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Caddis flies (Trichoptera) of the River Pasłęka (Northern Poland)

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Abstract — 73 taxa of caddis flies were identified, of which 12 are species new to the Mazurian Lake District. In the spring sector larvae of the family Rhyacophilidae dominated. Potamophilous species of the families Polycetropodidae, Leptoceridae, and Hydropsychidae were characteristic for the upper river sector and of Brachycentridae and Leptodostomatidae for the lower ones. Below flow-through lakes increased numbers of larvae from the family Hydropsychidae were observed.

Key words: rivers, caddis flies, longitudinal distribution.

1. Introduction

The Mazurian Lake District is regarded as well known with respect to the Trichoptera fauna. The works by Ulmer (1913), Szczepańska (1958), Botosaneanu (1960), and Kumanski (1975) contain more comprehensive lists of species. 133 species of caddis fly are known from this region, however, it seems that the list is still not complete.

In the ecological aspect the caddis flies of Poland are poorly known. Numerous and comprehensive studies were carried out in montane and sub-montane streams and rivers (Riedel 1962, 1966, Dratnal, Szczęsny 1965, Dratnal et al. 1979, Szczęsny 1986, Glapska 1986) but only a few works concern lakes and lowland rivers.

The aim of the present work was to determine the species composition of caddis flies of the lowland River Pasłęka and to analyse their distribution in the longitudinal profile of this river.

2. Study area

The Pasłęka is the main river of the Olsztyn Lake District and the Warmia Lowland. It flows out of a drained lake (alt. 153.3 m) in the area of bifurcation of the watershed dividing the Pasłęka from the tributaries of the River Łyna, and in the locality of Ujście (alt. 2.2 m) discharges its

waters to the Vistula Haff through two river arms. The total length of the river is 220 km and the catchment area is 2330 km². The gradient of the river varies from 0.4—5.0‰. At the mouth, where the river is 45 m wide and up to 3 m deep the average annual flow is 12.75 m s^{-1}. The vegetation season lasts 200 days.

In its upper and lower sector the River Pasłęka flows chiefly through meadow and in its middle course through forest areas. The valley is in general wide and flat, being narrow and sharply out only in the middle course. The river flows through two larger lakes (Isąg and Sarąg) and a dam reservoir (Pierzchalskie Lake). The banks of the river are natural along almost its entire course. In the upper sector the bottom is gravelly-stony and in the remaining sectors sandy with wide stony riffles in some places. In the lower and middle sectors there appear large areas of stagnant water near the banks. The submersed vegetation show mosaic distribution.

Caddis fly larvae were collected in the years 1984—1986 at 11 stations distributed more or less uniformly along the river course (fig. 1).

3. Material and methods

Samples were collected at monthly intervals in the period April-November. Larvae were caught with a triangular hydrobiological sampler, qualitative samples being taken from an area of about 1 m². Altogether over 300 samples were collected, the number of samples from the particular stations depending upon the habitat differentiation and physical accessibility of some parts of the river, especially in its lower sector. The following habitats were taken into consideration: sandy, gravelly, and stony bottom, muddy stagnant waters near the banks, and plant environments.

The collected material was transported in large jars and sorted out *in vivo* on the same day. Larvae were fixed in 70% alcohol. The samples were collected during 2 days in order to limit losses connected with transport. The applied method of collecting probably results in underrated estimates of younger larval stages but with regard to older ones the catches were almost complete. This methodical concept is some kind of a compromise between the very accurate collecting of a small number of samples which are fixed *in situ*, and the less accurate but more frequent collection of a larger number.

