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THE INFLUENCE OF DIFFERENT THERMAL REGIME ON THE STRUCTURE OF COENOSES OF STENOTHERMAL HYDROBIONTS IN MOUNTAIN STREAMS

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Abstract: The influence of different thermal regime on the structure of macrozoobenthos in two mountain streams, Tomanov potok and Javorov potok (High Tatras Mts.) is analysed in the frames of investigation. The streams are situated at an altitude approx. 1300 m and run through supramontane zone. 83 macrozoobenthic species found were classified according to their temperature requirements as oligostenothermal and mesostenothermal ones. 25 species, of the Plecoptera, Trichoptera and Diptera orders, belong to oligostenothermal ones, occur only in the cold stream of Javorov potok with temperature below 7 °C. Mesostenothermal species occurring in the stream of Tomanov potok included mainly species of the Ephemeroptera order. Thermal regime in the monitored mountain streams has a decisive effect on macrozoobenthic communities. It acts discontinuously in the direction of the shift of vertical stream zoning. As a result of balanced thermal regime and low temperature Javorov potok acquires a transitive character between crenal and epirithral. The stream of Tomanov potok represents rhithral with qualitative dominance of epirhithral species. In the summer period, euryoecous mesostenothermal species typical of submontane streams penetrate in this stream.

Keywords: water thermal regime, macrozoobenthos, High Tatras Mts., Slovakia

INTRODUCTION

Water temperature belongs to important factors affecting metabolism, growth, reproduction, emergence and distribution of aquatic insects (VANNOTE & SWEENEY 1980). The authors mentioned below confirmed this statement by field and laboratory experiments (SWEENEY & VANNOTE 1981). MOOG & WIMMER (1994) has divided Austrian flows in biocoenotic areas on the basis of different temperatures. SIMMONS & HAWKINS (2001) has shown that direct measures of temperature can improve both the performance of predictive models and modeling of benthic community composition-based ordinations.

Several authors studied coenoses of selected macrozoobenthic groups under influence of different temperatures in conditions typical of our country. JEDLIČKA (1982, 1993), ILLÉŠOVÁ et al. (2000) studied communities of black flies in mountain streams of the High Tatras Mts. and the impact of environmental factors among which temperature proved itself as the key factor on these communities. KAMLER (1965, 1973), KAWECKA et al. (1971) studied temperature conditions in mountain streams of Poland as well as their impact on distribution of macrozoobenthos. Several authors dealt with the macrozoobenthos study in the High Tatras Mts. In Slovakia, within the limnological study of the Belá River, ERTL et al. (1984) has made the complete hydrobiological research of this significant alpine river. Low temperatures prevailing in streams during the year provide good opportunity to study the impact of temperature on macrozoobenthos in natural environment.

The aim of the study is to compare the structure of macrozoobenthos in the two Tatra streams with different thermal regime resulting from different source of their spring areas. The influence of temperature on the structure of macrozoobenthos was considered with regard to the fact that the studied streams have different thermal regime although they are situated approximately at the same altitude and in the same climate.

MATERIAL AND METHODS

The stream Tomanov potok (DFS 181 011 – 6785) flows out from the system of smaller and shallower mountain lakes called Tomanovské plesá. The lakes overheat in the summer period and the temperature reaches to 18-20 ºC. Mosses are not present on the bottom, riparian vegetation consists of spruce (*Picea abies)*.

The stream Javorov potok (DFS 181 012 – 6785) flows out from the karst system of Červené vrchy Mts. in the alpine area, i. e. it has a balanced temperature all the time. In contrast to Tomanov potok this does not freeze to the bottom. The bottom is covered with mosses. An amount of mosses increases in the direction of the spring. Another physical and chemical characteristics are indicated in the Tab. 1. The Fig. 1 shows a different course of temperature curves in the compared streams. Material was collected by means of kicking technique. Samples from April and May were included in the cold period, samples from June and August in the warm period.

