EPIRHITHRAL COMMUNITIES OF MAYFLIES (EPHEMEROPTERA) OF THE ODRA RIVER BASIN (CZECH REPUBLIC)

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ABSTRACT

Eleven localities with minimal anthropic impact were sampled in the Odra River basin in 1995-1996. The main aim was (i) to define taxocoenoses of mayflies within the epirhithral benthic communities (ii) to compare data obtained recently with those from 1955-1960 in order to define long-term changes in species composition and biodiversity. The programmes and methods of TWINSPAN (Two Way INdicator SPecies ANalysis) and DECORANA (DEtrended CORrespondence ANAlysis) were used to define mayfly taxocoenoses. *Rhithrogena iridina, Baetis alpinus* and *Epeorus sylvicola* were found to be the most important indicators of mayfly communities in this area. Long-term environmental changes are discussed, no pronounced tendencies to deterioration within the area studied are apparent.

INTRODUCTION

Several authors (Zelinka, .1953; Losos and Marvan, 1957; Obrdlík, 1979, 1981; Simanov and Kantorek, 1987; Landa and Soldán, 1989) dealt with surface water quality in the Odra River basin and several faunistic studies of localities of this area (Kolenati, 1859; Tomaszewski, 1932; Zelinka, 1950, 1951, 1953; Tuša, 1974a, 1974b; Zelinka, 1977, 1979) were published. During 1950-1965 the Institute of Entomology of the Academy of Sciences of the Czech Republic together with the Dept. of Zoology and Ecology of Masaryk University organized a large-scale faunistic programme of research of aquatic insect distribution (e.g. so-called Research Project No. 210). Three aquatic insect orders important from the biomonitoring point of view (i.e. Ephemeroptera, Plecoptera and Trichoptera) were used as models. Landa and Soldán (1989), Soldán et al. (1998) defined long-term changes of mayfly taxocoenoses of epirhithral localities situated in this area on the basis of samples taken in 1950-1965, 1970-1985 and 1994-1996.

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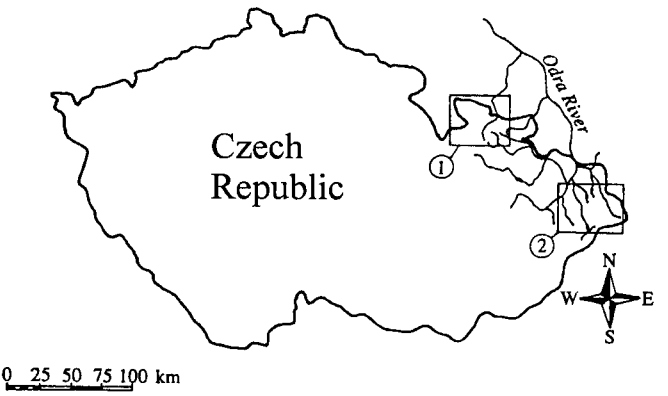

Fig. 1. Location of study areas – the Jeseníky (1) and Beskydy Mts. (2)

A new classification method of rivers was established in Great Britain (Wright et al., 1989). This method – RIVPACS (River InVvertebrate Prediction And Classification System) – is using the concept of natural reference localities, which are predicting for specific places on the base of recent levels of natural abiotic factors. Actually present macroinvertebrate community is compared to community predicted.

The main aim of this study is to define the taxocoenoses of mayflies in epirhithral benthic communities and to compare the data obtained with those from 1955 – 1960 in order to define long-term changes in species composition and biodiversity.

STUDY AREA AND METHODS

The samples were taken at 11 localities of the Odra River basin (the Baltic Sea drainage area) in four seasons in 1995 (July, October) to 1996 (March, June). Only undisturbed localities were selected. Study areas were situated in two geographically different parts of the Odra River basin: the Jeseníky and Beskydy Mts. (Fig. 1). The localities were situated in the upper reaches (epirhithral). The Jeseníky Mts. belong to the Hercynian subprovince and are mainly formed from mica schist, gneisses, phyllites – acide rocks, poor in nutriments. Feeding of rivers of this area with cool water during the year has considerable influence on cool stenotherm benthic fauna composition. Average annual temperature is 7.1 °C and annual total of precipitation is 846 mm (Mt. Jeseník). Six localities (L1,.., L6) at altitudes of 350 – 770 m above sea level were studied.

