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ORGANIC MATTER IN A LOWLAND RIVER OF STRONGLY MODIFIED DISCHARGE
1. SEASONAL DYNAMICS OF BENTHIC AND TRANSPORTED ORGANIC MATTER IN DIVERSE HABITATS – RESPONSE OF THE BENTHOFAUNA

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Summary. In a fourth order stream section of a lowland river with a strongly modified hydrologic regime (summarizing effect of impoundment and short term daily but abrupt releases of water) resembling the fluctuations of rivers below storage electricity plants, the seasonal and spatial dynamics of the benthic (BPOM) and transported (TPOM) particulate organic matter over the annual cycle was analysed. This hydrologic regime produced a mosaic of patches with different stabilities on the river bed below the dam, which was reflected in the spatial and seasonal dynamics of the benthofauna and in the composition of organisms in the drift.

Keywords: river, disturbances, particulate organic matter, macroinvertebrates

INTRODUCTION

The whole pool of organic matter in a given river section is a total of matter inputs from various sources and the primary "in situ" production. Because organic matter constitutes the main food sources for microorganisms and detritivorous consumers, which are the main "route" along which the matter is transferred to higher trophic levels, the main seasonal quantitative changes in various habitats, processes of decomposition (fragmentation), and the role of water organisms in its transformation constitute the subject of research in numerous riverine ecosystems [20, 31, 32, 35].

The aim of the study was to assess the seasonal dynamics of different types of organic matter, both of allochthonous and autochthonous origin, in some dominant habitats of a lowland river of strongly disturbed hydrologic regime and the response of the benthic fauna, also the migration via drift, to such changes.

STUDY AREA

The lowland Drzewiczka River is part of the Vistula drainage basin. The Drzewiczka River rises at 248 m a.s.l, is 81.3 km long and empties into the Pilica River at 130 m a.s.l. Its catchment area is ca. 1083 km^2 and the slope ranges from 2.7-2.5% in the upper reaches to 0.8-0.7% in the middle and lower course. The study area (20°28' E and 51°27' N) was established within a fourth order stream section, 28 km upstream of the mouth and 1.5 km downstream of the dam reservoir. This reservoir, called Lake Drzewieckie, has an area of 0.84 km^2, and was constructed between 1932-1936, mainly in order to supply water to a metallurgic factory and for recreation. In 1980 a wild-water slalom canoeing track (W-WSCT, about 2 km long) of a mountainous character was built just below the dam reservoir. Due to these constructions the hydrological regime of the river downstream of the dam became very variable and decisively different from the natural one. Every day, mainly in the afternoon, over a two hour period, a large volume of water (3-5 times exceeding the median) was released to enable the training of canoeists.

In the 160 m long study site, 5 different dominant habitats, on average 0.5 m deep, were identified (the figure of the study area is presented in [27]):

H_1 – this habitat is located on the left side of the river, close to the end of the W-WSCT (the upper habitat). The average current velocity was 0.37 m s^{-1} (range 0.20-0.55), average substrate index (SI) 8.9 mm (range 6.5-12.4), average benthic chlorophyll *a* density 114.9 mg m^{-2} (range 17.2-305.8),

H_2 – located along the left bank, was a depositional (stagnant) habitat, a very low flow area with a large amount of fine and coarse particulate organic matter and covered with emerged macrophytes; average SI was 8.1 mm (range 6.1-13.6), average benthic chlorophyll *a* density 380.1 mg m^{-2} (range 108.1-999.3),

H_3 – this habitat was the most dominant in the investigated study area. Vegetation cover included large patches of *Potamogeton lucens* L. and *Potamogeton crispus* L. Small patches of *Potamogeton pectinatus* L. also covered the riverbed of this habitat (the macrophyte habitat). *Cladophora glomerata* (L.) Kutz filaments coated these macrophytes, especially in June; average current velocity was

0.33 m s^{-1} (range 0.12-0.60), average SI 1.0 mm (range 0.2-2.4). Chlorophyll *a* concentration in periphyton and epiphyton was 259.9 mg m^{-2} (range 72.9-589.7).

