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Longitudinal Changes in the Structure of Macrozoobenthos and its Microdistribution in Natural and Moderately Eutrophicated Waters of the River Rajčianka (Strážovské vrchy)

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Abstract

Results of investigations on the macrozoobenthos of the river Rajčianka (Strážovské vrchy) were presented. Based on hierarchic classification and ordination of the localities examined, a mountain zone (crenal and epirhithral) and a submountain zone (metarhithral 1 + 2) were distinguished; they were characterized by typical communities of macrozoobenthos taxa. From the source to the lower course, the trophic diversity gradually increased. Due to eutrophication, total diversity in the lower course decreased. Diversity was the greatest in winter and summer. Macrozoobenthos communities characteristic of individual stratotopes were established. Microdistribution of most macrozoobenthos species was closely related to their nutritional requirements. Longitudinal zonation was substantially more marked on the colonization of stones, periphyton and mosses than on detritus and mud-sand sediments. Using various kinds of saprobity indices, water at the source was classified as xenosaprobic, in the upper and central stream as oligosaprobic and at the beginning of the lower stream as of inferior oligosaprobity; below the town Rajec it was up to beta-mesosaprobic. Longitudinal and seasonal incidence of individual trophic groups corresponded to the course of the river continuum dynamics.

Introduction

Water streams represent an integral part of valleys. From the source to the estuary a stream undergoes a gradual series of continuos changes in the gradients of physical conditions, which induce corresponding responses in the structure of the respective biocenoses. The latter develop in a continuos process of stabilization according to the supply of organic matter into the system.

The present study is an attempt to demonstrate on the river Rajčianka as a model system the relationship between longitudinal zonation , diversity and trophic structure of the macrozoobenthos and the degree of water pollution. It represents a continuation of previous studies in the upper Váh river basin (KRNO, 1982, 1983, 1986).

Materials and Methods

Qualitative collections of macrozoobenthos were made in October, February, April, June and August of 1979 and 1980 by a ring net (mesh size 0.5 mm). In this period, the regularly examined stratotopes included stones, the periphyton, wet and submerged moss colonies, sediments of detritus and muddy and sandy substrate. The stream order was expressed according to Strahler (1964).

Hierarchic trophic diversity indices (HTDI) were expressed according to Osborn et al. (1980). HT_1 values represent trophic level of diversity, within which trophic groups of predators, shredders, scrapers, collectors and filtrators are distinguished. HT_2 values represent the specific level.

Determined biological materials were separated into the trophic groups just mentioned; they reflect real differences in the mode of food collection, its quality and accessibility. Use was made of the reports by Cummins (1973), Kawecka (1974), Malmqvist et al. (1978), Cummins and Klug (1979), Hawkins and Sedell (1981) and Minshall et al. (1982).

Species dominance was expressed according to Krno (1982). The values were scored based on a 6-member scale, depending on the number of species in a sample.

D = 100/N (N = number of taxa in the sample) From the D value, the degrees of dominance were calculated within the following ranges:

1. <0, 0.25D> – Adominant
2. <0.25, 0.5> – Subdominant b
3. <0.5D, D> – Subdominant a
4. <D, 2D> – Dominant b
5. <2D, 4D> – Dominant a
6. <4D, 100> – Eudominant

These values served as a basis for a numerical classification of localities and stratotopes of the Rajčianka river. The cluster analysis and ordination method DCA, the NCLASprogramme (Jedlička, Mucina, 1982), was used.

The various kinds of saprobity indices (Mrázek, 1984) were evaluated with the use of the programme Brouci (Research Institute of Water Management, Brno).

Characteristics of the localities examined

The river Rajčianka (Fig. 1) is a left-hand tributary of the river Váh, into which it empties itself at the village Strážov. Rajčianka is collecting waters from Strážovské vrchy and Malá Fatra mountains. In the following list, the numbers in parantheses, given with each locality, refer to the number of the respective locality in the Databank of the fauna of Slovakia (DFS).

Locality 1 (7076): a limnocrenal source situated 940 m above sea level. Its bottom consists of travertine gravel and sand and is covered by moss and a layer of detritus in which beech leaves prevail. Water temperature varied from 3.5 to 5.8 °C.

Locality 2 (7077): a 1-m wide second order mountain brook, at a distance of 1 km from the source. It passes at 800 m above sea level through a dense spruce – beech forest. Its slope is 60 ‰ and it is 10 – 20 cm deep. The prevailing substrate are stones rather densely covered by mosses; sediments of plant debris on the bottom are frequent. Water temperature varied from 2.5 to 11.0 °C.

Locality 3 (7077): a 2 – 5 m wide third order submountain brook at a distance of 7 km from the source. It passes at 590 m above sea level through a thin spruce – pine forest; dense alder and willow stands occur on the banks. The slope decreases to 8 ‰, water depth reaches 20 – 30 cm. The prevailing substrate are stones frequently covered by mosses and colonies of diatoms. The average annual water flow is 1.35 m^3s^{-1}. Water temperature varied from 0 to 18 °C.

Locality 4 (6977): a 10-m wide fifth order small river at a distance of 17 km from the source. Alder and willow stands cover the banks. The slope decreased to 5 ‰, water depth reaches 30 – 50 cm. The prevailing substrate are stones frequently covered by a thick periphyton of filamentous algae. The average annual water flow is 1,82 m^3s^{-1}. Water temperature varied from 0 to 16 °C.

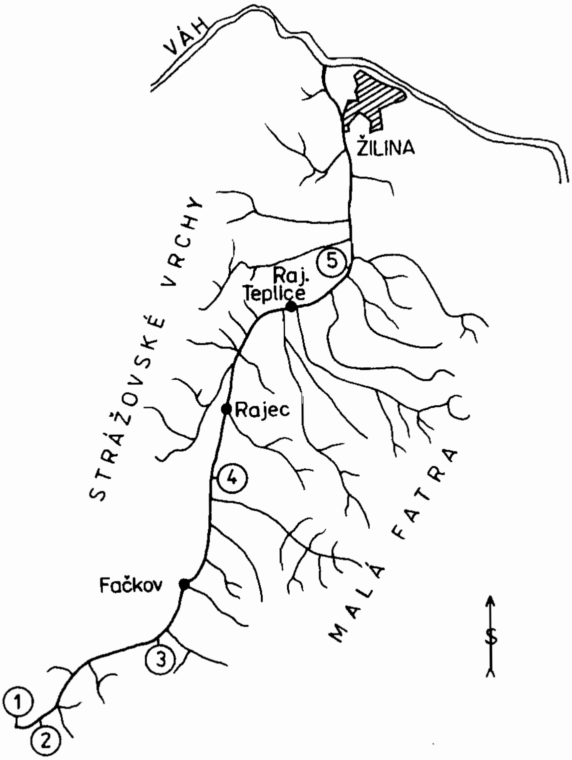

Fig. 1. Rajčianka river basin

Locality 5 (6878): a 17-m wide fifth order submountain river at a distance of 27 km from the source. It passes at 384 m above sea level through fields; thin willow stands occur on the banks. The slope is 4 ‰ and water depth 15 – 20 cm. The prevailing substrate are stones frequently covered by colonies of filamentous algae. Water temperature varied from 0 to 18 °C. The average annual water flow at Rajčianka estuary is 5.79 m^3s^{-1}.