The Beskydy Mts. belong to the Carpathian subprovince. Flysh sandstone and claystone represent prevailing types of substratum in this area. Erosion of these rocks results in the abundant occurrence of flat stones. Air temperature conditions are similar to the Jeseníky Mts. Average annual temperature is 7.4 °C (Frenštát) but average precipitations are higher than in the Jeseníky Mts. Annual total precipitations exceed 1000 mm in the whole area (Culek, 1996). Five localities (L7,..., L11) at the altitudes of 540 – 720 m above sea level were studied here. Localities were sampled semiquantitively. Sampling was limited to 5 minutes at each locality in order to compare species composition and numbers of speciemens more correctly at all localities. All samples were taken with a hydrobiological net using the kicking-technique (Lillehammer, 1974). Samples were taken from all types of habitats. Species representatives were collected from each macrozoobenthos sample and the rest were counted. The samples were immediately fixed with 4 % formaldehyde. Imagines were fixed with 70 % alcohol. Characteristics of bottom and banks, stream width and depth, and current speed were

Table 1. List of mayfly taxa collected in the Jeseníky and Beskydy Mts.

Taxon	Studied sites										
	The Jeseníky Mts.						The Beskydy Mts.				
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11
Rallidentidae											
Ameletus inopinatus	•										•
Baetidae											
Alainites muticus	•	•		•	•	•	•	•	•	•	•
Baetis alpinus	•	•			•	•	•	•	•	•	•
Baetis buceratus			•								
Baetis lutheri						•					
Baetis melanonyx						•	•	•		•	
Baetis rhodani	•	•	•	•	•	•	•	•	•	•	•
Baetis vernus	•		•					•			
Baetis sp. juveniles	•	•	•	•				•	•		
Centroptilum luteolum			•								
Heptageniidae											
Epeorus sylvicola	•	•		•	•	•	•	•	•	•	•
Rhithrogena carpatoalpina	•	•		•	•	•		•	•	•	•
Rhithrogena iridina	•		•	•		•	•	•	•	•	•
Rhithrogena semicolorata	•	•				•		•	•		
Rhithrogena sp. juveniles	•							•	•	•	
Ecdyonurus aurantiacus			•								
Ecdyonurus starmachi									•		
Ecdyonurus subalpinus	•	•					•	•		•	
Ecdyonurus submontanus	•						•				
Ecdyonurus venosus	•		•	•	•	•	•	•	•	•	•
Ecdyonurus sp. juveniles	•						•	•	•		
Electrogena quadrilineata	•						•	•	•		•
Leptophlebiidae											
Habroleptoides confusa	•	•	•	•	•	•	•	•	•	•	•
Habrophlebia lauta				•				•	•		
Ephemeridae											
Ephemera danica			•								
Ephemerellidae											
Ephemerella ignita		•	•	•		•		•	•		
Ephemerella mucronata	•	•	•	•	•	•		•		•	•
Torleya major						•					
No. of species	15	10	11	10	8	14	11	16	13	11	11

measured at each locality investigated. Temperature, pH, DO (dissolved oxygen), and conductivity were measured by HORIBA U-10 multimeter. General classification of surface sediment were estimated according to current scales (boulders, cobbles, coarse gravel, gravel, sand and silt). Determination of mayflies and analysis of water chemistry were conducted in the laboratory. Samples of water were taken three times (point sample) and total organic carbon, nitrates, nitrites, total phosphorus, and total alcalinity were measured.