H_4 – along the left bank (the bank habitat). Average current velocity was 0.37 ms^{-1} (range 0.11-0.64), average SI 14.7 mm (range 3.6-23.6), average chlorophyll *a* concentration in periphyton was 168.7 mg m^{-2} (average 13.9-436.9),

H_5 – consisted of an erosional, high-flow area along the right bank (the riffle); average current velocity 0.56 m s^{-1} (range 0.34-0.81); average SI was 10.8 mm (range 6.2-14.8). Benthic chlorophyll *a* concentration was 107.4 mg m^{-2} (range 15.6-240.3).

It is worth noting that the Drzewiczka River flows through agricultural land overgrown by numerous grasses; the riparian trees were characterised mainly by *Alnus glutinosa* (L.) Gaertn. and *Populus* sp.

MATERIAL AND METHODS

Benthic samples from the five sampling habitats were collected in the Drzewiczka River monthly, in the morning, from November 2000 to October 2001. Ten samples were collected with a 10 cm^2 (100 cm^2 of stream-bed area); a tubular sampler was used at each earlier described habitat (H_n).

In each habitat (H_n) temperature, depth, current speed, area of the habitat were measured and presence of macrophytes was noted.

On the basis of obtained samples the following characteristics were estimated:

- the population parameters of zoobenthos,
- scale of inorganic particle size classification [9].

On the basis of these data the single inorganic substrate index was calculated – SI [25], and amounts of benthic particulate organic matter (BPOM) were estimated. Using sieves and filters this organic matter was divided into two fractions: [23]: coarse (BCPOM > 1 mm) and fine particulate organic matter (BFPOM < 1 mm).

In order to estimate amounts of both fine and coarse transported organic matter and number of drifting macroinvertebrates three nets were mounted on 0.5x0.7 m frames and were 1.5 m in length; they were put into each habitat for ten minutes; see details in [16]. Collected coarse material was divided into three fractions: terrestrial plants (allochthonous matter), unidentified detrital material (detritus and others) and autochthonous matter (mainly *Potamogeton*). To measure total amounts of transported organic matter (TPOM) triplicate water samples were collected in 10 l plastic bags. These samples were filtered through Whatman filters; see details in [16].

Migrating macroinvertebrates from nets were sorted, identified, counted and then recalculated for 100 m^3; see details in [13].

Additionally benthic samples of 50 cm^2 each were also taken at each location in order to estimate chlorophyll *a* concentration. Periphyton was measured as chlorophyll *a* concentration using the Golterman *et al.* method [12].

All statistical analyses were carried out using CCS Statistica [26]; see details in [16].

RESULTS

Environmental variables

Significant statistical differences between given habitats were recorded between particular habitats over the annual cycle in current velocity, granularity of inorganic substrate, 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 (Tab. 1). Submerged macrophytes (mostly *Potamogeton*) occurred only in the main channel (H_3).

Table 1. A one-way ANOVA was used to determine significant differences of given environmental parameters between five habitats of the Drzewiczka River (df = 4;55) and between dates (November 2000-October 2001, df = 11;48)

Statistics / Parameters	Habitats F	Habitats P	Time F	Time P
Depth (m)	1.727	0.157	6.685	0.000
Current velocity (m s^{-1})	43.561	0.000	0.260	0.990
SI (mm)	88.578	0.000	0.074	0.999
BFPOM (g m^{-2})	2.248	0.076	3.329	0.002
BCPOM (g m^{-2})	20.777	0.000	0.349	0.970
TFPOM (g m^{-3})	2.759	0.037	6.041	0.000
TCPOM (g m^{-3})	1.092	0.369	2.371	0.020
Detritus and others (g m^{-3})	3.099	0.023	1.009	0.453
Autochthonous matter (g m^{-3})	1.998	0.107	0.760	0.677
Allochthonous matter (g m^{-3})	0.353	0.840	3.790	0.001
Chlorophyll *a* (mg m^{-2})	6.630	0.000	3.040	0.004

SI – granularity of inorganic substrate index, two benthic particulate organic matter (BPOM) fractions: coarse (BCPOM) and fine (BFPOM) and two transported particulate organic matter fractions (TPOM): coarse (TCPOM) and fine (TFPOM), chlorophyll *a* concentration in periphyton.

Seasonal and spatial dynamics of the benthic (BPOM) and transported (TPOM) particulate organic matter

The amount of fine particulate benthic and transported POM decisively varied from season to season (Fig. 1). Fine particulate organic matter dominated in the BPOM of each habitat; its highest values being recorded in bottom overgrown by emerged macrophytes (BFPOM constituted over 60% of BPOM), while the lowest amounts of benthic POM (ten and several percent each) were detected at the fast current habitat (H_5) and in the habitat closest to the dam (H_1).

