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POPULATIONAL PARAMETERS OF TRICHOPTERANS (*TRICHOPTERA*) IN DOMINANT HABITATS OF A PERMANENTLY DISTURBED LOWLAND RIVER

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A b s t r a c t. Water release through the dam, additionally determined by the functioning of a wild-water slalom canoeing track, strongly modified natural discharge of the lowland Drzewiczka River, contributing to a considerable heterogeneity of environmental conditions; the biota, their resource and their habitats were distributed as patches. Having more physically heterogenous environments this section of the Drzewiczka River contained a greater abundance of macrobenthos than streams with less heterogeneous habitats, chironomid insects being dominants, and ephemeropterans and trichopterans eudominants. Over the annual cycle much difference in the distribution of trichopterans was recorded. In the reophilous habitats scrapers represented by *Psychomyia pusilla* (up to 6500 inds m^{-2} in December), and filtrators of the family *Hydropsychidae – Hydropsyche contubernalis* (up to 2400 inds m^{-2} in June) and *Hydropsyche pellucidula* and *Hydropsyche modesta* were the most abundant. The habitat overgrown by submerged macrophytes was represented by the same species that occurred in the riffle, but in much lower abundance. In the stagnant habitat infrequent case trichopterans, such as *Mystacides* sp., *Anabolia nervosa*, and caseless ones, *Lype reducta* and *Cyrnus* sp., were recorded. In this very mosaic river section, which is 160 m in length, 16 trichopteran taxa were noted.

K e y w o r d s: benthos, river, perturbations, Hydropsychidae, Psychomyidae

INTRODUCTION

Intensive changes of discharge, particularly those of high frequency, lead to a transformation of the riverbed and, consequently, to considerable heterogeneity of environmental conditions [10, 15, 21, 26, 28, 30]. Usually, a consequence of this is a rich and diverse biota, one that takes advantage not only of various physical attributes of environment, but most frequently also of rich food resources. This diversity of substrate creates greater chance of survival during environmental disturbances [14–17, 19].

The aim of the research carried out in the Drzewiczka, a river of permanently disturbed discharge, is to assess the heterogeneity of its bottom, and its colonization by various organisms, ones that also take advantage of various food resources. Special emphasis will be directed to *Trichoptera* because of their co-dominance with Ephemeroptera among insects in terms of density, following *Chironomidae*, and their trophic position in riverine food webs (filter feeders and scrapers). Filtering collectors usually alter the composition of transported organic matter, in this way influencing the food available to collectors and provide important energy subsidies to predators.

STUDY AREA

The Drzewiczka River is right tributary of the Pilica River. The study site, 160 m in length, was established in a fourth order, straightened river section, 2 km downstream of the dam of a reservoir called Lake Drzewieckie. The reservoir was constructed for industrial purposes in the 30's of the last century, while a 1.5 km long artificial wild-water slalom canoeing track (W-WSCT) was additionally constructed for white water canoeists just below the dam in the 80's. Releases of water from the reservoir, several times a week and for two hours daily, were necessitated by the requirement to water the track to create conditions resembling a mountainous river section. In other words, during the releases the discharge is increased by 2-5 times as compared with the median of the natural discharge.

The study area was located just downstream of the W-WSCT (figure of the study area is given in [32]; the mean depth of the river is about 0.5 m). The common alder (*Alnus glutinosa* (L.) Gaertn.) dominate the banks of the river. Five habitats, H_n, differing in several physico-chemical parameters, were established in the area:

$\mathbf{H_1}$ – this habitat is located on the left side of the river. The average current velocity was 0.37 m s^{-1} (range 0.20-0.55), average SI (inorganic substrate index) 8.9 mm (range 6.5-12.4), average benthic periphyton measured as chlorophyll *a* concentration 114.9 mg m^{-2} (range 17.2-305.8),

$\mathbf{H_2}$ – stagnant meander located along the left bank. Bottom overgrown by emerged macrophytes; average SI was 8.1 mm (range 6.1-13.6), average benthic periphyton measured as chlorophyll *a* concentration 380.1 mg m^{-2} (range 108.1-999.3),