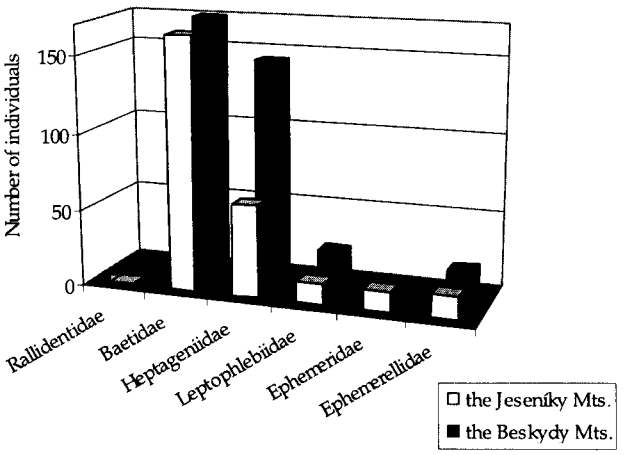

Fig. 2. Average abundance per locality.

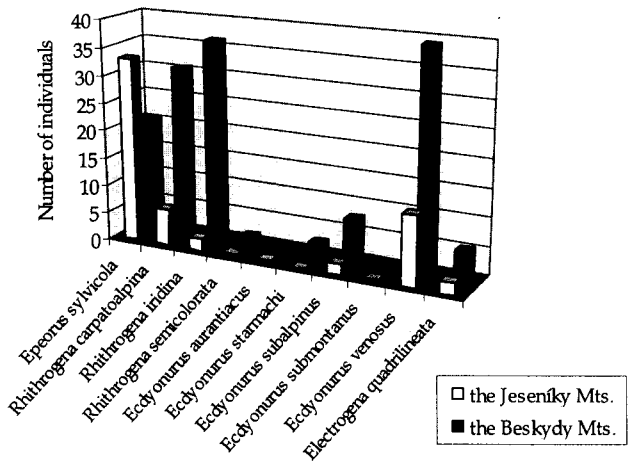

Fig. 3. Average abundance of family Heptageniidae per locality.

Estimation dominancy of individual species and diversity were estimated according to current diversity indices (Margalef, Shannon–Weaver) (cf. Washington, 1984). The saprobial indices were calculated according to Czech State Norm No. 83 05 32 (Sládeček et al., 1981). The programmes and methods of TWINSPAN (Hill, 1979a) and DECORANA (Hill, 1979b) were used to define mayfly taxocoenoses and indicator species.

RESULTS AND DISCUSSION

At the localities studied, 25 mayflies species were found, most of them belonging to the Heptageniidae (10 species) (Tab. 1). The highest species richness was found at the site

Table 2. The parameters of analysed localities which were used in DCA analysis. (The result of Monte Carlo permuted test)

No.	Locality		Altitude	Distance from source (km)	Max. measured temperature of water (°C)	Average conductivity ($\mu S.cm^{-1}$)
L1	Ramzovský brook	Studied sites	590	5.1	12.2	87
L2	Stříbrný brook		750	6.8	11.6	110
L3	Černý brook		350	1.7	14.9	198
L4	Červený brook		400	2.5	14.3	89
L5	Střední Opava		770	2.9	13.8	60
L6	Černá Opava		610	9.9	12.8	83
L7	Trojanovický brook		600	1.5	10.9	80
L8	Mohelnice		540	1.1	10.2	84
L9	Morávka		707	2.0	11.7	406
L10	Ropičanka		670	2.8	10.3	76
L11	Tyrka		720	1.5	10.2	90
12	Svratka	Added sites	490	13.6	14.8	148
13	Sitka		320	19.0	16.0	197
14	Branná		440	17.1	12.3	150
15	Jezerní brook		630	1.5	14.0	162
16	Trnava		570	2.1	13.0	518
17	Litava		320	3.0	15.0	507
18	Fryšávka		690	5.4	13.0	133
19	Kyjovka		425	2.5	13.0	384
20	Opava		350	38.1	15.9	152
21	Jihlava		185	79.6	23.1	300