Over the annual cycle the lowest percentages of BCPOM in total benthic POM (ten and several percentages each) were recorded in the reophilous habitats. In these habitats a high fluctuation in BCPOM amount deposited on the bottom was observed: at H_4 (variability coefficient of 69%), H_5 (98%, respectively) and H_1 (73%); consequently, high current speed did not contribute to CPOM retention (Table 2).

Table 2. Pearson "r" correlation coefficients between abiotic and biotic parameters, also between benthos density, in the investigated habitats

River parameters	
Depth (m)	
Current velocity (m s^{-1})	-BFPOM*, -BCPOM***, -TFPOM*, -TCPOM*, -chlorophyll *a* ***
SI (mm) Substrate garnularity	-BCPOM***, -macrophytes***, -chlorophyll *a**
Macrophytes	BCPOM*, TCPOM*
Chlorophyll *a*	BCPOM*
Taxa	
Oligochaeta	-SI**, BCPOM**, chlorophyll *a**
Ephemeroptera	
Simuliidae	-SI**, BCPOM*, macrophytes *
Chironomidae: Tanypodinae	TCPOM*
Chironomidae: Orthocladiinae	cur. vel..***, -BCPOM*
Chironomidae: Chironomini	-SI*, chlorophyll *a* *
Chironomidae: Tanytarsini	
Trichoptera	SI**, cur. vel. ***, -BCPOM***, -chlorophyll *a* **

Significance level of correlation coefficient:*P < 0,05, ** P < 0,01, *** P < 0,001; cur. vel. – current velocity, other explanations as in Table 1

In transported POM, fine particulate organic matter (TFPOM) decisively dominated, constituting 99% of total TPOM; its amount decisively differed from habitat to habitat and varied in given habitats over the annual cycle (Tab. 1, Fig. 1). Such temporal differences were also noted in the coarse TPOM, particularly its allochthonous fraction, and still more so in the autumn-winter season. Alders and other trees and shrubs of the ecotone zone also considerably contributed to

TCPOM. As regards autochthonous TCPOM the highest biomass of each submerged macrophyte species was noted at H_3 in July.