In order to obtain an approximate evaluation of the absolute number of Trichoptera in the River Pasłęka, quantitative investigations were carried out twice (in July and October 1985) at selected stations (1, 2, 3, and 6). Only the habitat most characteristic for the upper and middle river course, a stony bottom in the current, was considered. 24 samples were taken using Sadowski's apparatus with a surface of about

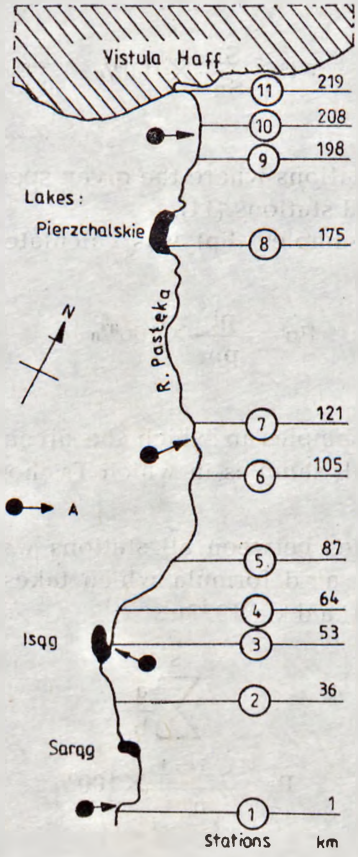

Fig. 1. Map of the study area. 1—11 — stations; A — point sources of pollution

2000 cm², and 80 by gathering 1 dm³ of gravel with a scoop. The quantitative investigations were only complementary to the qualitative studies which were the basis of the present work.

Simultaneously with the catching of larvae, imagines of caddis flies were caught in the vicinity of the river in order to verify the accuracy of identifications. The too small number of imagines caught is certainly a methodical defect, the result being that a certain number of larvae were identified only as to genus.

The material used as the basis of the present work included 9150 larvae and 23 imagines.

In accordance with B i e s i a d k a (1980), the following classes were differentiated for estimating the structure of dominance: eudominants (species whose number exceeded 10%), dominants (5.1—10%), subdominants (2.1—5%), and recedents (below 2%).

Frequency at the stations (Fs) was calculated according to the formula:

$$Fs = \frac{Si}{Sn} \times 100\% \quad (1)$$

where:

Si — the number of stations where the given species was found,
Sn — the number of all stations (11).

Frequency in the samples (Fp) was calculated according to the formula:

$$Fp = \frac{pi}{pn} \times 100\% \quad (2)$$

where:

pi — the number of samples in which the given species was found,
pn — the number of all samples in which Trichoptera larvae were found (256).

Faunistic similarities between all stations were calculated according to the modified Jaccard formula which takes into account the numbers of species (Biesiadka 1977):

$$P = \frac{\sum_{i=1}^{s} \frac{a_i}{b_i}}{n} \times 100\% \quad (3)$$

where:

P — the faunistic similarity between two compared stations,
s — the number of species common to the two stations,
n — the total number of species occurring at the two stations,
a — a smaller number of specimens of the common species,
b — a larger number of specimens of the common species.

Approximate data concerning the state of purity of the river and loads of wastes from point sources of pollution were obtained from the Environmental Research and Control Centre at Olsztyn.

4. Results

4.1. General characteristics of caddis flies

73 taxa were found to occur (Table I). With regard to species composition this material constitutes 30% of the caddis fly fauna of Poland and 58% of species so far recorded in the Mazurian Lake District.

Table I. Characteristics of caddis flies of the River Pasłęka. N - number of larvae; D - percentage dominance; Fs - frequency at the stations in percentage; Fp - frequency in the samples in percentage; i - imagines were also caught for this species