Mohelnice - L8 (16 species) in the Beskydy Mts. and at the locality Ramzovský brook - L1 (15 species) in the Jeseníky Mts. *Baetis* species were the most abundant, mainly *Baetis alpinus* and *B. rhodani*. *B. rhodani* was eudominant at 9 sites and *B. alpinus* at 8 sites. *Alainites muticus* showed the highest dominancy during the second sampling period (up to 87 %). The highest values of dominancy were recorded in the case of *Ephemera danica* at Černý brook – L3 (up to 85 %) where a lot of patches of sand substrate occurred. Species of the genera *Baetis* and *Rhithrogena* predominated between eudominant species in the Beskydy Mts. (Figs 2, 3). A similar situation was observed in the Jeseníky Mts. although no species of the genus *Rhithrogena* belonged to eudominant species here. In the Beskydy Mts., the species of the genus *Rhithrogena* were frequently found due to different substrate roughness (below flat stones). This particular microhabitat is typical for larvae of this genus. Species composition seems to be affected also by other factors, namely glaciation and presence of Carpathian elements. Effects of the last continental glaciation reaching to the Moravian Gate is recognizable here (Soldán, pers. comm.) while the Beskydy Mts. were not influenced. We can see this phenomenon on the example of *Ecdyonurus starmachi*, which was found in the Beskydy Mts. but not in the Jeseníky Mts. It represents a typical Carpathian species.

Diversity index was determined for each sample. Decrease of diversity was detected during autumn (sample 2) and in spring (sample 4) in some cases. It is caused by the end of emergence of some species in the first case and, on other hand, by occurrence of a large quantity of juvenile stages – especially *Baetis* spp. and *Ecdyonurus* spp. accumulated into a single taxon (*Baetis* sp. juveniles or *Ecdyonurus* sp. juveniles, respectively). In the second case, the diversity decrease was influenced by spring snow melting and drift loses following increase of discharge.

Saprobial indices show very good water quality. Xeno- or oligosaprobity was determined at all types of sites, only Černý brook had ß-mezosaprobity character. This site generally differed from the others.

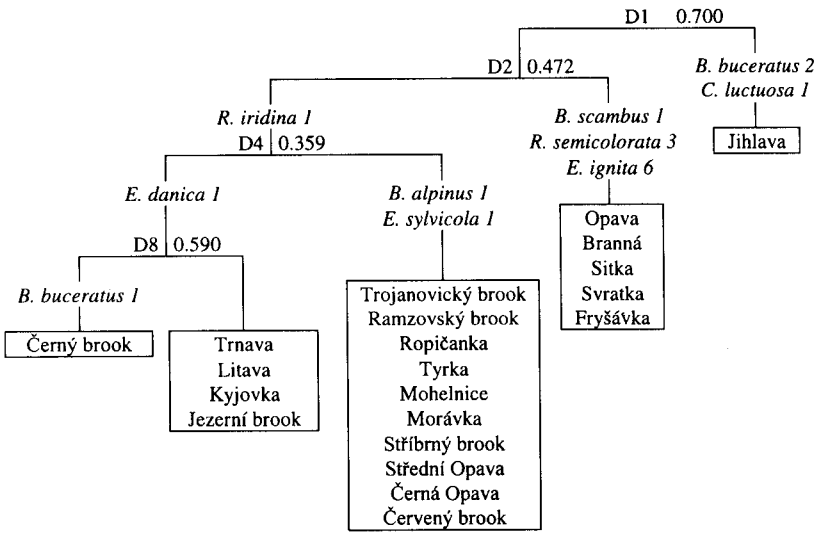

Fig. 4. Divisive hierarchic classification (TWINSPAN) with depicted indicator species. Separated groups of localities are marked out in five boxes.
[1]No. of division, [2]eigenvalue, [3]pseudospecies level.