H_3 – the middle of the river with numerous patches of submerged macrophytes in summer; the average current velocity was 0.33 m s^{-1} (range 0.12-0.60), average SI 1.0 mm (range 0.2-2.4), average benthic periphyton and epiphyton measured as chlorophyll *a* concentration was 259.9 mg m^{-2} (range 72.9-589.7),
H_4 – along the left bank of the a straightened river section; average current velocity was 0.37 m s^{-1} (range 0.11-0.64), average SI 14.7 mm (range 3.6-23.6), average benthic periphyton measured as chlorophyll *a* concentration was 168.7 mg m-^{2} (average 13.9-436.9),
H_5 – the riffle on the right bank of the river average current velocity was 0.56 m s^{-1} (range 0.34-0.81); average SI 10.8 mm (range 6.2-14.8), average benthic periphyton measured as chlorophyll *a* concentration 107.4 mg m^{-2} (range 15.6-240.3).

MATERIALS AND METHODS

At each habitat, 100 cm^2 was of river bottom was sampled with a tubular sampler 10 cm^2 in cross-section area. Additionally, water velocity and river depth were measured there. On the basis of obtained samples the following characteristics were assessed:
– the basic populational parameters of the formerly sorted out invertebrates,
– weight percentage analysis of inorganic substrate according to its particle size, e.g. sand, gravel, stones [5] was carried out. On the basis of this data the single index of inorganic substrate – SI – was calculated [27],
– amount of benthic particulate organic matter (BPOM). Using sieves and filters the organic matter was segregated into two fractions: coarse (BCPOM > 1 mm) and fine (BFPOM < 1 mm) [25]. Sampling and analysis methods are given in [12],
– benthic periphyton measured as chlorophyll *a* concentration using the Golterman *et al.* method [11]; see details in [12].
Samples were also collected to measure total and given fraction amounts of transported particulate organic matter (TPOM); see details in [12].
Statistica packet was used for calculations; see details in [12].

RESULTS

Significant statistical differences between given habitats were recorded between habitats over the annual cycle in current velocity, scale of particle size classification, benthic coarse particulate organic matter (BCPOM) and transported fine particulate organic matter (TFPOM), amount of periphyton on the river bottom and degree to which the bottom was overgrown by macrophytes (ANOVA, see in [8]).

Stagnant H_2 turned out the least abundant in trichopterans, where their density did not exceed 200 inds m^{-2}, particularly in summer (Fig. 1). Case trichopterans, such as *Mystacides* sp., *Anabolia nervosa*, and caseless ones of *Lype reducta* and *Cyrnus* sp., mostly dominated there.

About 60% of all *Trichoptera* specimens were collected at the habitat of high water velocity and coarse inorganic matter (H_5, Fig. 1). They were particularly abundant in December (9500 inds m^{-2}), when the highest density of the species of *Psychomyia pusilla* (6500 inds m^{-2}) was recorded. This species was also an eudominant at other habitats of high water velocity (H_1 and H_4), beside *Hydropsyche contubernalis* (up to 2400 inds m^{-2} in June) and *Hydropsyche pellucidula* and *Hydropsyche modesta* (Fig. 1). Statistically significant differences between Drzewiczka habitats were detected in the density of dominant species (Kruskal-Wallis test, $P < 0.000$). The result obtained ensued from density differences between H_1 and H_5 (U Mann-Whitney test, $P < 0.002$), H_2 and H_5 ($P < 0.000$) and H_2 and H_4 ($P < 0.009$).

An all the habitats (except H_2) two trophic groups, filtrators and scrapers were noted. Only at H_2 a considerable percentage, but of low density, of shredders was /were observed. Filtering collectors were mostly represented by three taxa of *Hydropsychidae*: *H. contubernalis*, *H. pellucidula* and *H. modesta,* while scrapers by *P. pusilla*. The Spearman rank correlation coefficient values between given river variables and densities of dominant trichopteran species are presented in Table 1.