Taxa	N	D	Fs	Fp
Rhyacophilidae	169			
Rhyacophila vulgaris Pictet, 1834	2	0.02	9	0.27
- obliterata Mc Lachlan, 1865	61	0.67	9	5.59
- fasciata Hagen, 1859 i	57	0.62	27	3.46
- dorsalis (Curtis, 1834)	13	0.14	27	1.60
- nubila (Zetterstedt, 1840)	21	0.23	36	3.99
- sp. Pictet, 1834 (juv.)	14	0.15	27	2.13
Glossosomatidae	2			
Agapetus fuscipes Curtis, 1834	2	0.02	18	0.53
Hydroptilidae	36			
Ithytrichia lamellaris Eaton, 1873	35	0.38	45	5.05
Hydroptila sp. Dalman, 1819	1	0.01	9	0.27
Hydropsychidae	5086			
Hydropsyche angustipennis (Curtis, 1834)	7	0.08	36	3.99
- pellucidula (Curtis, 1834)	3167	35.00	72	46.81
- siltalai Doehler, 1963	811	9.00	54	17.56
- sp. Pictet, 1834 (juv.)	271	3.00	63	6.38
Cheumatopsyche lepida (Pictet, 1834)	831	9.00	63	22.07
Polycentropodidae	158			
Polycentropus flavomaculatus (Pictet, 1835)	131	1.40	45	10.90
- irroratus (Curtis, 1835)	8	0.09	18	1.35
Plectrocnemia conspersa (Curtis, 1834) i	7	0.08	27	0.80
- sp. Stephens, 1836	1	0.01	9	0.27
Cyrnus trimaculatus (Curtis, 1834)	5	0.05	9	0.27
- flavidus Mc Lachlan, 1864	1	0.01	9	0.27
Holocentropus stagnalis (Albarda, 1874)	4	0.04	9	0.27
- dubius (Rambur, 1842)	1	0.01	9	0.27
- sp. Mc Lachlan, 1878	1	0.01	9	0.27
Phryganeidae	5			
Phryganea grandis, Linne, 1783	1	0.01	9	0.27
- bipunctata Retzius, 1783	1	0.01	9	0.27
Oligostomis reticulata (Linne, 1761)	2	0.02	18	0.53
Trichostegia minor (Curtis, 1834)	1	0.01	9	0.27
Brachycentridae	1417			
Brachycentrus subnubilus Curtis, 1834	1415	15.00	81	43.52
Oligoplectrum sp. Mc Lachlan, 1868	2	0.02	18	0.53
Limnephilidae	1006			
Drusus biguttatus (Pictet, 1834)	21	0.23	27	3.19
Limnephilus bipunctatus Curtis, 1834	12	0.13	36	1.60
- griseus (Linne, 1758)	3	0.03	9	0.53
- lunatus Curtis, 1834	3	0.03	18	0.53
- rhombicus (Linne, 1758)	6	0.07	18	0.80
- flavicornis (Fabricius, 1787)	1	0.01	9	0.27
Limnephilus stigma Curtis, 1834	1	0.01	9	0.27
- marmoratus Curtis, 1834 i	1	0.01	9	0.27
- nigriceps (Zetterstedt, 1840)	19	0.21	45	2.66
- decipiens (Kolenati, 1848)	16	0.17	18	1.33
- borealis (Zetterstedt, 1840)	1	0.01	9	0.27
- vittatus (Fabricius, 1798)	3	0.03	9	0.53
- fuscicornis Rambur, 1842	1	0.01	9	0.27
- sp. Leach, 1815 (juv.)	74	0.81	63	3.99
Hydatophylax sp. Wallengren, 1865	1	0.01	9	0.27
Halesus sp. Stephens, 1837	134	1.40	63	10.37
Potamophylax nigricornis (Pictet, 1834) i	1	0.01	9	0.27
- latipennis (Curtis, 1834)	346	4.00	63	10.64
Chaetopteryx villosa (Fabricius, 1798) i	75	0.82	36	5.32
Chaetopterygopsis maclachlani Stein, 1874	17	0.19	9	1.86
Chaetopterygini spp.	289	3.00	63	5.32
Anabolia laevis (Zetterstedt, 1848) i	81	0.89	54	6.38
Grammotaulius sp. Kolenati, 1848	1	0.01	9	0.27
Adicella sp. Mc Lachlan, 1877	1	0.01	9	0.27
Allogamus sp. ? Schmid, 1955	2	0.02	9	0.27
Goeridae	2			
Lithax obscurus ? (Hagen, 1859)	1	0.01	9	0.27
Silo pallipes (Fabricius, 1781)	1	0.01	9	0.27
Lepidostomatidae	1051			
Lepidostoma hirtum (Fabricius, 1775)	592	6.00	73	24.94
Lasiocephale basalis (Kolenati, 1848)	459	5.00	63	12.23
Leptoceridae	211			
Athripsodes bilineatus (Linne, 1758)	2	0.02	9	0.53
- nereus (Curtis, 1834)	22	0.24	36	2.39
- aterrimus (Stephens, 1836)	11	0.12	45	1.88
- albifrons (Linne, 1758)	97	1.00	63	11.70
- sp. larva nova	16	0.17	27	0.80
Oecetis furva (Rambur, 1834)	4	0.04	27	0.80
Ceraclea alboguttata (Hagen, 1860)	1	0.01	9	0.27
- nigronervosa (Retzius, 1783)	3	0.03	18	0.53
- sp. larva nova	6	0.07	18	0.53
Mystacides longicornis (Linne, 1758) i	9	0.10	9	0.27
- sp. ? Berthold, 1827	4	0.04	27	0.53
- sp. ?I Berthold, 1827	1	0.01	9	0.27
- sp. ?II Berthold, 1827	1	0.01	9	0.27
Triaenodes bicolor (Curtis, 1834)	30	0.33	36	2.39
- sp. Mc Lachlan, 1865	9	0.10	27	0.80
Leptocerus tineiformis Curtis, 1834	2	0.02	9	0.27
Sericostomatidae	5			
Notidobia sp. Stephens, 1829	3	0.03	9	0.27
Sericostoma sp. Latreille, 1825	2	0.02	18	0.53
Molannidae	2			
Molanna angustata Curtis, 1834	2	0.02	18	0.53