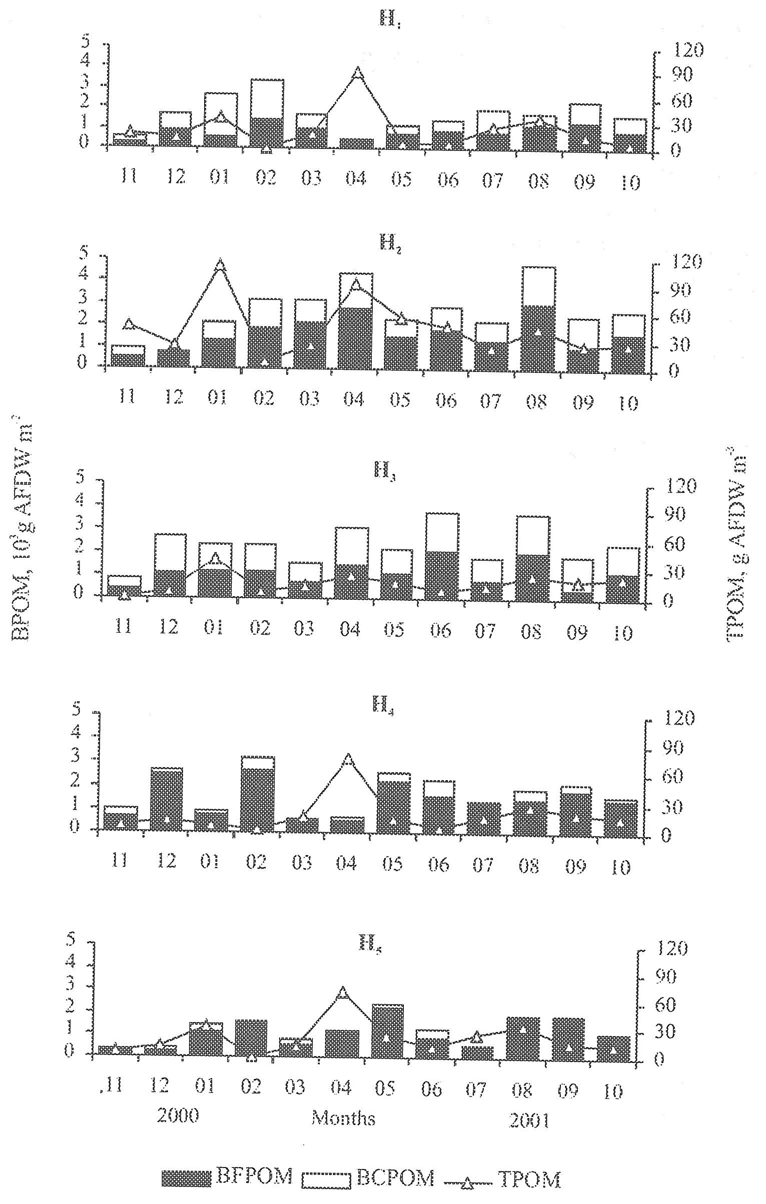

Fig. 1. Seasonal dynamics of benthic (histograms) and transported organic matter (solid line) in the investigated habitats (H_n) of the Drzewiczka River expressed in ash free dry weight (AFDW)

The values of Pearson "r" correlation coefficient was used to examine the relationship between abiotic and biotic parameters (Tab. 2).

Benthos and drift

The highest invertebrate density occurred H_3 at H_5, only slightly lower in H_4, and the lowest at H_2 (Fig. 2). Of *Chironomidae*, the following taxa dominated: *Orthocladiinae* at H_1, H_4 (where they reached the highest density), H_3 and H_5, *Chironomini* at H_2, H_3 (maximum density) and H_4, Tanytarsini at H_3, Tanypodinae at H_2, H_5 (maximum density) and H_3, while among other macroinvertebrates *Oligochaeta* at habitats H_2, H_3 (maximum density) and H_1, *Simuliidae* at H_3, and Trichoptera: Hydropsychidae at H_5 (max. density), H_4 and H_1 and Psychomyidae at H_5 (max. density), H_4 and H_1.

Most transported organisms in the water column were recorded at habitat H_2 and H_3 (Fig. 2). Among drifting invertebrates *Chironomidae* decisively dominated; they were such as Orthocladiinae at H_5, H_1, H_4 and H_3 (max. density), Tanytarsini at H_2 and H_3 (max. density), *Chironomini* at H_3, and Tanypodinae at H_2. Of the other insects also *Simuliidae* at H_1, H_3 (max. density), H_4, H_5, H_2 and many of *Ephemeroptera* (mainly *Baetis* and *Caenis*) at H_2 were common components of the drift. Oligochaeta were abundant at H_4 (max. density) and H_2 (Fig. 2).

DISCUSSION

Seasonal and spatial dynamics of organic matter in ecosystems affected by human impact

Dam reservoirs are constructed for various purposes; each of them also possesses its own specificity determined by geographic, climatic, hydrologic or geology of terrain-related conditions. The discharge regime of water released from Lake Drzewieckie to the river resembles that of storage electricity plants, which operate according to diurnal fluctuations in energy demand [22, 29]. Consequently, it may be assumed that short-term releases of a "large" water, which is several times greater than a 'normal discharge', modifies the Drzewiczka section downstream of the dam and the W-WSCT, thus making it very heterogenous in environmental conditions (patchiness of habitats) and enable a greater number of co-occurring species to exist [9]. In this section both habitats of high stability, at which the development of emerged or submerged vegetation prevented the washing out of organic matter in periods of high flood, as well as typically reophilous ones, for which high cumulating of POM was not observed, were detected.