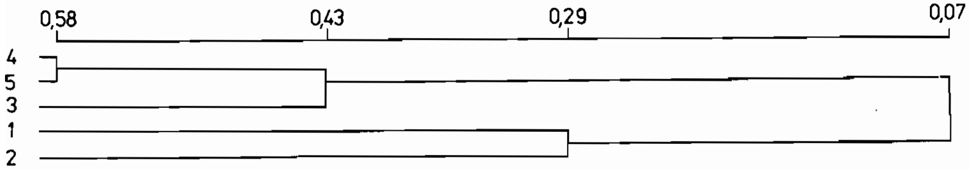

Fig. 2. Dendrogram of classification of localities

Fig. 3. Pozri v prílohe.

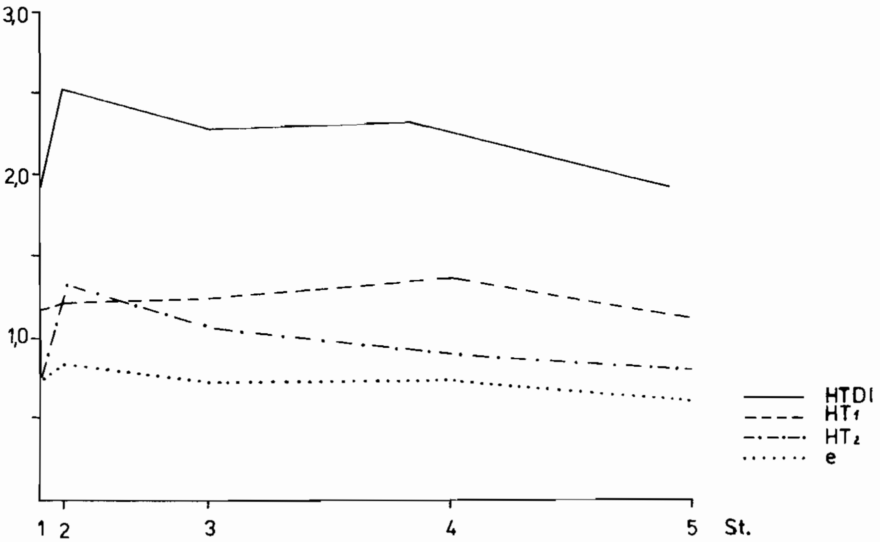

Fig. 4. Hierarchic trophic diversity indices of Rajčianka macrozoobenthos
HDTI – hierarchic trophic diversity index
HT_1 – trophic level of diversity
HT_2 – specific level of diversity
e – equitability

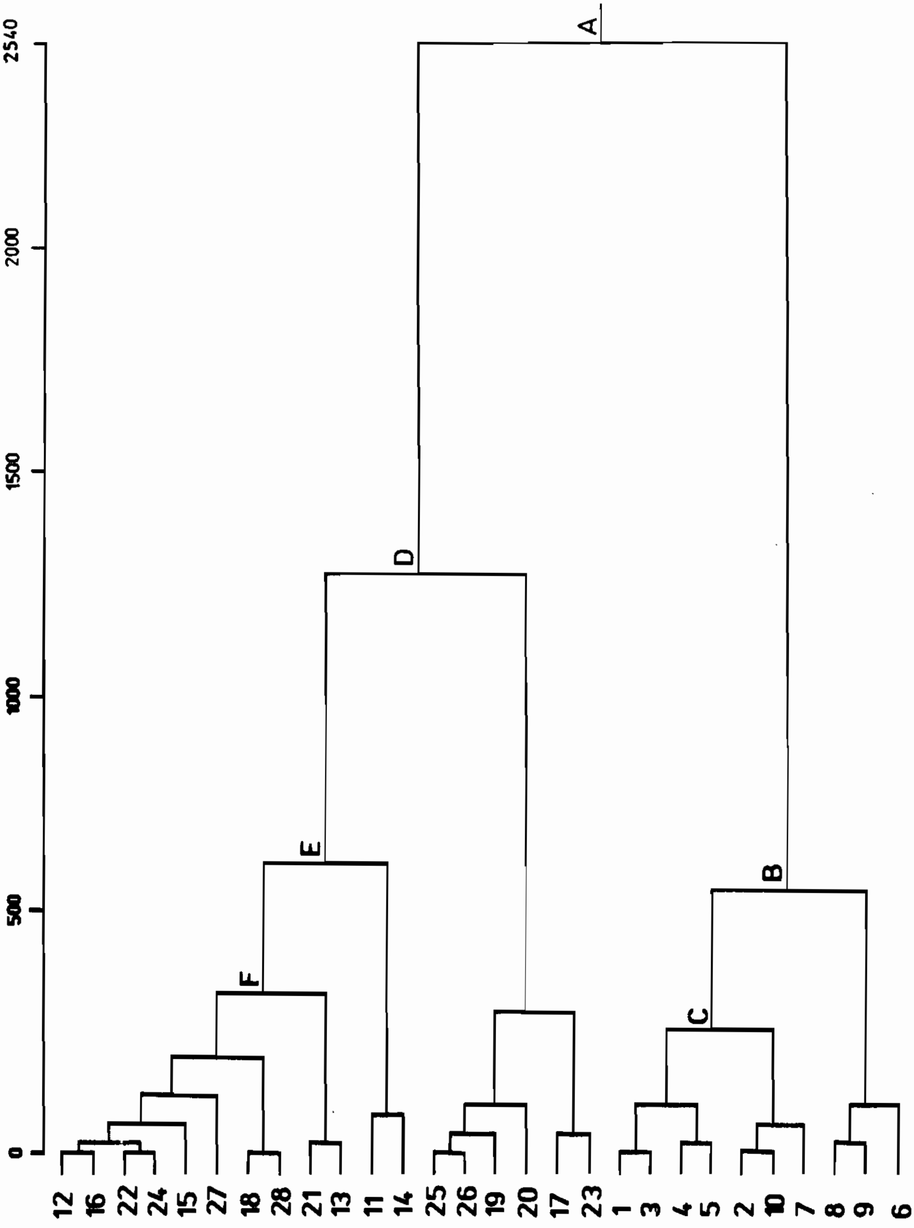

Fig. 5. Dendrogram of classification of Rajčianka stratotopes (A – F = dichotomy designations)