The following 12 species new for the region were identified: *Agapetus fuscipes, Rhyacophila dorsalis, R. obliterata, R. vulgaris, Ithytrichia lammelaris, Plectrocnemia conspersa, Hydropsyche siltalai, Oligostomis reticulata, Drusus biguttatus, Chaetopteryx villosa, Chaetopterygopsis maclachlani,* and *Ceraclea alboguttata.*

The greatest species differentiation was characteristic of the families Limnephilidae, Leptoceridae, and Polycentropodidae, and a slightly lesser one for Rhyacophilidae, Hydropsychidae, and Phryganeidae. The largest numbers of specimens were found above all in the families Hydropsichidae, Brachycentridae, Lepidostomatidae, and Limnephilidae (Table I).

The number of specimens varied very greatly, ranging from 1--3167 individuals (Table I).

All classes of dominance were found in the collected material. The greatest effect on the number of species was exerted by the class of recedents (almost 90% of all species recorded) and the number of larvae by the class of eudominants and dominants (together 80%). In the collected material the eudominants were *Hydropsyche pellucidula* and *Brachycentrus subnubilus.* As dominants there appeared *Hydropsyche siltalai, Cheumatopsyche lepida, Lepidostoma hirtum,* and *Lasiocephala basalis.* The class of subdominants was represented by three taxa: *Potamophylax latipennis, Chaetopterygini* and *Hydropsyche* sp. juv. The remaining 65 species belonged to recedents (Table I).

The commonest taxa (the greatest frequency at the stations) were *Brachycentrus subnubilus, Hydropsyche pellucidula, Lepidostoma hirtum,* and *Halesus* sp., *Chaetopterygini, Lasiocephala basalis,* and *Athripsodes albifrons* (Table I). The most constant occurrence (frequency in the samples) characterized *Hydropsyche pellucidula* and *Brachycentrus subnubilus.*

The largest number of larvae was found among stones (40%) and on the gravelly bottom (31%), being fewer among plants (17%) and in stagnant waters (9%), and the fewest number in sand (3%).

At four selected stations the density of larvae in the current environment varied from 15 indiv. m^{-2} (July, Station 2) to 1019 indiv. m^{-2} (October, Station 3). The smallest average number of larvae in 1 dm^3 of gravel was found at Station 1 (5.6 individuals) and the largest at Station 3 (55 individuals).