Comparison of these results with data from 1955 – 1960, when the large-scale faunistic research of aquatic insect was organised, shows long-term environmental changes not very pronounced at studied sites. There were a lot of taxonomical shifts during the last 40 years, especially into the genera *Rhithrogena, Baetis* and *Ecdyonurus.* Several new species were recently defined. Consequently, more species than ascertained by the Research Project No. 210 are now recorded from the area studied. Only *Rhithrogena hybrida* was not found, but this species evidently occur in other parts of the Jeseníky Mts. (Landa, 1989).

For precision of method TWINSPAN analogical data from the Odra and Morava Rivers basins were added (Tab. 2). Analysis supported considerable similarity of the 10 localities investigated. The first division (D1) – Jihlava is an epipothamal lowland river with *Baetis buceratus* and *Caenis luctuosa* as indicator species. During the second division (D2) the group of large rivers from the Morava, Odra and Dyje Rivers basins was divided according to *Baetis scambus, Rhithrogena semicolorata* and *Ephemerella ignita* as indicator species. The fourth division (D4) divided the group of sandy and slowly flowing rivers (including site Černý brook - L3) according to *Ephemera danica* as indicator species from group of epirhithral localities. Indicator species for the group of epirhithral localities were *Rhithrogena iridina, Baetis alpinus* and *Epeorus sylvicola.* This is the result of divisive hierarchic classification (Fig. 4). *Baetis alpinus, Baetis vernus* and *Alainites muticus* were determined to be eudominant and euconstant species of this community. *Baetis lutheri, Ecdyonurus starmachi* and *Torleya major* were found out to be specific species, collected only at one locality.

Detrended correspondence analysis was used for considering the influence of environmental characteristics on mayfly communities. Significance of environmental variables was tested by Monte Carlo permuted test (Ter Braak, 1991). Altitude (alt), conductivity (cond), distance from source (kmsource) and the maximum annual water temperature (tmax) were found to be important (Fig. 5). The most expressive positive correlation was found between the maximum annual temperature of water and distance from source. On other hand, the maximum negative correlation was found between altitude and the maximum annual water tem-

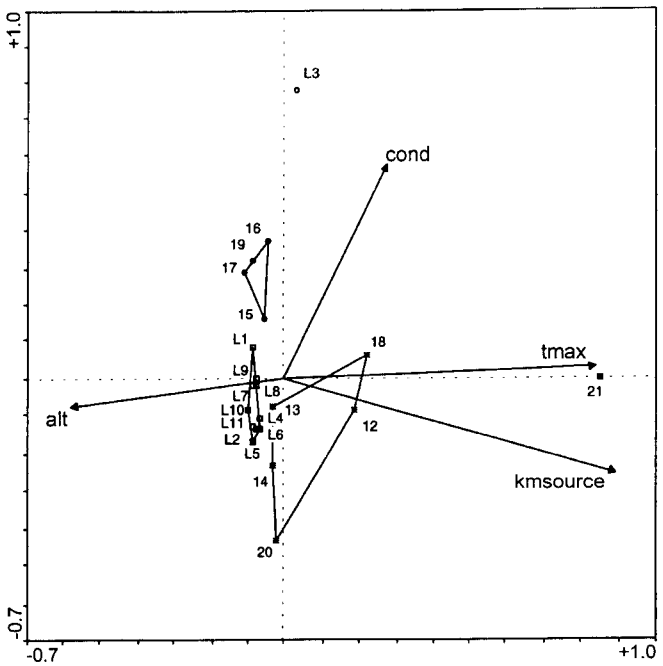

Fig. 5. Detrended correspondence analysis (DCA), ordination plot of localities and environmental variables on the first two DCA axes.

perature (Fig. 5). Low correlation was found between conductivity and other environmental factors. The most expressive correlation was found between altitude and occurrence of species of epirhithral community. The results of this study represent basic data for definition of characteristic communities of macroinvertebrates at anthropically undisturbed river segments and will be included into recently constructed predicting models analogical to the British RIVPAC system which are planned to be used at numerous localities within the whole Czech Republic.

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