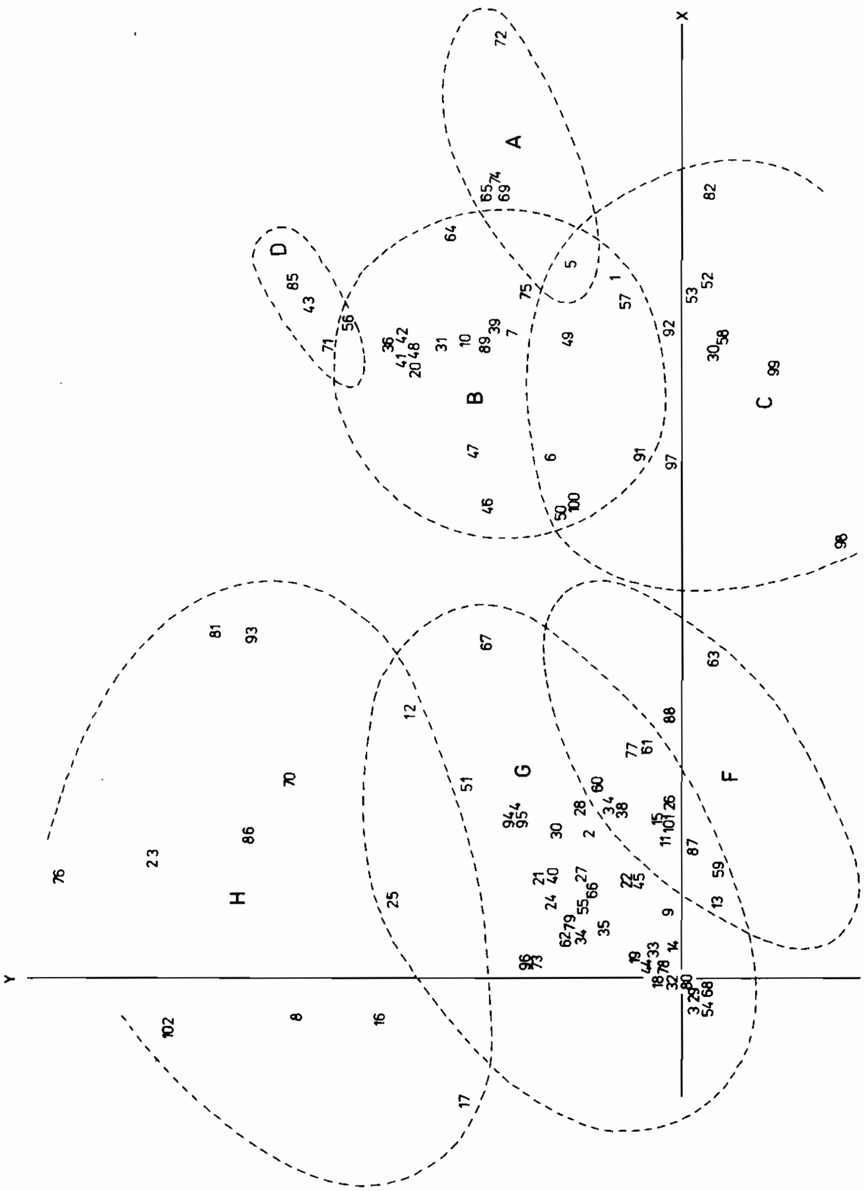

Fig. 6. PCA ordination of macrozoobenthos taxa of Rajčianka stratotopes
A – communities of taxa bound to stones and algal periphyton of the crenal
B – communities of taxa bound to stones and periphyton of the epirhithral
C – communities of taxa bound to mosses of crenal and epirhithral
D – communities of taxa bound to detritus sediments ofcrenal and epirhithral
F – communities of taxa bound to mosses of metarhithral
G – communities of taxa bound to stones and periphyton of metarhithral
H – communities of taxa bound to detritus and muddy and sandy sediments of metarhithral