RESULTS AND DISCUSSION

There were macrozoobenthos 83 species found in the both streams in total. 59 species were found in Javorov potok and 61 species in Tomanov potok (Tab. 2). Mayflies (Ephemeroptera) represented the most abundant macrozoobenthos group in the both streams as well as in the both temperature periods. Reduced species spectrum of mayflies (Tab. 2) in the both monitored streams results from their ecological requirements because the majority of species prefers higher water temperature. Higher qualitative abundance of mayflies in Tomanov potok may be due to higher water temperature and to the fact that its riparian vegetation consists of spruce as opposed to Javorov potok, which is not forested. *Electrogena lateralis* Curtis, 1834, *Rhitrogena iridina* Kolenati, 1839, *Baetis melanonyx* (Pictet, 1845), *Rhitrogena podhalensis* Sowa et Soldán, 1986 occurred in Tomanov potok only. It is the evidence of their mesostenothermal character. Species found in Tomanov potok belong to submontane ones tolerating wider range of temperature. *Rhithrogena podhalensis* and *Rhithrogena tatrica* Zelinka, 1953 are endemic Tatra Mts. species of dinodal distribution.

Stoneflies (Plecoptera) represent the aquatic insect species the best adapted to the cold and to the flow of water. 11 species of stoneflies were found in both streams, 8 of them occurred in cold Javorov potok (Tab. 2) only. The occurrence of these species is bound to temperature not exceeding 14 °C also on other sites of Slovakia. *Protonemura brevistyla* (Ris, 1902) and *Leuctra rosinae* Kempny, 1900 are alpine species occurring in the Central Europe. In Slovakia, they are known in the Tatras Mts. only. *Leuctra pusilla* Krno, 1985 is a West Carpathian species occurring in the transection from Vtáčnik to the Tatras Mts. on sites with water temperature not exceeding 10 °C. The species was described in the mountain lakes Terianske pleso in the Tatras Mts. (KRNO 1985). *Capnia vidua* Klapalek, 1904 and *Arcynopteryx compacta* (Mc Lachlan, 1872) belong to coldwater species bound to alpine lakes and streams. It is known that they occur also in lower altitudes in spring areas with temperature not exceeding 10 °C. From zoogeographical point of view *Arcynopteryx compacta* is a typical oreotundral species, *Capnia vidua* is boreomontane one and both of them are of Siberian origin. *Diura bicaudata* (Linnaeus, 1758) is also a Siberian species of boreomontane origin occurring in lower zones in streams with temperature to 12 °C. *Protonemura hrabei* Rauser, 1956, *Protonemura nitida* (Pictet, 1835), *Leuctra inermis* Kempny, 1899 occurring only in Tomanov potok have Central European to European character of distribution.

Of 16 species of caddis-flies (Trichoptera) found with respect to water temperature and their occurrence in studied biotopes only species occurring in colder Javorov potok and warmer Tomanov potok are interesting ones (Tab. 2). Three oligostenothermal species *Apatania fimbriata* (Picket, 1834), *Acrophylax vernalis* Dziedzielewicz, 1912, *Psilopteryx psorosa* (Kolenati, 1860) occurring in Javorov potok only are the evidence of their distribution on the Slovak territory. Their occurrence is bound to spring areas. Caddis-flies found in Tomanov potok only: *Philopotamus montanus* (Donovan, 1813), *Plectronemia conspersa* (Curtis, 1834) occur in submontane regions only (SZCZESNY 1986, CHVOJKA 1992).

Among Diptera, midges (Chironomidae) represent the highest number of species (Tab. 2). A majority of recorded taxa are species requiring high oxygen content and sensitive to temperature and water clearness. These montane species reported in Javorov potok only are oligostenotherm: *Eukiefferiella brevicalcar* (Kieffer, 1911), *Paratrichocladius rufiventris* (Meigen, 1830). The species *Cardiocladius capucinus* (Zetterstedt, 1850) was found in metarhithral only at this sampling site situated at the highest altitude in Slovakia. Diptera of the Tipulidae, Limoniidae and Psychodidae family represented the small number of species (Tab. 2). Dinodal species *Savtshenkia cheethami* Edwards, 1924, *Berdeniella helvetica* Sara, 1957 were recorded in the Javorov potok. The occurrence of species from the Psychodidae family in Javorov potok could be explained except for low temperature also with the presence of abundant moss overgrowth on boulders where larvae of the *Berdeniella* sp. genus live.