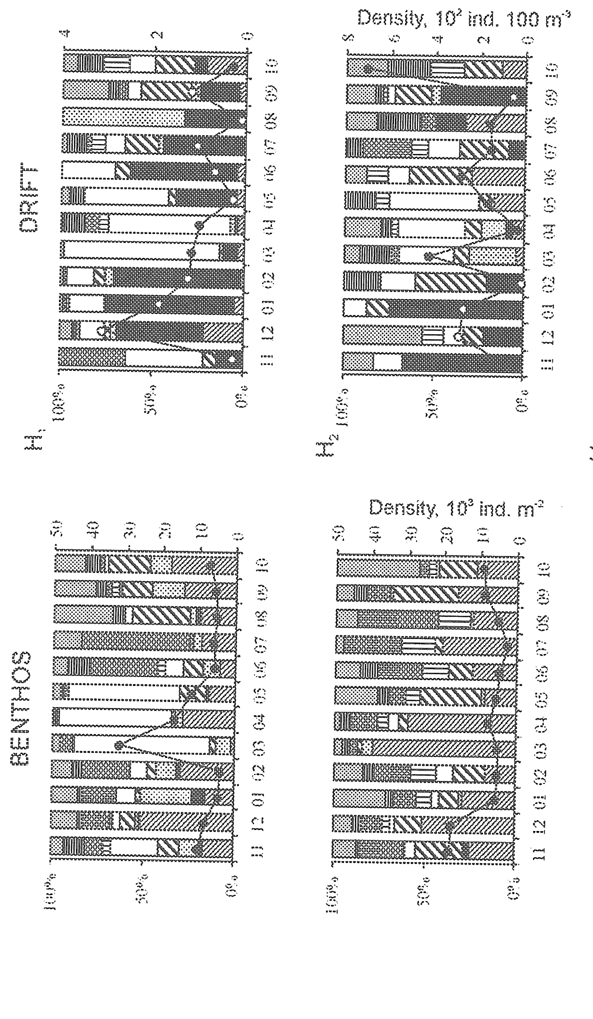

Fig. 2. Seasonal density dynamics of main invertebrate taxa in the benthos and drift (solid lines) and their percentages (histograms) in the investigated habitats (H_n) of the Drzewiczka River