Table 1. Spearman rank correlation coefficients between density of selected trichopteran species and abiotic and biotic parameters;

Taxa	River parameters				
C. lepida	current velocity ***,	SI **,	– BCPOM ***,	– chlorophyll *a* **	
H. contubernalis	current velocity ***,	SI ***,	– TFPOM * ,	– BCPOM ***,	– chlorophyll *a* **
H. modesta	current velocity **,	SI ***,	– BCPOM ***,	– chlorophyll *a* ***	
H. pellucidula	current velocity ***,	SI **,	– TFPOM *,	– BCPOM ***,	– chlorophyll *a* *
P. pusilla	current velocity ***,	SI ***,	– BCPOM ***,	– chlorophyll *a* *	
Trichoptera total	current velocity ***,	SI ***,	– TFPOM *,	– BCPOM ***,	– chlorophyll *a* ***

SI – inorganic substrate index; BCPOM – benthic coarse particulate organic matter;
TFPOM – transported fine particulate organic matter; chlorophyll *a* – concentration in periphyton.
Significance level of correlation coefficient:*P < 0,05, ** P < 0,01, *** P < 0,001.

Canonical correspondence analysis proved a statistically significant correlation between most of the investigated river variables and density of dominant trichopteran species ($R = 0.884$, Chi square test = 255.20, $P = 0.035$).

DISCUSSION

One positive result of impounding a river is huge amount of high quality food that is flushed downstream from the reservoir and mostly utilized by filtrators [1, 2, 20, 29, 37]. It was determined that it is just this guild that plays an essential role in the budget of organic matter, connecting processes occurring in water col-

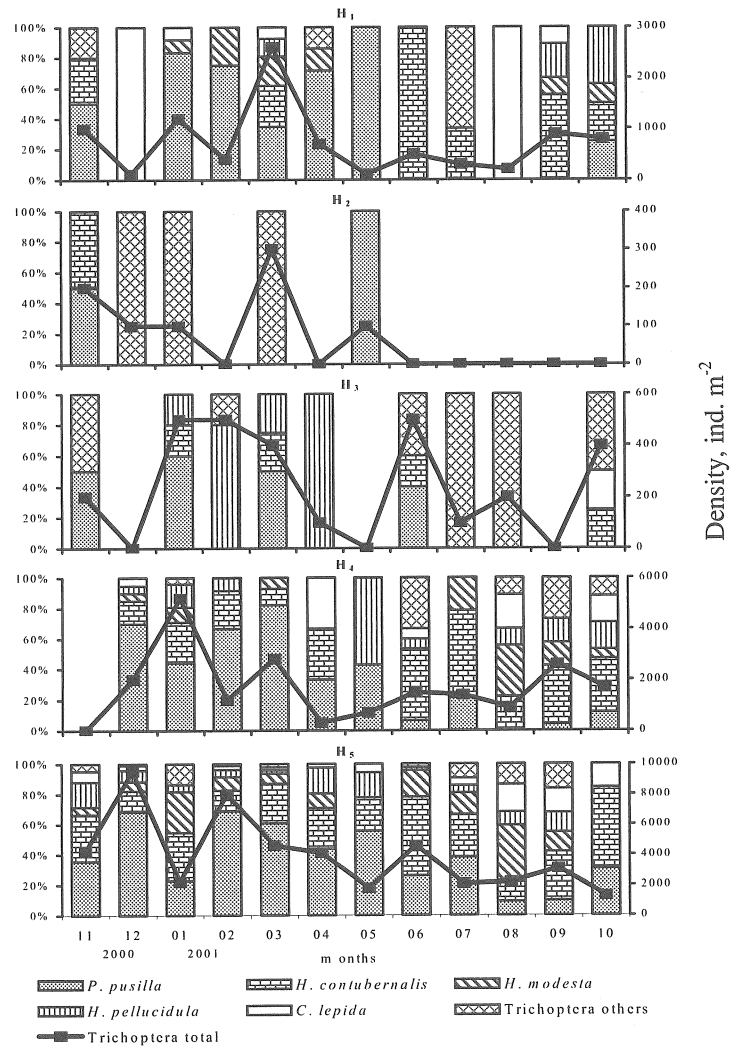

Fig. 1. Seasonal dynamics of density of dominant *Trichoptera* taxa (solid line) and their percentages (histograms) in the total *Trichoptera* density in given habitats (H_n) over the annual cycle in Drzewiczka River

umn with those in river bottom [22, 35]. Algae and detritus usually belong to the basic food resource of this trophic group; additionally, considerable percentages of crustaceans (*Cladocera*) and rotifers are observed among specimens inhabiting river reaches below dams of reservoirs [6, 33, 34].