As regards the Simuliidae family there is an interesting finding of the species *Simulium oligotuberculatum* described by KNOZ (1965) directly from Tomanov potok. Its another occurrence since the above mentioned year has been confirmed on the finding-place only in our collections. It is the second locality of its occurrence in Slovakia. The distribution of this species is dinodal because HALGOŠ (1998) indicates its occurrence in the pupal stage in the mountains of Sierra Nevada in Spain.

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VPLYV ROZDIELNEHO TEPLOTNÉHO REŽIMU TEČÚCICH VÔD NA ŠTRUKTÚRU CENÓZ STENOTERMNÝCH HYDROBIONTOV V HORSKÝCH BYSTRINÁCH

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SÚHRN

V práci porovnávame štruktúru makrozoobentosu dvoch tatranských tokov s rozdielnym teplotným režimom spôsobeným rozdielnym pôvodom pramenísk týchto tokov. Pri posudzovaní vplyvu teploty na štruktúru makrozoobentosu sme využili skutočnosť, že skúmané toky majú rozdielny teplotný režim, pričom sa nachádzajú v rovnakej nadmorskej výške a klíme. Zistili sme výrazné rozdiely v štruktúre cenóz jednotlivých tokov z hľadiska zastúpenia skúmaných skupín makrozoobentosu v oboch tokoch. V chladnejšom Javorovom potoku sme zistili 59 druhov, z ktorých 25 bolo viazaných len na tento tok. V teplejšom Tomanovom toku sme zistili 61 druhov, pričom 21 druhov sa vyskytovalo iba v tomto toku. Na základe našich výsledkov môžeme konštatovať, že Javorový potok predstavuje prechod medzi krenálom a epiritrálom s teplotným režimom odpovedajúcim krenálu a vodnatosťou a inými fyzikálno-chemickými charakteristikami zas epiritrálu v montánnej zóne s väčším zastúpením vysokohorských, horských a endemických druhov. Tomanov potok zas predstavuje ritrál s kvalitatívnou prevahou epiritrálových druhov charakteristických skôr pre podhorské toky. Zistili sme nové druhy pre faunu Slovenska: *Berdeniella helvetica* (Sara, 1957), *Limnophyes gurgicola* (Edwards, 1929). Zaujímavý je aj nález druhu *Simulium oligotuberculatum* (Knoz, 1965), ktorý bol opísaný z Tomanovho potoku a jeho ďalší výskyt od uvedeného roku bol potvrdený na mieste nálezu až v našich zberoch.

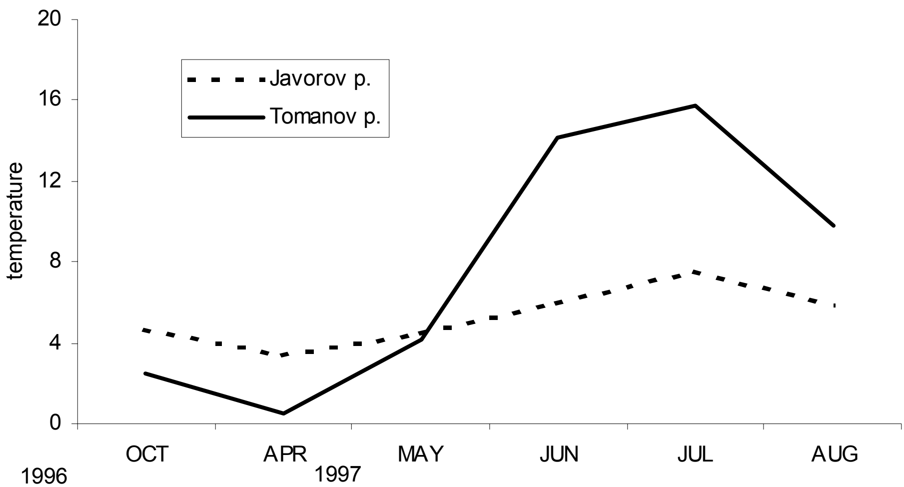

Fig. 1. Course of water temperature in streams Javorov and Tomanov potok (High Tatras Mts.)