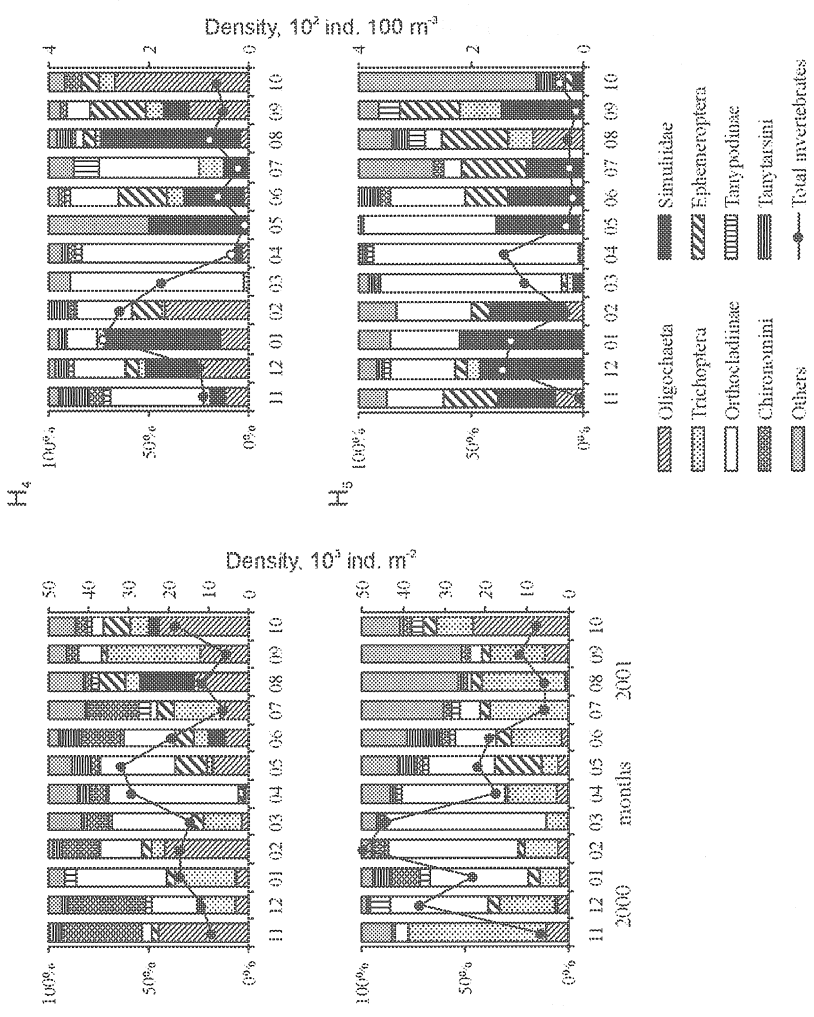

Fig. 2. Continuaction

Generally, FPOM dominates both in sediment and in transported POM [16, 21], thus it is important in distributing energy and associated nutrients within streams at multiple spatial and temporal scales. Particulate transported organic matter is utilised by organisms filtrating food from the water column, such as some trichopterans (*Hydropsyche*), Simuliidae or some chironomid taxa. The abundance of suspension feeders can increase in response to a supply of food released from the reservoirs, such as mainly phytoplankton, zooplankton and particulate organic matter. However, the specimens of this functional trophic group may remove only a low percentage of suspended matter [3]. The zoobenthos of the Drzewiczka River did not diverge from the typical structure of rivers below dams – in those habitats where a possibility of attaching and constructing nets occurred a considerable abundance of filtrators, Simuliidae and *Hydropsychidae* was recorded [30].

Allochthonous organic matter was considerably transported in the Drzewiczka, but both the transport and retention depended not only on the kind of matter, but also on physical features and hydraulics of the habitat. These results are confirmed by data from the literature [1]; the retention of coarse particulate organic matter fluctuates depending on leaf type and increases at the presence of debris dam and mechanical obstacles.

Macrophytes, periphyton

Macrophytes rarely contribute to the energy budget of a river; also, they are no food for invertebrates. However, aquatic vascular plants form one of the most important habitats for many invertebrates, chiefly because they offer relatively stable and deposit-free surfaces on which it is easy to forage and/or construct larval cases. Note that macrophytes offer additional surface areas allowing epiphytic forms to develop on them. In addition, submerged macrophytes are considered important refuges from predation and provide a heterogeneous substrate allowing co-existence. Finally, macrophytes may create favourable conditions for pelophilous zoobenthos by trapping fine particulate organic matter on the bottom [11, 14, 34]. The composition of phytomacrofauna is dependent on numerous factors, of which the leaf morphology and plant architecture are important [28]. On the whole, two taxa of dipterans, Chironomidae and Simuliidae, dominate on aquatic macrophytes in rivers [15, 17]. Also in the Drzewiczka River scrapers (*Orthocladiinae*: *Cricotopus*) and filtering collectors (Simuliidae) dominated in the epiphytic fauna.

The index of benthic coarse and fine POM in the Drzewiczka was highest in the habitat overgrown by submerged macrophytes, which confirms their significant role in the cumulating of organic matter. However, despite the retention of BCPOM at that habitat no significant presence of shredders was detected; it seems that the relatively high current velocity did not contribute to their development. However, by increasing deposition of fine particulate organic matter macrophytes contribute to the development of other pelophilous form of zoobenthos [8, 14, 17], represented by Chironomini (Chironomidae) in the Drzewiczka.

In turn, at the Drzewiczka habitat overgrown by emerged vascular plants the presence of shredders (*A. aquaticus*) was most pronounced. The percentage of the specimens of this guild was highest in October, consequently, it correlated with a great mass of coarse particulate organic matter inputs. Oligochaets and insects: chironomids (Chironimini) and mayflies (*Caenis*) were mostly those that collected food from the bottom (gathering collectors) at that stagnant habitat.

Intensive growth of algae (periphyton) in rivers below the dam was mainly caused by increased availability of nutrients [5]. Riffle habitats of the Drzewiczka River, with larger inorganic substrateparticles, were classified by the amount of chlorophyll *a*, according to Dodds *et al.* [10], to meso-eutrophic ecosystems;at other habitats, both emergedand submerged macrophyte-covered, the respective chlorophyll *a* amounts were much higher. In the Drzewiczka periphyton scrapers were represented by insects: Orthocladiinae (Chironomidae) and *Psychomyia pusilla* (Trichoptera) [30].

Invertebrate drift

Discharge is considered one of the most important factors affecting drift density; considerable increase in discharge usually causes fast reaction of invertebrates and then essential increase in density of organisms migrating with the current [6, 18]. The longer the stabilization period preceding the peak lasts the stronger the reaction is [24]. Despite the varying discharge the density of animals migrating in the Drzewiczka remained on a level approximate to values recorded in other running waters [2, 7]. Also, the composition of the downstream moving fauna was similar to those in other rivers – the drift was usually dominated by mobile zoobenthos forms, such as Ephemeroptera, Simuliidae, and also Orthocaldinae (Chironomidae). The organisms of this chironomid taxon display a tendency to drift during all their ontogeny period [33].