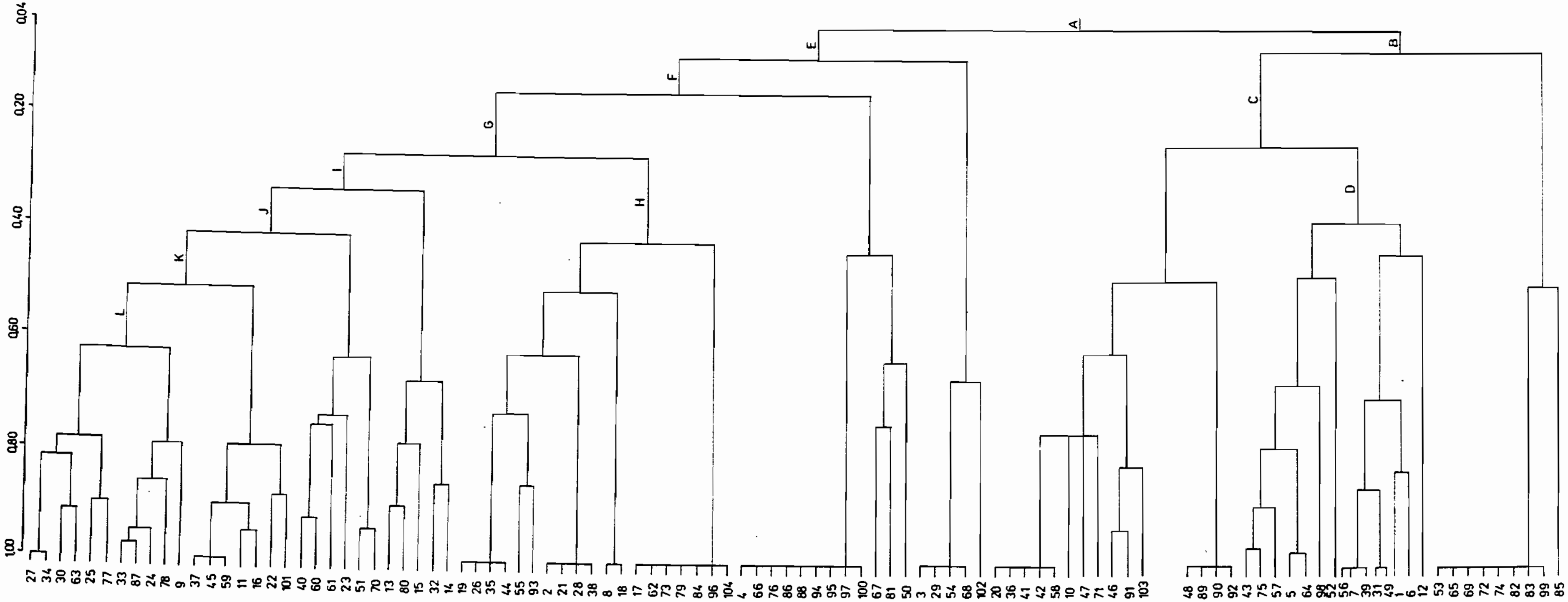

Fig. 3. Dendrogram of classification of macrozoobenthos of the Rajčianka localities examined (A - L = dichotomy designations)

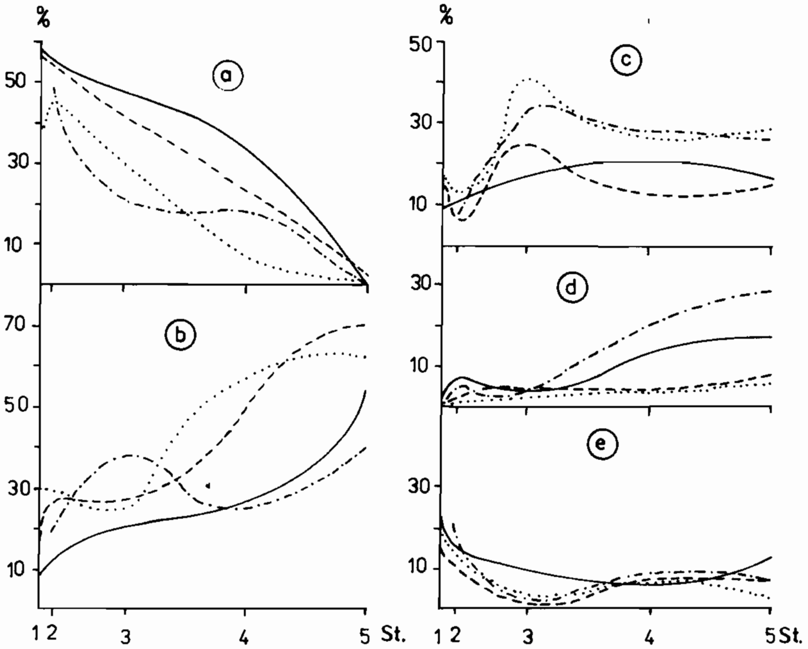

Fig. 7. Seasonal dynamics of the incidence of functional trophic groups of Rajčianka macrozoobenthos ——— winter, – – – spring, ... summer, –.–.– autumn
a – shredders, **b** – scrapers, **c** – collectors, **d** – filtrators, **e** – predators

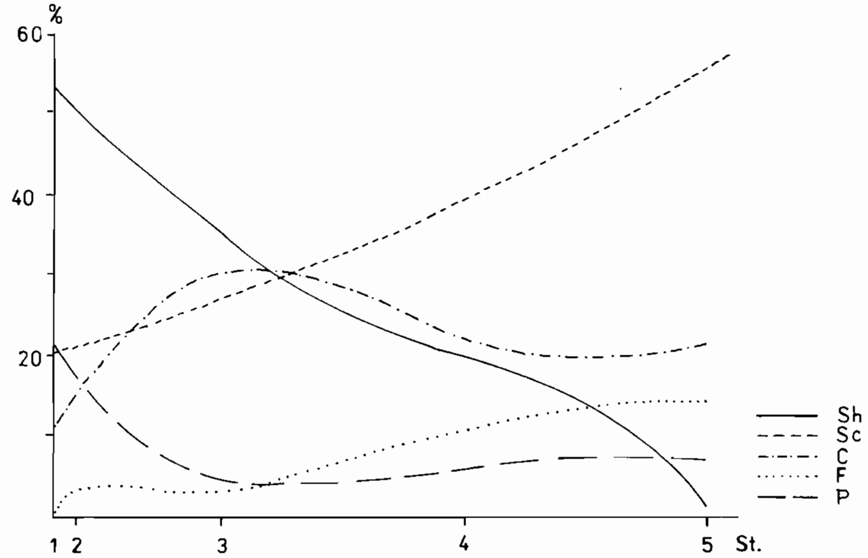

Fig. 8. Longitudinal zonation of the incidence of functional trophic groups of Rajčianka macrozoobenthos
Sh – shredders, **Sc** – scrapers, **Co** – collectors, **F** – filtrators, **P** – predators

