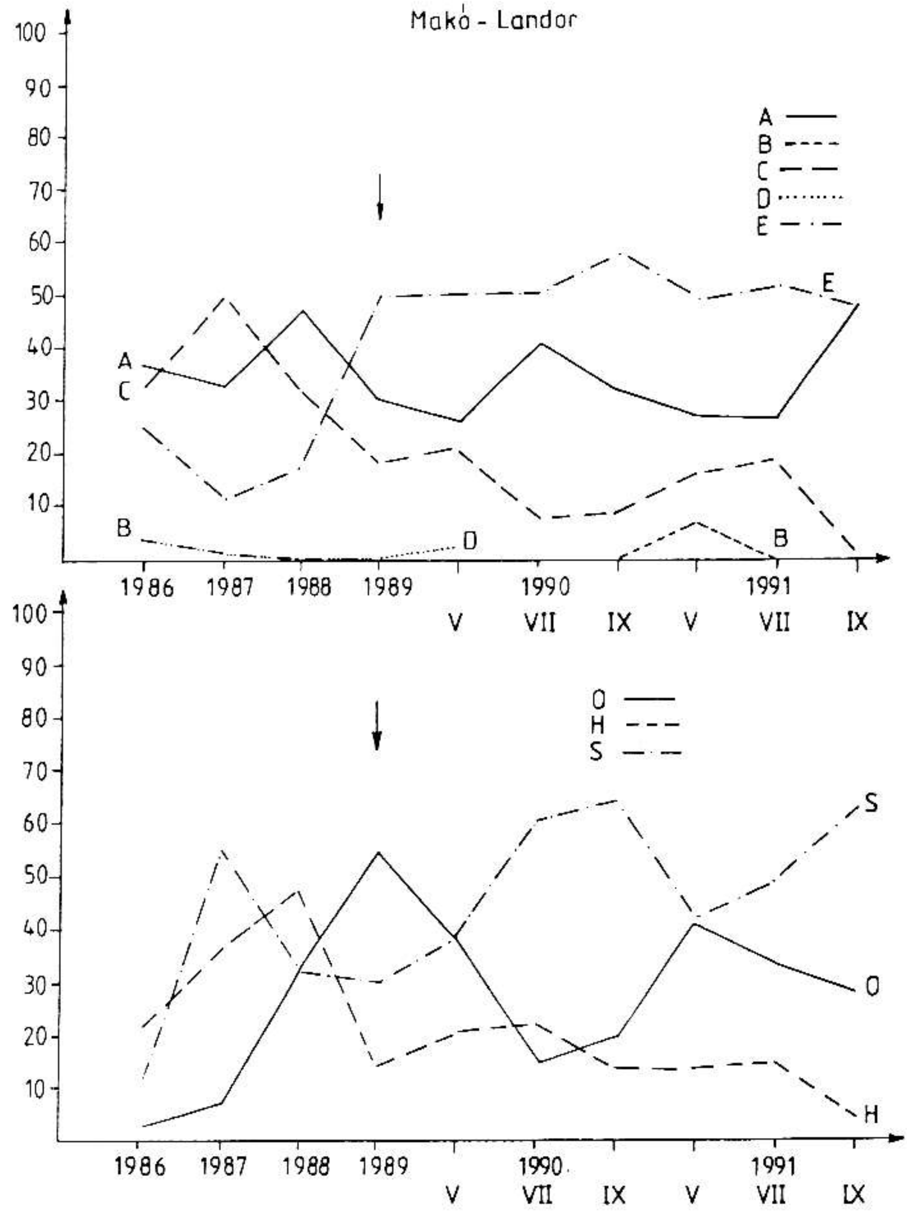
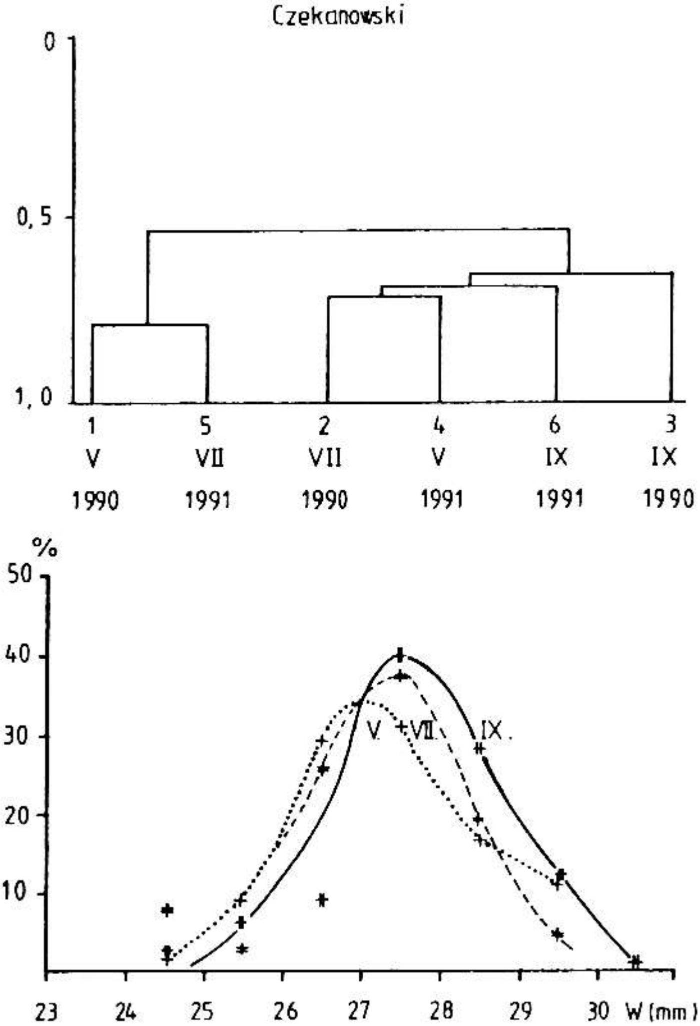