Presence of filtering collectors such as Simuliidae (Diptera) or Trichoptera in river sections downstream of impoundments is not only a result of abundant high quality food, but also the possibility of convenient attaching to stony or gravelly substrate in conditions of high water velocity [9, 18, 24, 29]. The density of filtrators usually decreases together with increase in the distance from the dam [31, 36, 37].

Conditions favouring the development of filtrator populations were recorded in the Drzewiczka River section downstream of the dam and the W-WSCT. The discharge regime that had been untypical for several dozen years created heterogenous environmental conditions, and as a result, habitat diversity with highly abundant and diverse zoobenthos. The patchiness of the river section studied also determined spatial co-existing of various Hydropsychidae taxa. A considerable abundance of *H. contubernalis*, *H. modesta*, and *C. lepida* is typical of much larger rivers than the Drzewiczka, ones that also carry great amounts of transported organic matter [3].

Note that in running waters the abundance of Hydropsychidae larvae is much dependent not only on water velocity, scale of inorganic particle size and food resources [4], but also on water temperature [13], interactions between various filtrator taxa [7, 23] and numerous other factors. Perhaps, the domination of *H. contubernalis* in the Drzewiczka may be explained by its lower sensitivity to discharge fluctuations and oxygen content in water [3] as compared with *H. pellucidula*.

CONCLUSIONS

Hydraulic stress caused by high frequency of large water volume releases from a dam reservoir created a considerable heterogeneity of environmental conditions, and, consequently, habitat patchiness of the Drzewiczka River bed downstream of the dam. The considerable habitat diversity resulted in a great number of co-occurring species, with dominant reophilous forms, of strong preferences to coarse substrate, such as trichopterans of the *Hydropsychidae* family. The coexistence of *H. contubernalis*, *H. modesta*, and *C. lepida* determined in the fourth order stream section of the Drzewiczka River is rather typical of river sections of higher orders due to much transported organic matter there.

The composition and amounts of food resources (TFPOM) flushed from the reservoir contributed to the presence of filtering collectors, mainly *Hydropsychidae* (*Trichoptera*) and *Simuliidae* (*Diptera*).

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PARAMETRY POPULACYJNE CHRUŚCIKÓW (*TRICHOPTERA*) W DOMINUJĄCYCH SIEDLISKACH RZEKI O PERMANENTNIE ZMIENIANYM PRZEPŁYWIE

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Streszczenie. Upust wody do rzeki poniżej tamy, dodatkowo zdeterminowany funkcjonowaniem górskiego toru kajakowego, silnie zmodyfikował naturalny przepływ nizinnej rzeki Drzewiczki przyczyniając się do znacznej heterogenności warunków środowiskowych. Ta mozaikowość siedlisk spowodowała powstanie bogatej i zróżnicowanej bentofauny z dominującymi owadami *Chironomidae*, oraz eudominantami *Ephemeroptera* i *Trichoptera*. W cyklu rocznym stwierdzono znaczne różnice w rozmieszczeniu chruścików. W zoobentosie siedlisk reofilnych najliczniejsze były osobniki dwu grup troficznych: zdrapywacze reprezentowane przez *Psychomyia pusilla* (do 6500 osobników·m^{-2} w grudniu), oraz filtratory z rodziny Hydropsychidae – *Hydropsyche contubernalis*, (do 2400 osobników·m^{-2} w czerwcu) oraz *Hydropsyche pellucidula* i *Hydropsyche modesta*. Siedlisko pokryte zanurzonymi makrofitami reprezentowane było przez te same gatunki, co w bystrzu, ale w znacznie mniejszej obfitości. W siedlisku lenitycznym odnotowano nieliczne chruściki domkowe takie jak: *Mystacides* sp., *Anabolia nervosa* oraz bezdomkowe: *Lype reducta* i *Cyrnus* sp. W tym heterogennym odcinku rzeki o długości 160 m stwierdzono 16 taksonów chruścików.

Słowa kluczowe: bentos, rzeka, zaburzenia, Hydropsychidae, Psychomyidae