4.2. Analysis of occurrence in the longitudinal profile

On the basis of the qualitative material an analysis of changes in the number of specimens and taxa of Trichoptera in the longitudinal profile of the river was carried out, flow-through lakes and point sources of pollution being taken into account (fig. 2, Table II). The spring sector

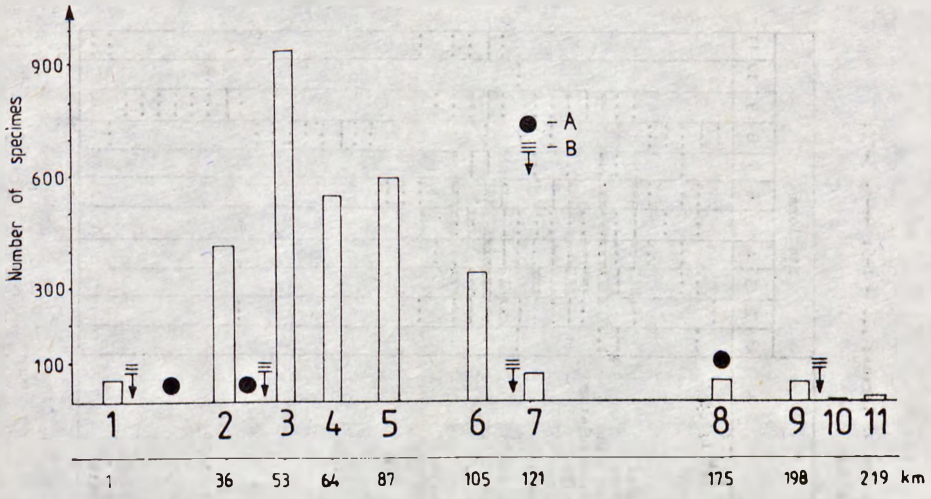

Fig. 2. Average annual number of caddis fly larvae in the longitudinal profile of the River Pasłęka. 1—11 — stations. A — flow-through lakes; B — point sources of pollution

(Station 1) was characterized by small numbers of Trichoptera, the largest numbers occurring in the upper and middle river sector (Stations 2—6) below the flow-through lakes and point sources of pollution. At Stations 7, 8, and 9 a distinct decrease in numbers was observed and at Station 10 only one larva was caught. At Station 11 the numbers slightly increased but were still small (fig. 2). Changes in the number of species in the longitudinal profile were analogical to changes in the number of specimens (Table II).

In order to determine the distribution of particular species of caddis fly in the longitudinal profile, they were arranged according to their range of occurrence (Table II). Station 1 differed decidedly from the others. Five species were found solely at this station, i.e. *Rhyacophila obliterata*, *Rh. vulgaris*, *Chaetopterygopsis maclachlani*, *Potamophylax nigricornis*, and *Lithax obscurus*. Moreover, *Rhyacophila fasciata* demonstrated the largest number of specimens here. With regard to the range of occurrence, Stations 2—6 were distinguished by the most numerous species. They constituted a group of very similar faunistic character, though some slight differences in the species composition could be observed (Table II). Stations 8 and 9 also showed a great specifity. In Pierzchalskie Lake (Station 8) 9 exclusive species were identified — *Grammotaulis* sp., *Cyrnus flavidus*, *Mystacides longicornis*, *Mystacides* sp. I, *Mystacides* sp. II, *Mystacides* sp. III, *Trichostegia minor*, *Phryganea grandis*, and *Limnephilus stigma*. *Cyrnus trimaculatus*, *Holocentropus*

Table II. Range of occurrence of caddis fly larvae in the longitudinal profile. Numbers of larvae: ... - 1-5; ——— - 5-20; ●●● - 20-50; ◆◆◆ 50-100; XXX 100-300; XXX - above 300

Species	Statione 1	2	3	4	5	6	7	8	9	10	11
Rhyacophila obliterata	+++										
Chaetopterygopsis maclachlani	———										
Rhyacophila vulgaris	...										
Potamophylax nigricornis	...										
Lithax obscurus	...										
Rhyacophila fasciata	+++	...									...
Limnephilus lunatus	...	...									
Notidobia sp.		...									
Athripsodes bilineatus		...									
Leptocerus tineiformis		...									
Plectrocnemia sp.		...									
Ceraclea alboguttata		...									
Rhyacophila dorsalis	———	...	...								
Polycentropus irroratus		...	...								
Ceraclea nigronervosa		...	...								
Sericostoma sp.		...	...								
Allogamus sp.			...								
Limnephilus flavicornis			...								
Rhyacophila sp. juv.		———	...			...					
Chaetopteryx villosa	———	———	———	———							
Plectrocnemia conspersa			...	...							
Limnephilus griseus				...							
- bipunctatus	———	...	...						●●●		
Rhyacophila nubila	...	———	———			———					
Athripsodes cinereus		———	...	———	...						
Agapetus fuscipes			...		...						
Hydatophylax sp.					...						
Adicella sp.					...						
Drusus biguttatus			...	...	———						
Limnephilus decipiens			———		———						
Athripsodes sp.			———		...	...					
Oligostomis reticulata	...				...						
Ithytrichia lammelaris		———	———	...	———						
Hydropsyche angustipennis		...		...	...	...	...				
Oligoplectrum sp.				...			●●				
Triaenodes sp.					...	...	...				
Halesus sp.	...	———	———	...	———	...	...				
Potamophylax latipennis	———	———	———	XXX	———	———		●●			