Results and Discussion

Longitudinal zonation of macrozoobenthos

A survey of the macrozoobenthos taxa collected is presented in Table 1. Based on the hierarchic classification of the localities, the river Rajčianka was divided into two zones, namely the mountain and the submountain zone (Fig. 2). Within the mountain zone, crenal (locality 1) and epirhithral (loc. 2) could be distinguished. The submountain zone was separated into metarhithral$_1$ (loc. 3) and metarhithral$_2$ (loc. 4 and 5). Typical of crenon and rhithron communities were certain macrozoobenthos taxa, as follows from the hierarchic classification of macrozoobenthos taxa (Fig. 3). The first dichotomy A separates taxa of the mountain zone from the other taxa. The next *dichotomy B* separates adominant crenon species. *Dichotomy C* separates dominant crenon and epirhithron taxa from subdominant and adominant species of the mountain zone. *Dichotomy D* separates dominant epirhithron species *Polycelis felina, Gammarus fossarum, Baetis alpinus, Rhithrogena iridina, Isoperla sudetica, Leuctra rauscheri* and *Perlodes intricata* from the dominant crenon species *Nemoura marginata* and other dominant species of the mountain zone. *Dichotomy E* separates adominant species of locality 5 from characteristic taxa of the submountain zone. *Dichotomy F* separates subdominant and adominant taxa of metarhithron$_1$. *Dichotomy G* separates adominant metarhithron species and *dichotomy H* adominant species of locality 4. *Dichotomy I* separates dominant and subdominant species of locality 5. *Dichotomy J* separates dominant and subdominant species of metarhithron$_1$ – *Ephemera danica, Leuctra albida, Nemoura flexuosa, Protonemura intricata,* P. *praecox* and *Allogamus auricollis. Dichotomy K* separates dominant species of locality 4. *Dichotomy L* separates dominant species of metarhithron$_2$ – *Ephemerella ignita, Rhithrogena semicorolata, Hydropsyche pellucidula* and *Rhyacophila nubila* from dominant and subdominant species of the metarhithron *(Ephemerella mucronata, Habroleptoides modesta, Rhithrogena ferruginea, Amphinemura sulcicollis, Elmis aenea, Hydropsyche instabilis).*

The epirhithron structure markedly resembled that found in Chočské vrchy and Kozie chrbty (KRNO, 1987), mountains formed exclusively by sedimented rocks and situated in the rain shadow of higher mountains. All three regions are characterized by a relatively low average elementary outflow of 15 – 20 l $s^{-1}km^{-2}$ (ATLAS, 1980). A number of typical mountain species are missing there (KRNO, 1987). At the same time the structure of Rajčianka metarhithron$_1$ and metarhithron$_2$ corresponded to those of metarhithron$_2$ and metarhithron$_3$ in the upper Váh river basin (KRNO, 1986).

Diversity of macrozoobenthos

In the crenal, the diversity parameters varied only little: HT_1 (1.16 – 1.23), HT_2 (0.63 – 0.86), HTDI (0.84 – 1.99) and e (0.74 – 0.86). By contrast, in the epirhithral [HT_1 (1.00 - 1.30), HT_2 (0.76 - 1.61), HTDI (2.02 - 2.89) and e (0.79 – 0.94)] and metarhithral [HT_1 (0.95 – 1.55), HT_2 (0.59 – 1.22), HTDI (1.73 – 2.48) and e (0.45 – 0.85)] these variations were much greater. This was due to a more pronounced seasonality of these biotopes manifested in the dynamics of developmental cycles of macrozoobenthos species (DAVIS, 1980). The seasonal diversity was the most marked in winter and summer. Similar conclusions were reached by MACKAY and KALFF (1969). In the winter, great amounts of fallen leaves represent a broad food spectrum for detritophagous species. In the spring, the latter are leaving the aquatic environment and diversity thus decreases. The summer increase in diversity is connected with mass hatching of summer species feeding on algal colonies and decomposing detritus (the concentration of the latter increases due to reduced water flow). The autumn decrease in diversity is connected with flying out of summer macrozoobenthos species. The gradual increase in trophic diversity HT_1 (Fig. 4) from the source to locality 4 is in accordance with the river continuum theory (VANNOTE et al., 1980, OSBORNE et al., 1983). It is a consequence of an increase in relative uniformity of representation of various trophic groups of macrozoobenthos in the direction to the river's estuary. The decrease in locality 5 was due to organic pollution of water below the town Rajec. HTDI and HT_2 reached their maxima in locality 2 and not in locality 4 as could be expected based on the river continuum theory. This was due to the fact that the high diversity in the incidence of trophic groups of macrozoobenthos in the metarhithral was connected with an uneven distribution of the incidence of various taxa within individual groups. It is a consequence of human activities in this part of the Rajčianka river basin – moderate eutrophication (agriculture, settlements) and deforestation of the territory. A similar course of diversity was observed on the river Ľupčianka (KRNO, 1982).

Microdistribution of macrozoobenthos

This is a result of complex interactions of environmental factors like flow rate, substrate and quantity and quality of food (MINSHALL, MINSHALL, 1977). Competition does not play such an important role as originally expected (REICE, 1981).

As illustrated in Fig. 5, the first dichotomy A separates stratotopes of the mountain zone from other stratotopes. *Dichotomy B* separates stony substrate, periphyton and submerged moss biotopes of the epirhithral. *Dichotomy C* separates stratotopes of crenal and epirhithral detritus and that of epirhithral wet moss from stratotopes of the stony substrate, periphyton and mosses of the crenal. The first *dichotomy A* simultaneously separates metarhithral stratotopes. *Dichotomy D* separates stratotopes of stony substrate, periphyton and submerged moss of metarhithral$_2$. *Dichotomies E* and *F* separate stratotopes of stony substrate, periphyton and mosses of metarhithral$_1$ from stratotopes of detritus and muddy sediments of metarhithral. It follows from the foregoing that longitudinal zonation is significantly more manifested in the colonization of stones, periphyton and mosses than in muddy and sandy or detritus sediments.

As shown in Fing. 6 and Table 1, in algal periphyton scrapers were dominant *(Beatis alpinus, B. lutheri, B. rhodani, Epeorus sylvicola, Rhithrogena iridina, R. semicorolata, Hydroptila sp.* div. and *Bythinella austriaca).* Shredders were represented by *Allogamus auricollis* and predators by *Polycelis felina.* Taxa occurring in the stony substrate were similar to those found in the periphyton. In addition, this stratotope was characterized by collectors *(Habroleptoides modesta, Elmis latreillei* and the genus *Ecdyonurus),* shredders (*Gammarus fossarum,* genus *Leuctra*), filtrators (genus *Hydropsyche* and family *Simuliidae*) and, in particular, large species of predators (*Isoperla sudetica, Dinocras cephalotes,* genera *Perla* and *Perlodes, Rhyacophila nubila).* Particles of detritus are captured by submerged moss, thus creating good trophic conditions for detritophagous species (CUMMINS, KLUG, 1979). Among collectors, *Beatis vernus, B. rhodani, Ephemerella ignita, Elmis latreillei* and family *Psychodidae were* dominant. Shredders were represented by *Aphinemura sulcicollis, Leuctra rauscheri, Nemoura flexousa, N. marginata* and *especially* the genus *Protonemura* and *Gammarus fossarum,* scrapers by *Bythinella austriaca* and predators by *Polycelis felina* and the genera *Isoperla* and *Rhyacophila.* The fauna of wet moss resembled that of the preceding stratotope, but was poorer. The quantitatively most rich trophic group of detritus sediments were shredders (*Gammarus fossarum, Leuctra braueri* and genera *Allogamus, Sericostoma* and *Potamophylax.* Dominant among collectors were *Caenis beskidensis* and *Centroptilum luteolum,* among scrapers *Bythinella austriaca* and *Baetis rhodani* (algal colonies on detritus) and among predators *Polycelis felina* and *Perlodes intricata.* In muddy and sandy substrate, collectors *(Ephemera danica, Ephemerella ignita* and *Caenis beskidensis)* prevailed; shredders were represented by *Allogamus auricolis* and filtrators by *Pisidium* sp. *div.*