Tab. 1. Actual physio-chemical characteristics of streams Javorov potok and Tomanov potok (High Tatras Mts.)

Physiochemical parameters	Unit	16.10.1996		14.5.1996		30.6.1997		28.8.1997	
		J.p.	T.p.	J.p.	T.p.	J.p.	T.p.	J.p.	T.p.
Temperature	ºC	4.7	2.5	4.5	4.2	6.3	14.2	5.8	9.8
Stream velocity	$cm.s^{-1}$	106.0	75	193	159				
Discharge	$l.s^{-1}$	363.0	161	1650	472				
pH			7.8	7.6	7.6	8.1	7.8	7.8	7.6
Conductivity	$\mu.S.cm^{-1}$	176.0	87	86	55	86	93	203	130
Ca	$mg.l^{-1}$	30.1	15.4	35.1	12.6			22.7	16.4
O_2	$mg.l^{-1}$			11.9	11.6			11.1	10.4
O_2	%			93	90			90	93
BSK_5	$mg.l^{-1}$			2.6	2.6			2.1	2.1

Explanations: J.p. - Javorov potok, T.p. - Tomanov potok

Tab. 2. Dominance of macrozoobenthos species found in the streams Tomanov and Javorov potok in the High Tatras Mts.

Taxon	Thermal preference °C	Javorov potok Dominance during		Tomanov potok Dominance during	
		cold period	warm period	cold period	warm period
Turbellaria					
Crenobia alpina (Dana, 1776)	O	SD	D	R	R
Oligochaeta					
Nais variabilis Piguet, 1906	M			SR	
Mesenchytraeus armatus (Levinsen, 1884)	O	SR		SR	
Cognetia sphagnetorum (Vejdovsky, 1877)	M			SR	
Eiseniella tetraedra (Savigny, 1826)	M			SR	
Haplotaxis gordioides (Hartmann, 1821)	O	SR			SR
Amphipoda					
Gammarus balcanicus Schäferna, 1922	M			SR	
Ephemeroptera					
Ameletus inopinatus Eaton, 1887	O	SR		SR	SR
Baetis melanonyx (Pictet, 1845)	M				SD
Baetis alpinus (Pictet, 1843-1845)	O	SD	ED	SD	ED
Electrogena lateralis Curtis, 1834	M				SR
Rhithrogena iridina Kolenati, 1839	M				SR
Rhithrogena podhalensis Sowa et Soldán, 1986	M				SR
Rhithrogena tatrica Zelinka, 1953	O	ED	D	D	SR
Plecoptera					
Nemoura monticola Rauser, 1965	O	SR		R	
Protonemura auberti Illies, 1954	O	SD		R	SR
Protonemura austriaca Theischinger, 1976	O	SR	SR		
Protonemura brevistyla (Ris, 1902)	O	SR	SR		
Protonemura hrabei Rauser, 1956	M				SD
Protonemura montana Kimmins, 1941	M		R		SD
Protonemura nimborum (Ris, 1902)	O	SR	R	SR	
Protonemura nitida (Pictet, 1835)	M				R
Leuctra armata Kempny, 1899	O	SD	R	SD	
Leuctra autumnalis Aubert, 1948	O	R	SD	R	R
Leuctra braueri Kempny, 1898	O	R	SD	SR	
Leuctra inermis Kempny, 1899	M			SR	SR
Leuctra pseudosignifera Aubert, 1954	O	R	R	SD	R

Tab. 2. Continued.