Figure 8. Percentage distribution of ecological species groups and nutritional types in the forest at Makó-Landor.



V. May	W=27.3; S=1.14;V=1.32
VII. July	W=27.2; S=1.18; V=1.38
IX. September	W=27.7; S=1.10; V=1.20

Figure 9. Seasonal distributions based on simple average clustering with the Czekanowski Index, and the mean shell breadth (W) of Chilostoma in 1991. S: standard deviation, V: variance.

Table 2. Changes of constant/dominant species in snail assemblages in Bagiszeg and Landor.

Bagi-szeg		1967		1969		1971		1972		1974		1975		1978		1985	
		D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%
Perforatella vicina	C	66.55	100	51.16	90	33.87	90	18.75	100	15.70	70	19.44	100	27.60	60	65.15	100
Helicigona banatica	A	13.31	70	16.27	60	-		26.66	40	-		-		17.60	60	-	
Bradybena fritucum	C	10.89	40	23.25	70	-		-		-		-		-		-	
Cochlodina laminata	A																
Carychium tridentatum	A	-		-		-		-		-		61.11	90	21.62	70		
Carychium minimum	A																
Arion subfuscus	C	-		-		12.90	60	-		-		-		-		-	
Vallonia pulchella	E																
Cochlicopa lubrica	E																
Helix pomatia	C																

Makó-Landor		1986		1989		1990 V		VII		IX		1991 V		VII		IX	
		D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%	D%	F%
Perforatella vicina	C			-		+		+		-		5.26	60	+		-	
Helicigona banatica	A	25.40	40	13.83	100	10.25	40	19.83	80	13.06	90	12.28	70	9.52	30	66.66	50
Bradybena fritucum	C			17.92	100	-		-		5.52	70	9.64	70	-			
Cochlodina laminata	A	+		+		+		-		6.53	70	+		+		+	
Carychium tridentatum	A																
Carychium minimum	A					-		16.52	60	12.56	50	13.15	50	-		-	
Arion subfuscus	C																
Vallonia pulchella	E			38.99	100	28.20	80	39.66	90	46.23	80	28.94	80	31.74	90	25.64	70
Cochlicopa lubrica	E			8.80	90	16.66	70	9.09	80	9.54	80	14.91	70	14.28	70	17.51	90
Helix pomatia	C	20.83	30														

The clustering is confirmed by Chilostoma shell breadth measurements performed by Domokos in 1990-1991 (Bába & Domokos 1992). Fig. 9 shows data for 1991, corresponding to the gradual thickening of the apertural lip.