State of purity of Rajčianka waters

Values of the index of saprobity are presented in Table 2. For comparison, values determined by the method of PANTLE – BUCK (1955) were also included in spite of that according to SLÁDEČEK (1973) this method does not offer reliable information about the border values of saprobity. The suitability of the methods used was eveluated by MRÁZEK (1984). The methods of ZELINKA – MARVAN (1961) takes into account the whole sample including extreme values of species with a low incidence, while the extreme values are omitted by two other methods. In a simulation model it is important to secure safety of the results. From this point of view it is therefore more appropriate to use a method by which the values of the saprobity index would be shifted to a lower water quality. In locality 1, the water was xenosaprobic; it remained very pure also in localities 2 and 3 (oligosaprobity). Moderate eutrophication occurred at lower altitudes (locality 4) – inferior oligosaprobity. Due to increased eutrophication (BITUŠÍK, 1985) below the town Rajec, the quality of water reached beta-mesosaprobity in locality 5. Eutrophication in the central and especially the lower course of the river was accompanied by an increased incidence of algal scrapers, the incidence of Plecoptera decreasing markedly. In the course of the year, the highest value of the index of saprobity in the rhithral was recorded in summer with the exception of the beta-saprobic course at Rajec, where it occurred in autumn.

Functional trophic groups of macrozoobenthos

The incidence of shredders was the lowest in summer (Fig. 7); their proportion started to increase in summer and reached a maximum in the winter. In the spring, their incidence was again decreasing. This was due to accumulation and deterioration of coarse detritus and its distribution in the course of the annual cycle. HAWKINS and SEDELL (1981) confirmed a marked correlation between abundance of shredders and the mass of coarse detritus all the year round. An opposite picture was recorded in scrapers: maximum in the spring and summer and a minimum in winter. HAWKINS and SEDELL (1981) and MINSHALL et al. (1983) showed that the biomass of scrapers is determined by the primary production of algae. Collectors were the most frequent in the summer and autumn, while filtrators were so in autumn and winter. Similar results were reported by CULP and DAVIES (1982). A dependence of organisms in running waters on the supply of alochthonous organic materials has been documented by numerous studies (HYNES, 1975). In the temperate zone, the amount of these materials increases in autumn or by the end of the winter season (deteriorating plant debris is transported with melting snow into water streams). The life cycle of detritophagous animals is accomodated to these seasonal fluctuations (ROSS, 1963). In the mountain zone of Rajčianka there is a dense mixed forest. CUMMINS (1974) showed that first order streams obtain 99 % of energy from terrestrial environment. On the other hand, a dense forest cover negatively affects gross primary productivity. The upper stream of Rajčianka (localities 1 and 2) is most closely connected with the adjacent terrestrial environment. Due to this fact, shredders dominate in the crenal and epirhithral (Fig. 8). Towards the estuary, their proportion markedly decreases. Larger streams are less influenced by adjacent terrestrial environment and are more dependent on the supply of substances by the tributaries and by gross primary productivity (MINSHALL et al., 1983). The latter increases the stream downwards (ANDERSON, SEDELL, 1979). At the same time in the central and lower course deforestation and eutrophication take place; as demonstrated by ZELINKA et al. (1977), they positively affect both primary and secondary productivity. Due to these factors, the abundance profile of scrapers shows an opposite course (Fig. 8). A weak predation pressure by fishes in the mountain zone (low water abundance and great slope of the stream) make it possible that the proportion of predators in the macrozoobenthos remained comparatively high. MINSHALL (1967) and MALMQVIST et al. (1978) observed a gradual increase of fine detritus from the source to the estuary, accompanied by an increased proportion of filtrators and collectors. I confirmed this observation in the first group. In collectors, an important role was played by the fact that *Oligochaeta* and *Chironomidae,* dominant especially in the lower course of Rajčianka, were not included in the analysed material.

The proportion of individual functional trophic groups of macrozoobenthos was in accordance with the course of the dynamics of the river continuum, which reglects the size, quantity and quality of detritus particles, temperature variation, the amount of dissolved organic substances and the ratio of gross primary productivity to respiration (VANNOTE et al., 1980). In general, it may be concluded that a positive correlation exists between functional trophic groups and the source of their nutrition. As shown by HAWKINS and SEDELL (1981), these changes along with changes in the slope, subtrate and flow rate from the source to the estuary result in changes of colonization by individual taxa as well as by whole trophic groups. Classification into certain trophic groups makes an analysis of macrozoobenthos easier and leads to better understanding of natural and disturbed ecosystems. MINSHAL et al. (1983) stressed the general validity of this theory; deviations are due to climate and geology of the river basin, character of littoral vegetation, character of tributaries and local stream geomorphology.

Acknowledgements

Thanks are due to Dr. BITUŠÍK, the author of reports on chironomids of the river Rajčianka (BITUŠÍK, 1985), for the supply of his macrozoobenthos collections.