CONCLUSIONS

Human impact-related heterogeneity of environmental conditions in the Drzewiczka contributed to the high habitat diversity, to the occurrence of a high number of species and habitat-specificity of particular organisms. Rich food resources, such as POM and periphyton, may be exploited by highly abundant invertebrate consumers, mainly represented by three functional trophic groups: collectors, suspension feeders and periphyton scrapers.

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REFERENCES

1. **Allan J.D.:** Ecology of running waters (in Polish). PWN, Warszawa, 1-450, 1998.
2. **Anderwald P.H., Konar M., Humpesch H.:** Continuous drift samples of macroinvertebrates in a large river, the Danube in Austria. Freshwat. Biol., 25, 461-476, 1991.
3. **Benke A.C., Wallace J.B.:** Trophic basis of production among net-spinning caddiesflies in a southern Appalachian stream. Ecology, 61, 108-118, 1980.
4. **Benke A.C., Meyer J.L.:** Structure and function of a blackwater river in the southeastern U.S.A. Verh. Internat. Verein. Limnol., 23, 1209-1218, 1988.
5. **Blinn D.W., Cole G.A.:** Algal and invertebrate biota in the Colorado River: comparison of pre- and post-dam conditions. W: Colorado River ecology and dam management, Proceedings of a Symposium, Santa Fe, New Mexico, National Academy Press, 102-123, 1991.
6. **Brittain J.E., Eikeland T.J.:** Invertebrate drift – review. Hydrobiologia, 166, 77-93, 1988.
7. **Cellot B.:** Macroinvertebrate movements in a large European river. Freshwat. Biol., 22, 45-55, 1989.
8. **Cogerino L., Cellot B., Bournaud M.:** Microhabitat diversity and associated macroinvertebrates in aquatic banks of a large European river. Hydrobiologia, 304, 103-115, 1995.
9. **Cummins K.W.:** An evaluation of some techniques for the collection and analysis of benthic samples with special emphasis on lotic waters. Am. Mid. Nat., 67, 477-504, 1962.
10. **Dodds W.K., Jones J.R., Welch E.B.:** Suggested classification of stream trophic state: distributions of temperate stream types by chlorophyll, total nitrogen, and phosphorus. Wat. Res., 32, 1455-1462, 1998.
11. **Dodds W.K., Biggs B.J.F.:** Water velocity attenuation by stream periphyton and macrophytes in relation to growth form and architecture. J. N. Am. Benthol. Soc., 21, 2-15, 2002.
12. **Golterman H.L., Clymo R.S., Ohnstad M.A.M.:** Method for chemical analysis of fresh waters. Sci. Publ., 116-121, 1978.
13. **Grzybkowska M.:** Diel drift of Chironomidae in a large lowland river (Central Poland). Neth. J. Aquat. Ecol., 26, 355-360, 1992.