Gallery forests of the Maros River in Romania

Based on the collected material, the relationship between willow woods and gallery forests was examined using single linkage clustering. The objects are divided into one small and two large seeds.

Cluster seed 1 includes species-poor willow-poplar stands and gallery forests strongly affected by cultural effects (localities 14,18, 28, forests at Csála, Bezdin and Makó).

Cluster seed 3 falls into three parts, the first two including forests from Bagiszeg, Csála and Landor, the latter also present in the third part.

Cluster seed 3 includes the species-poor gallery forest of Pécska (Pecica). The cluster membership and the composition of seed parts indicates that there is no big quantitative and qualitative difference between the gallery forests of the Upper Tisza and those of Hungary and Romania, notwithstanding the large geographical differences. The discrepancies are caused mainly by natural and anthropogenic effects of various origin. The differences caused by external factors are shown by structural characteristics (Fig. 11)

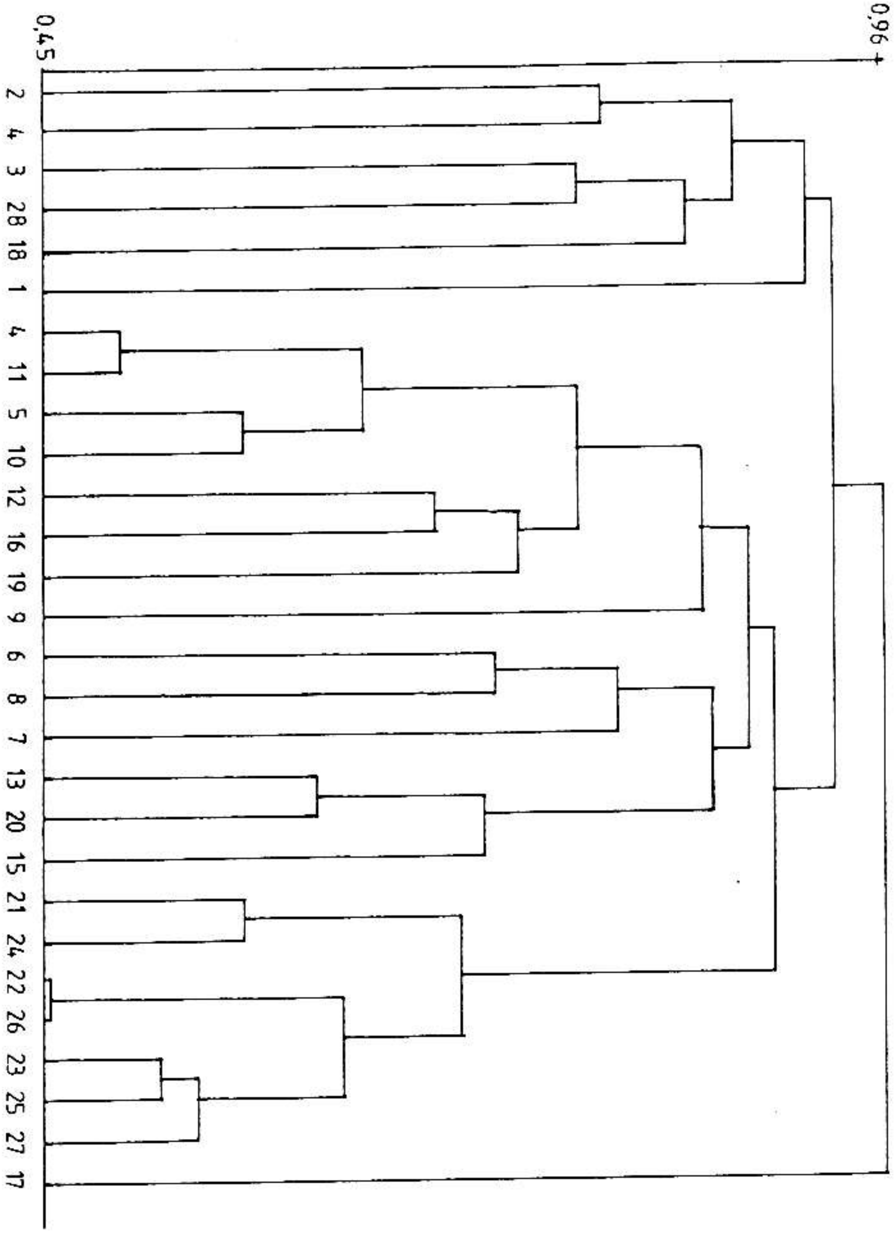


Figure 10. Simple average clustering of forests along the Maros River.

and the scattergram of Principal coordinates analysis (Fig. 12). The species are distributed into three groups, as confirmed by the PCoA diagram. Accordingly, species of ecological group E (Succinea oblonga, Cochlicopa lubrica, Vallonia pulchella) characterize the Landor and Pécska forests (Fig. 12/II). The large abundance of these species contribute to the percenage of bush forest (BW) and steppe (S) inhabitants. Especially large abundance is typical of Bradybaena fruticum, from group BW. The willow-poplar woods and the bushy Csála forest belong to group I. Low numbers of species and individuals and, as a consequence, low species density are typical. The absence of Chilostoma characterizes the willow-poplar stands. Balea and Clausilia pumila occur only in this forest type at Bezdin (site 2).

The differential species of Bagiszeg forests and the gallery forests in Romania are in group IV (Fig. 1). Limax cinereoniger and, in Romania, Euomphalia strigella join these species.