Table 1

Macrozoobenthos of Rajčianka

Taxa	T	*Localities*					*Stratotop*						*n*
		1	2	3	4	5	S	D	C	PE	SM	WM	
1. *Polycelis felina* (DALY.)	P	3	5				4	3		4	4	3	111
2. *Dugesia gonocephala* (DUG.)	P			1	1		2				1		8
3. *Erpobdella octoculata* (L.)	P					1	1						1
4. *Ancylus fluviatilis* MÜLL.	Sc			1				1					1
5. *Bythinella austriaca* (FRAUN.)	Sc	5	1				5	5		4	5	2	92
6. *Gammarus fossarum* KOCH	Sh	5	6	4	1		4	4		2	5	4	221
7. *Baetis alpinus* (PICT.)	Sc		4				4			4	3		41
8. *Baetis fuscatus* (L.)	Sc/Co				1	1	2		1		1		8
0. *Baetis lutheri* MÜLL.-LIEB.	Sc			5	6	6	6	1		6	3	1	850
10. *Ecdyonurus submontanus* LUANDA	Co				1		1						3
11. *Baetis muticus* (L.)	Sc/Co			1	4	1	3				1	1	43
12. *Baetis rhodani* (PICT.)	Sc/Co	2	4	6	6	6	6	4	3	5	5	2	732
13. *Baetis scambus* EAT.	Sc/Co			1	2	4	4			2	2	1	57
14. *Baetis vardarensis* IKOM.	Sc				2	2	2			2	1		23
15. *Baetis vernus* CURT.	Sc/Co		1		1	5	3			2	4		84
16. *Caenis beskidensis* SOWA	Co			1	4		2	5	2		2		31
17. *Centroptilum luteolum* (MÜLL.)	Co				1			4					5
18. *Ecdyonurus dispar* (CURT.)	Co				1	1	1						4
19. *Ecdyonurus starmachi* SOWA	Co			1	1	1	1						7
20. *Ecdyonurus subalpinus* KLAP.	Co		1				1						3
21. *Ecdyonurus torrentis* KIMM.	Co			1	1		1						6
22. *Epeorus sylvicola* (PICT.)	Sc			2	3	1	3			3			27
23. *Ephemera danica* MÜLL.	Co			3			1		4				22
24. *Ephemerella ignita* (PODA)	Co			3	4	5	3	2	2	2	3	2	118
25. *Ephemerella mucronata* BENGT.	Co			3	3	3	3	2	1	3		2	60
26. *Ephemerella major* (KLAP.)	Co			1	1	1	1	1	1	1	1		11
27. *Habroledtoides modesta* (HAG.)	Co			4	5	1	5			1	1		94
28. *Habrophlebia lauta* (EAT.)	Co			1	1		1		1	1			7
29. *Rhithrogena diaphana* NAV.	Sc/Co					1	2						5
30. *Rhitrogena ferruginea* NAV.	Sc/Co			6	4		6			2	1		145
31. *Rhitrogena iridina* (KOL.)	Sc		6				6			4			110
32. *Rhithrogena germanica* EAT.	Sc				3	3	5						43
33. *Rhithrogena semicorolata* (CURT.)	Sc			2	5	4	6			4			117
34. *Amphinemura sulcicollis* (STEP.)	Sh			4	5	1	3			1	5	4	115
35. *Dinocras cephalotes* (CURT.)	P			1	1	1	2						9
36. *Diura bicaudata* (L.)	P		1			1							1
37. *Isoperla grammatica* (PODA)	P			1	3		2				2		15
38. *isoperla oxylepis* (DESP.)	P			1	1						1		5
39. *Isoperla sudetica* (KOL.)	P		4				4				2		23
40. *Leuctra albida* KEMP.	Sh			3	1	1	3						23
41. *Leuctra armata* KEMP.	Sh		1				1						1
42. *Leuctra autumnalis* AUB.	Sh		2				3						9

Table 1 cont.

Taxa	T	Localities 1	2	3	4	5	Stratotop S	D	C	PE	SM	WM	*n*
43. *Leuctra braueri* Kemp.	Sh	3	5				3	5					83
44. *Leuctra fusca (L.)*	Sh			1	1	1	3						14
45. *Leuctra hipposus* Kemp.	Sh			1	3		3	1		1	1		14
46. *Leuctra inermis* Kemp.	Sh		4	1	1		5			1	1		51
47. *Leuctra prima* Kemp.	Sh		2	1			3			1			11
48. *Leuctra pseudosignifera* Aub.	Sh		1				1						2
49. *Leuctra rauscheri* Aub.	Sh		5				5			2	3	1	52
50. *Nemoura cambrica* (Steph.)	Sh		1	1			1				1		8
51. *Nemoura flexuosa* Aub.	Sh			5	1		4	1		1	4	3	56
52. *Nemoura marginata* Pict.	Sh	4					3				4	2	25
53. *Nemoura monticola* Rauš.	Sh	1					1				1		3
54. *perla burmeisteriana* Claas	P					1	1						1
55. *Perla marginata* (Panz.)	P			1	2	1	2						14
56. *Perlodes intricata* (Pict.)	P		4				3	3		1			23
57. *Protonemura auberti* Illies.	Sh	5	5				5	1		3	5	4	137
58. *Protonemura hrabei* Raus.	Sh		2				1				3	2	9
59. *Protonemura autumnalis* Raus.	Sh			1	3	1				1	3	2	23
60. *Protonemura intricata* (Ris.)	Sh			3	2	1	2				4	3	37
61. *Protonemura praecox* (Mort.)	Sh			2	1		1			1	2		9
62. *Taeniopteryx auberti* Kis et Sowa	Sh				1		1						1
63. *Elmis aenea* (Moull.)	Co			6	3	2	1			1	2	3	114
64. *Elmis latreillei* (Bed.)	Co	5	3				5	2		2	3	1	73
65. *Esolus angustatus* (Müll.)	Co	1					1						1
66. *Esolus parallelepipedus* (Müll.)	Co			1			2						4
67. *Limnius perrisi* Duf.	Co		1	2			2						12
68. *Oulimnius tuberculatus* (Müll.)	Co					1	1						3
69. *Hydraena sp. div.*	Co	1					1						2
70. *Allogamus auricollis* (Pict.)	Sh			6			6	4	4	4	4	4	159
71. *Allogamus uncatus* (Brau.)	Sh	1	2				1	3			2		13
72. *Apatania sp. div.*	Sc	1								2			4
73. *Brachycentrus montanus* Klap.	F				1		1				1		3
74. *Crunoecia irrorata* (Curt.)	Sh	1					1						3
75. *Drusus annulatus* (Sreph.)	Sc	3	4				4	1		4	1	1	57
76. *Halesus radiatus* (Curt.)	Sh			1					1				3
77. *Hydropsyche instabilis* (Curt.	F		1	4	3	2	3			1	2		51
78. *Hydropsyche pellucidula* (Curt.)	F				5	5	5			3	3		146
79. *Hydropsyche saxonoca* McLach.	F				1		1						4
80. *Hydroptila sp. div.*	Sc				1	4	2			4			46
81. *Odnotocerum albicorne* (Scop.)	Sc		1	1			1	1					4

Table 1 cont.