Species	Stations 1	2	3	4	5	6	7	8	9	10	11
Limnephilus rhombicus		...						———			
- nigriceps	...		...		...	...		———			
Athripsodes atterimus			...	...		...	...	...			
Mystacides sp. I					...			...			
Oecetis furva				...		...		...			
Hydropsyche siltalai		+++	XXX	———	———	———			...		
Limnephilus sp. juv.	———		———	...	...		...	———	...		
Hydropsyche pellucidula	...	XXX	XXX	XXX	+++	XXX	...		———		
Polycentropus flavomaculatus		...	———	+++	...				———		
Lasiocephala basalis		———	XXX	———	+++	———	...		...		
Athripsodes albifrons		+++	———	———	...	———		...	...		
Hydropsyche sp. juv.		———	XXX	...	———	———	...		...		
Anabolia laevis	...	———		...	...			+++		...	
Cheumatopsyche lepida		XXX	XXX	———	———	XXX			...		...
Brachycentrus subnubilus		+++	XXX	XXX	XXX	XXX	———	...	———		———
Chaetopterygini spp.		———	———		XXX		———		+++		...
Lepidostoma hirtum		———	XXX	+++	XXX	XXX	———		...		...
Limnephilus borealis				...					...		
Triaenodes bicolor		...			———	...					...
Silo pallipes						...					
Hydroptila sp.						...					
Grammotaulius sp.								...			
Cyrnus flavidus								...			
Mystacides longicornis								———			
Trichostegia minor								...			
Mystacides sp. II								...			
- sp. III								...			
Phryganea grandis								...			
Limnephilus stigma								...			
Ceraclea sp.		...							...		
Cyrnus trimaculatus									———		
Holocentropus stagnalis									...		
- sp.									...		
Limnephilus vittatus									...		
- marmoratus									...		
- fusciformis									...		
Holocentropus dubius									...		
Molanna angustata								...			...
Phryganea bipunctata											...

dubius, *H. stagnalis*, *Holocentropus* sp., *Ceraclea* sp., *Limnephilus vittatus*, *L. marmoratus*, and *L. fisciformis* occurred only at Station 9. Stations 7 and 11 showed an only slightly specific Trichoptera fauna, while at Station 10 practically no caddis flies occurred.

The structure of dominance at the stations was very interesting (fig. 3). On its basis five groups of stations may be differentiated. Station 1 was characterized by a distinct dominance of *Rhyacophila obliterata* and *R. fasciata* and in the lower class of dominance by species of the families Limnephilidae and Rhyacophilidae. *Hydropsyche pellicidula* dominated at Stations 2, 3, 4, and 9, followed by *Hydropsyche siltalai*, *Cheumatopsyche lepida*, *Brachycentrus subnubilus*, and *Potamophylax latipennis*. Stations 5, 6, and 11 showed the greatest dominance of the species *Brachycentrus subnubilus*, which was followed by *Lepidostoma hirtum*, *Chaetopterygini*, *Hydropsyche pellucidula*, and *Cheumatopsyche lepida*. At Station 7 *Chaetopterygini* and *Lepidostoma hirtum* dominated and in the lower class of dominance *Brachycentrus subnubilus*. At Station 8 the decided dominante were *Anabolia laevis*, *Limnephilus* sp. juv., and *Mystacides longicornis*.