Anthropogenic effects are evident in both Hungary and Romania. The willow-poplar stands (Locations 1-3) are less disturbed. In the Lippa forest, close to the river, species of bush forests dominate. The Bezdion forests 2-3 show transition towards gallery forests via the dominance of the photophilous species group. The distribution of ecological species groups in sites 12, 13, 15 and 17 corresponds well with the Bagiszeg one. Sites 14 and 17 at Csála forest 16 at Pécska and 18 at Bezdin are strongly influenced by man. The low species density show this (Fig. 11.A), and the large dominance of bush forest and riparian species (Fig. 11.B). Especially striking is the external effect on forests 14, 17 and 18. The trees of forest 18 are mostly dead, they are included in the diagram as control. These forests are characterized by low species number, low diversity and species density. The proportion of BW, riparian and steppe species is high. The decrease of the diversity of ecological species groups and the increased dominance of groups E-C are decisive. The anthropogenic effects are similar to those after sylvicultural treatment in Landor and in the forest at Makó, leading to decreases in various characteristics (Fig. 11A,B,C, locations 18-28).

The distribution of nutritional types (Fig. 11D) is characterized by the dominance of omnivorous species in willow stands and less-disturbed forests (localities 1, 2, 3, 12, 16, and 19). In the disturbed forests, depending on the influential factor, the saprophagous (localities 13, 15, 23, and 26) or herbivorous types may dominate, especially in forests with poor herb layer (sites 14, 17, 28).

Summary

The results presented in this paper may be concluded as follows. The snail assemblages of 28 forests from 7 geographical locations are linked with an associated species group. The stability of this group is maintained by fauna transport from Transylvania through rivers. One constant-dominant species of the group is Chilostoma banatica, found in recent or subfossil state at the Upper Tisza (as arrived through the Szamos river), at the Fehér and Fekete Körös and at the Maros River.

Fluctuation and oscillation studies showed that in forests with a more humid climate and with constant influence of water) the snail assemblages regenerate from disturbed states (Bagiszeg). In dry climatic areas (continental climate), at Landor, after thinning, the ecological groups A-C are outcompeted by groups E-C. The dominance of forest dwellers, according to investigations in Romania, may be changed upon anthropogenic effects, however, via invasion by inhabitants of bush forests, steppe communities and by riparian species.