Taxa	T	*Localities* 1	2	3	4	5	*Stratotop* S	D	C	PE	SM	WM	*n*
82. *Parachiona picicornis* (PICT.)	Sh	1										3	4
83. *Plectrocnemia conspersa* (CURT.)	P	1					1						1
84. *Polycentropus flavomaculatus* (PICT.)	P				1		1						2
85. *Potamophylax cingulatus* (STEPH.)	Sh	1	1					2					6
86. *Potamophylax latipennis* (CURT.)	Sh			1			1	1	1				9
87. *Rhyacophila nubila* (ZETT.)	P			2	4	4	4			2	2	2	95
88. *Rhyacophila obliterata* MCLACH.	P			1							1		3
89. *Rhyacophila philopotamoides* MCLACH.	P		1				2				1		5
90. *Rhyacophila polonica* MCLACH.	P		1				1					1	4
91. *Rhyacophila tristis* PICT.	P		3	1	1		1			1	3	1	17
92. *Rhyacophila vulgaria* PICT.	P		1								1		2
93. *Sericostoma sp. div.*	Sh		1	1	2	1	1	3	1				19
94. *Silo pallipes* (FABR.)	Sc			1			1						2
95. *Silo piceus* (BRAUER.)	Sc			1		2							3
96. *Berea maura* (CURT.)	Sh				1		1				1		4
97. *Ceratopogonidae*	Co			1							2		5
98. *Psychodidae*	Co	3	5		3	1					5	6	88
99. *Lithax niger* HAG.	Sc	1									1		3
100. *Prosimulium sp. div.*	F		3		1	1	3			2	1		24
101. *Odagmia sp. div.*	F			3	3	2	3			2	3		39
102. *Pisidum sp. div.*	F					2			5				14
103. *Baetis melanonyx* (PICT.)	Sc/Co		1				1			1			4

T – fuctional trophic groups
Sh – shredders
Co – collectors
F – filtratos
Sc – scrapers
P – predators

S – stones
D – detritus
C – clay
PE – periphyton
SM – submerged moss
WM – wet moss
n – number of individuals

Table 2
Index of saprobity

Locality and method	*Winter*	*Spring*	*Summer*	*Autumn*	$\bar{x}$
Loc. 1					
Pantle-Buck (1955)	0,39	0,48	0,33	–	0,40
Zelinka-Marvan (1961)	0,15	0,38	0,02	–	0,18
Modus VÚV	0,14	0,13	0,13	–	0,13
Median valence VÚV	0,21	0,31	0,18	–	0,23
Loc 2					
Pantle-Buck (1955)	0,59	0,61	0,98	0,50	0,67
Zelinka-Marvan (1961)	0,49	0,50	0,85	0,30	0,54
Modus VÚV	0,27	0,24	0,30	0,19	0,25
Median valence VÚV	0,48	0,49	0,86	0,36	0,55
Loc 3					
Pantle-Buck (1955)	0,84	0,79	0,98	0,86	0,87
Zelinka-Marvan (1961)	0,77	0,72	0,93	0,79	0,80
Modus VÚV	0,56	0,54	0,77	0,82	0,67
Median valence VÚV	0,79	0,74	0,95	0,81	0,82
Loc 4					
Pantle-Buck (1955)	1,04	1,10	1,26	1,13	1,13
Zelinka-Marvan (1961)	1,01	1,07	1,23	1,09	1,10
Modus VÚV	1,03	1,26	1,56	1,34	1,30
Median valence VÚV	1,02	1,09	1,27	1,10	1,12
Loc 5					
Pantle-Buck (1955)	1,18	1,28	1,63	1,73	1,46
Zelinka-Marvan (1961)	1,13	1,23	1,60	1,66	1,41
Modus VÚV	1,89	1,77	1,88	1,95	1,87
Median valence VÚV	1,21	1,33	1,71	1,81	1,52

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Longitudiálne zmeny štruktúry makrozoobentosu a jeho mikrodistribúcia v prirodzených a mierne eutrofizovaných vodách riečky Rajčianky (Strážovské vrchy)

I. KRNO

Súhrn

V predloženej práci sa uvádzajú výsledky výskumu makrozoobentosu riečky Rajčianky (Strážovské vrchy). Na základe hierarchickej klasifikácie a ordinácie skúmaných lokalít sa rozlišuje horská zóna (krenál a epiritrál) a podhorská zóna (metaritrál$_{1+2}$), ktoré sú chakterizované typickými asociáciami taxónov makrozoobentosu. Od prameňa k dolnému toku postupne vzrastá trofická diverzita. Celková diverzita sa v dôsledku eutrofizácie znižuje v dolnom toku. Najvyššia diverzita sa zaznamenala v zimnom a letnom období. Pre jednotlivé stratotopy sa stanovili charakteristické asociácie makrozoobentosu. Mikrodistribúcia väčšiny druhov makrozoobentotov úzko súvisí s ich potravnými nárokmi. Longitudinálna zonácia sa podstatnejšie výraznejšie prejavuje na osídlení skál, nárastov rias a machu ako na detritových, resp. bahnito-piesčitých nánosoch. Na základe použitia rôznych druhov sapróbnych indexov je voda v prameni xenosapróbna, v hornom a strednom toku oligosapróbna, na začiatku dolného toku zodpovedá horšej oligosaprobite a pod mestom Rajec až beta-mezosaprobite. Longitudinálne i sezónne zastúpenie jednotlivých trofických skupín zodpovedá priebehu dynamiky riečneho kontinua.

Лонгитудинальные изменения структуры макрозообентоза и его микрораспределение в природных и средие эутрофизованных водах реки Райчанки (Стражовске холмы)

И. КРНО

Резюме

В предлагаемой работе приводятця результаты иццледований макробентоса реки Райчанки (Стражовские холмы). На основе иерархической классификации и ординации исследованных локалит различаем горную зону (кренал и эпитрал) и зону подножья гор (метаритрал$_{1+2}$), для которых характерны типичные ассоциации таксонов макробентоза. От истока к нижнему течению постепенно растёт трогическая диверзита. В целом диверзита вследствии эутрофизации понижается в нижнем течении. Самую высокую диверзиту мы замечали в зимний и летний период. Для отдельных стратотопов мы установили характерные ассоциации макробентоза. Микрораспределение большинства видов макробентов тесно связано с их потребностями пущи. Лонгттудинальные и сезонные представительства отдельных трофических групп зависит от хода динамичности речного мира.