Leuctra pusilla Krno, 1985	O	SD	R		
Leuctra rauscheri Aubert, 1957	O		SR	SR	R
Leuctra rosinae Kempny, 1900	O	SR	SR		
Capnia vidua Klapálek, 1904	O	SD			
Arcynopteryx compacta (Mc Lachlan, 1872)	O	SR			
Diura bicaudata (Linnaeus, 1758)	O	SR	SR		
Isoperla sudetica (Kolenati, 1859)	O	SD	R	SD	R
Perlodes intricatus (Pictet, 1841)	O	SD	R	R	R
Siphonoperla neglecta (Rostock, 1881)	M			SR	
Trichoptera					
Rhyacophila fasciata Hagen, 1859	E	SR	SR	SR	R
Rhyacophila polonica MacLachlan, 1879	E	SR		SR	SR
Rhyacophila tristis Picket, 1834	M			R	SD
Rhyacophila vulgaris Picket, 1834	M	SR	SR		
Philopotamus montanus (Donovan, 1813)	M			SR	SR
Philopotamus helvetica (Scopoli, 1763)	M	SD	SD	SD	SD
Plectronemia conspersa (Curtis, 1834)	M				SR
Apatania fimbriata (Picket, 1834)	O	SD	SR		
Drusus annulatus (Stephens, 1837)	E	SD	SD	SR	
Drusus discolor (Rambur, 1842)	O	SR	R	SR	R
Acrophylax vernalis Dziedzielewicz, 1912	O	SR			
Acrophylax zerberus Brauer, 1867	O	SD			
Melampophylax nepos (Mac Lachan, 1880)	O	R		SR	
Allogamus auricollis (Pictet, 1834)	M				SR
Allogamus uncatus (Brauer, 1857)	O	SD		R	
Psilopteryx psorosa (Kolenati, 1860)	O	SR			
Diptera					
Pseudodiamesa branickii (Nowicki, 1873)	O	SR	SR		SR
Brillia modesta (Meigen, 1830)	M	SR			
Cardiocladius capucinus (Zetterstedt, 1850)	M				SR
Corynoneura celtica Edwards, 1924	M		SR		SR
Corynoneura lobata Edwards, 1924	M	SR	SR	SR	R
Eukiefferiella brevicalcar (Kieffer, 1911)	O	SR			
Eukiefferiella devonica (Edwards, 1929)	O			SR	
Heleniella serratosioi Ringe, 1976	O	SR		SR	
Krenosmittia boreoalpina (Goetghebuer, 1944)	O			SR	
Limnophyes gurgicola (Edwards, 1929)	M			SR	
Orthocladius frigidus (Zetterstedt, 1838)	O	SR	SR	SR	
Parametriocnemus boreoalpinus Gouin,1942	O	SR	SR	SR	SR
Paraphaenocladius pseudirritus Strenzke, 1950	O	SR			
Paratrichocladius rufiventris (Meigen, 1830)	E		SR		
Parorthocladius nudipennis (Kieffer, 1908)	O	R	SR		
Stilocladius montanus Rossaro, 1979	O	R		SR	
Tvetenia bavarica (Goetghebuer, 1934)	O	R	SR	SR	SR
Tvetenia calvescens (Edwards, 1929)	M				SR
Pedicia (*Crunobia*) *straminea* (Meigen, 1838)	E	SR	SR	SR	
Limonia didyma (Meigen, 1804)	E	SR			
Savtshenkia cheethami Edwards, 1924	O	SR			
Savtshenkia goriziensis Strobl, 1893	O	SR			
Berdeniella helvetica (Sara, 1957)	O	R			
Berdeniella illiesi Wagner, 1973	O		SR		
Liponeura cinerascens minor Bischoff, 1922	M	SR		R	SD

Tab. 2. Continued.

Twinnia hydroides (Novák, 1956)	O	SR		SR	
Prosimulium rufipes (Meigen, 1830)	O	SD	SD	R	D
Simulium monticola Friederichs, 1920	O	SR		SD	
Simulium maximum (Knoz, 1961)	O				SR
Simulium argyreatum Meigen, 1838	O			R	R
Simulium oligotuberculatum (Knoz,1965)	O		R	SR	

Thermal preference: O – oligostenotherm 7-12 °C
M – mesostenotherm 0-18 °C
E – eurytherm

Dominance: 0-1 % ...……SR (subrecedent)
1-2 %..……..... R (recedent)
5-10 %.…….. SD (subdominant)