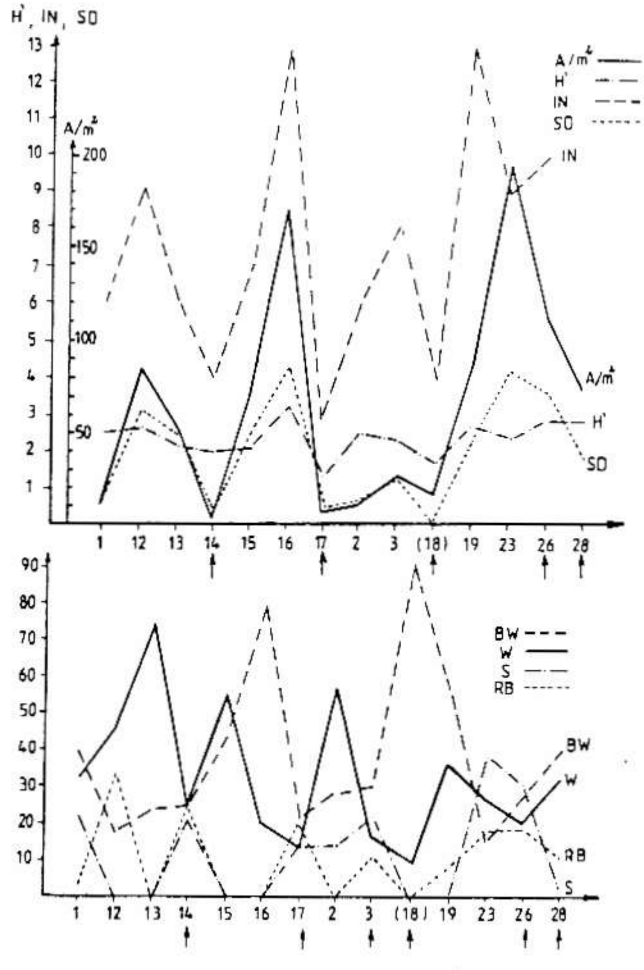


Figure 11. A, B. Structural properties of collecting sites. A (upper): A/m^2, species number (IN), species density (SD) and diversity (H'); B (lower): habitat types of Lozek.

In dry climates the dominance of omnivorous species in gallery forests is replaced by the dominance of saprophagous elements. Similarly to forests desiccated by sylvicultural intervention and to mown grasslands, the seasonal dynamics of snail assemblages is changed. This is also reflected by the monthly average shell breadth data of Chilostoma banatica.

The forests can be assigned into three groups by PCA. This grouping is influenced by differences between plant communities (Group I: willow-poplar stands) and cultural effects. After sylvicultural treatment, the forests of Landor and Makó are separated (group II). These differences are manifested in the species composition of groups as well.