14. **Grzybkowska M., Dukowska M.:** Impact of the dam-reservoir on river macrobenthic community: long-term study of Jeziorsko reservoir and the Warta River in central Poland. Pol. J. Ecol., 49, 243-259, 2001.
15. **Grzybkowska M., Dukowska M., Majecki J., Kucharski L.:** Seasonal dynamics of macroinvertebrates associated with submerged macrophytes a lowland river downstream of the dam reservoir. Ecohydrology & Hydrobiology, in print.
16. **Grzybkowska M., Dukowska M., Szczerkowska E., Majecki J., Kucharski L.:** Habitat mosaicness of a river; reaction of a benthfauna to strong hydraulic stress (in Polish). In: Tucholskie Primaeval Forest – reseources and their protection (Ed. K. Gwoździński). Wydawnictwo Uniwersytetu Łódzkiego, 185-204, 2001.
17. **Kaenel B.R., Matthaei C.D.:** Disturbance by aquatic plant management in streams effects on benthic invertebrates. Reg. Rivers: Res. Mgmt., 14, 341-356, 1998.
18. **Meissner K., Muotka T., Kananen I.:** Drift responses of larval blackflies and their invertebrate predators to short- term flow regulation. Arch. Hydrobiol. 154, 529-542, 2002.
19. **Mileska M.I.:** Geographic-landscape disctionary of Poland (in Polish). PWN, Warszawa, 1-935, 1983.
20. **Minshall G.W., Robinson C.T.:** Macroinvertebrate community structure in relation to measures of lotic habitat heterogenity. Arch. Hydrobiol., 141, 129-151, 1998.
21. **Minshall G.W., Thomas S.A., Newbold J.D., Monaghan M.T., Cushing C.E.:** Physical factors influencing fine organic particle transport and deposition in streams. J. N. Am. Benthol. Soc., 19, 1-16, 2000.
22. **Moog O.:** Quantification of daily peak hydropower effects on aquatic fauna management to minimise environmental impacts. Reg. Rivers: Res. Mgmt., 8, 5-14, 1993.
23. **Petersen R.C., Cummins K.W., Ward G.M.:** Microbial and animal processing of detritus in a woodland stream. Ecol. Monogr., 59, 21-39, 1989.
24. **Perry S.A., Perry W.B.:** Effects of experimental flow regulation on invertebrate drift and stranding in the Flathead and Kotenai Rivers, Montana, USA. Hydrobiologia, 134, 171-182, 1986.
25. **Quinn J.M., Hickey C.W.:** Magnitude of effects of substrate particle size, recent flooding and catchment development on benthic invertebrates in 88 New Zealand rivers. N. Z. J. Mar. Freshwat. Res., 24, 387-409, 1990.
26. Statistica for Windows. StatSoft, Inc., Tulusa, 1997.
27. **Szczerkowska E., Grzybkowska M., Dukowska M., Tszydel M.:** Organic matter in a lowland river of strongly modified discharge. 2. Discharge volume and "resistance" of habitats (in print).
28. **Tokeshi M., Pinder L.C.V.:** Microhabitas of stream invertebraates on two submersed macrophytes with contrasting leaf morphology. Holarctic Ecology, 8, 313-319, 1985.
29. **Troelstrup N.H., Hergenrader G.L.:** Effect of hydropower peaking flow fluctuations on community structure and feeding guilds of invertebrates colonising artificial substrates in a large impounded river. Hydrobiologia, 199, 217-228, 1990.
30. **Tszydel M., Szczerkowska E., Grzybkowska M., Dukowska M.:** Populational parameters of trichopterans (Trichoptera) in dominant habitats of a permanently disturbed lowland river (in print).
31. **Wallace J.B., Webster J.R., Cuffney T.F.:** Stream detritus dynamics: regulation by invertebrate consumers. Oecolgia, 53, 197-200, 1982.
32. **Webster J.R., Meyer J.L.:** Stream organic matter budget. J. N. Am. Benthol. Soc., 16, 3-79, 1997.

33. **Williams C.J.:** Downstream drift of the larvae of Chironomidae (Diptera) in the River Chew, S.W. England. Hydrobiologia, 183, 59-72, 1989.
34. **Wood P.J., Armitage P.D.:** Sediment deposition in a small lowland stream – management implications. Regul. Rivers: Res. Mgmt., 15, 199-210, 1999.
35. **Yamada H., Nakamura F.:** Effect of fine deposition and channel works on periphyton biomass in the Makomanai River, northern Japan. Riv. Res. Applic., 18, 481-493, 2002.

MATERIA ORGANICZNA W NIZINNEJ RZECE O SILNIE MODYFIKOWANYM PRZEPŁYWIE
1. DYNAMIKA SEZONOWA BENTONICZNEJ I TRANSPORTOWANEJ MATERII ORGANICZNEJ W ROZMAITYCH SIEDLISKACH – REAKCJA BENTOFAUNY

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Streszczenie. W czwartorzędowym odcinku nizinnej rzeki, o silnie modyfikowanym reżimie hydrologicznym (sumaryczny efekt piętrzenia wody oraz codziennego krótkotrwałego, ale gwałtownego uwalniania wody), przypominającym fluktuacje przepływu rzek poniżej elektrowni szczytowych, badano dynamikę sezonową i przestrzenną bentonicznej (BPOM) i unoszonej (TPOM) materii organicznej w cyklu rocznym. Ten reżim hydrologiczny spowodował silną mozaikowość siedlisk odcinka rzeki poniżej tamy; znalazła ona odzwierciedlenie w dynamice przestrzennej i sezonowej bentofauny oraz w składzie migrujących zwierząt bentonicznych (dryfie).

Słowa kluczowe: rzeka, zakłócenia, POM, bezkręgowce