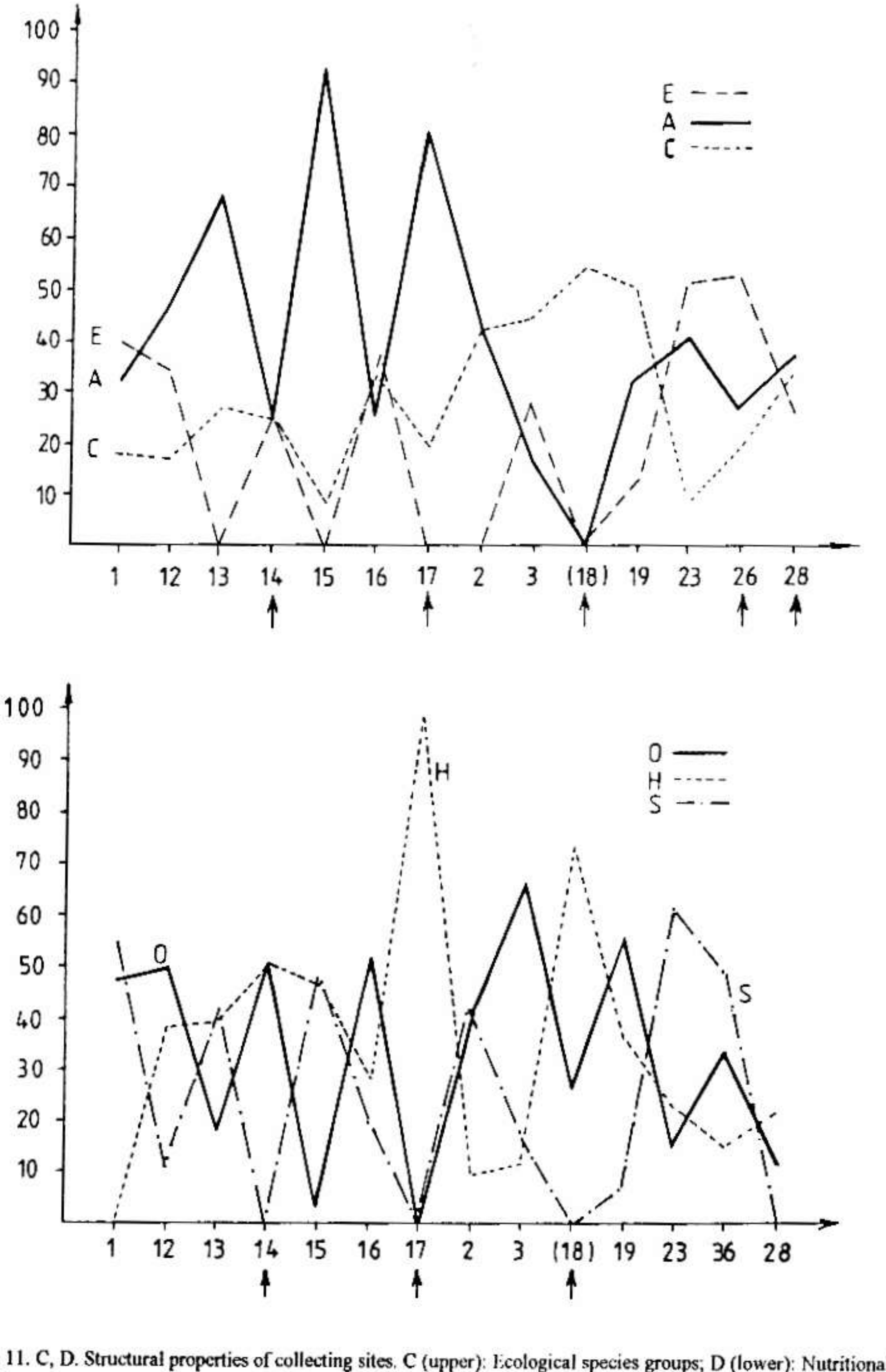


Figure 11. C, D. Structural properties of collecting sites. C (upper): Ecological species groups; D (lower): Nutritional types.

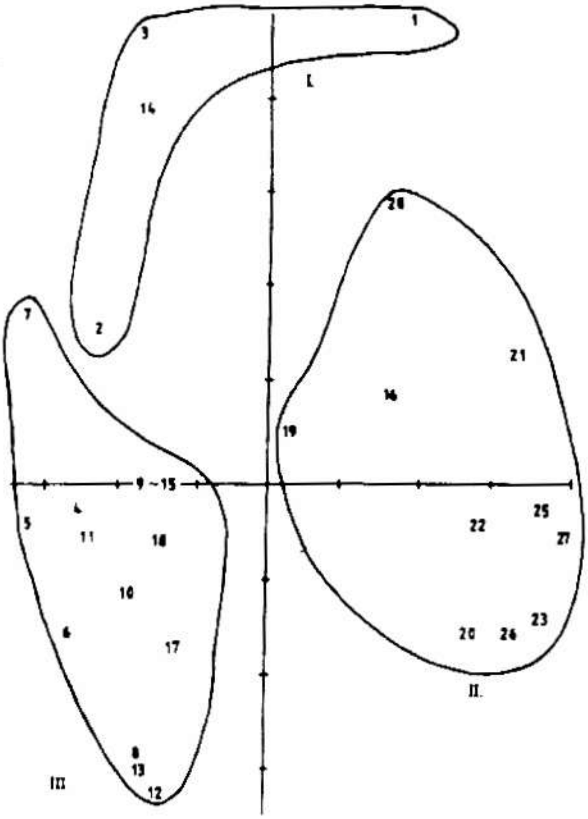


Figure 12. Principal coordinates analysis of forest types.

References

Andó, M. (1992): The hydrogeography of the Maros (Mureş) River and its rivers system. (manuscript).

Bába, K. (1969): Die Malakozoologie einiger Moorwälder in Alföld.Opusc. Zool. 9. 71-76.

Bába, K. (1977): Die Kontinentalen Schneckenbestände der Eichen-Ulmen - Eschen Auwäldern (Fraxino pannonicae - Ulmetum pannonicum Soó) in der ungarischen Tiefebene. Malakologia 16:51-57.

Bába, K.(1979): Die Succession der Schneckenzönosen in den Wäldern des Alföld und die Methoden zum Studium der Succession. Malakologia 18:203-210.

Bába, K. and Domokos, T. (1992). The occurence and ecology of Chilostoma banaticum (Rossmässler 1838) in Hungary. Unitas Malacologica Abstracts of the Eleventh International Malacological Congress, Síena pp. 383-385.

Bába, K. (1993): Seasonal examinations in a fenwood and marsh meadows habitat in the area of Tiszaalpár (Hungary). Lavori S.I.M. Atti Congresso di Parma 11-13 oktobre 1990, Parma 24, 1-15.

Czógler, K. and Rotarides, M. (1938): Analyse einer vom Wasser angeschwemmten Molluskenfauna. Magyar Biol. Kut. Int. Munkái Tihany 10, 8-44.

Domokos, T. (1987): The influence of climate on the form of Helicigona banatica snail shells at a site of occurence in the Alföld. Alföldi Tanulmányok 11:45-67.

Domokos, T. (1992): Proposal for the preservation of a part of the Sitkai-erdö (Sitkai-forest) Hungary, Békés County (Simultaneous occurrence of Hygromia kovacsi and Helicigona banatica). Malacological Newsletter 11:55-56.

Drăgulescu, C. (1992): An Eco-Phytocoenologic characterization of the Mureş Valley from Izvoru Mureş to the confluence with the Tisza. (manuscript).

Feoli, E. and Orlóczi, L. (1979): Analysis of concentration and detection of underlying factors in structural tables. Vegetatio 40:49-54.

Frömming, E. (1954): Biologie der Mitteleuropäischen Landgastropoden. Dunkler-Humbolt, Berlin pp. 1-404.

Kakas, J. (1950): Természetes kritériumok alapján kijelölhető éghajlati körzetek Magyarországon (Climatic zones delineated on basis of natural criteria). Időjárás 64:328-339

Lozek, V. (1964): Quartärmollusken der Tschechoslowakei. Tschechoslowakischen Akademie der Wissenschaften. Praha, pp. 1-374.

Podani, J. (1991): Syn-Tax IV Computer programs for data analysis in ecology and systematics In: E. Feoli and L. Orloczi (eds): Computer Assisted Vegetation Analysis. Kluwer, the Netherlands pp. 437-452.

Soó, R. (1980): A magyar flóra és vegetáció rendszertani növényföldrajzi kézikönyve VI. (Synopsis Systematico-Geobotanica Florae Vegetationisque Hungariae) Akadémiai Kiadó, Budapest .

Soós, L. (1915): A Nagy-Alföld Mollusca faunájáról (Mollusc fauna of the Great Plain). Állattani Közlemények 14:147-173.

Soós, L. (1943): A Kárpát-medence Mollusca faunája (Mollusc fauna of the Carpathian basin). Magyar Tudományos Akadémia, Budapest, 1-478.

K. Bába, P. Kondorossy, Dept. of Biology, Gy. Juhász Teacher's Training College, H- 6701 Szeged P.O.Box 396., Hungary