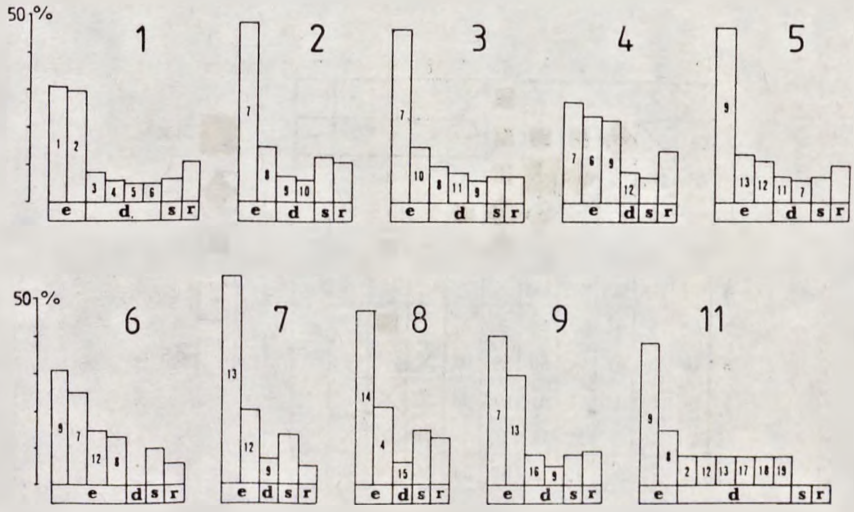

Fig. 3. Dominance structure at eleven stations. e — eudominants; d — dominants; s — subdominants; r — recedents. 1 — *Rhyacophila obliterata*; 2 — *R. fasciata*; 3 — *Chaeteropterygopsis maclachlani*; 4 — *Limnephilus* sp. juv.; 5 — *Rhyacophila nubila*; 6 — *Potamophylax latipennis*; 7 — *Hydropsyche pellucidula*; 8 — *Chematopsyche lepida*; 9 — *Brachycentrus subnubilus*; 10 — *Hydropsyche siltalai*; 11 — *Lasiocephala basalis*; 12 — *Lepidostoma hirtum*; 13 — *Chaetopterygini* 14 — *Anabolia laevis*; 15 — *Mystacides longicornis*; 16 — *Polycentropus flavomaculatus*; 17 — *Phryganea bipunctata*; 18 — *Triaenodes bicolor*; 19 — *Molanna angustata*. (Subdominants and recedents taken as a total)

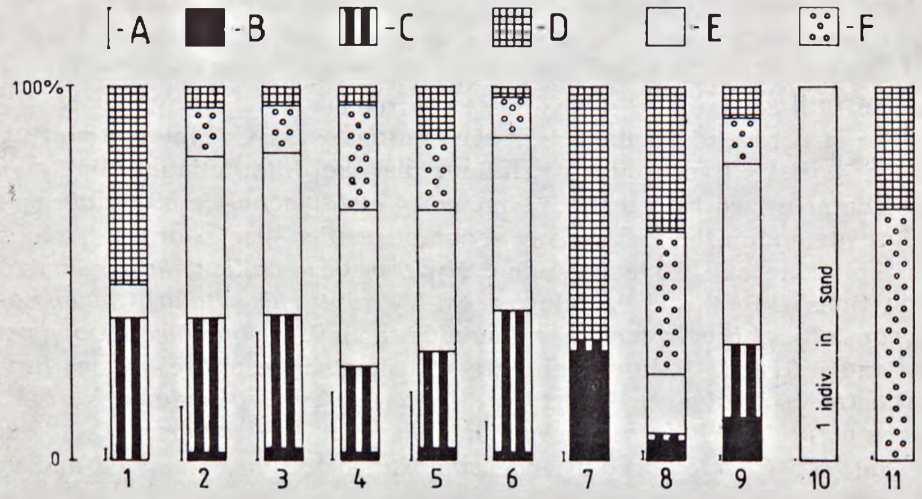

Fig. 4. Percentage share of caddis fly larvae in the longitudinal profile, the character of the substratum being taken into account. A — number of larvae at the station; B — sand; C — gravel; D — stagnant waters; E — stones; F — plants

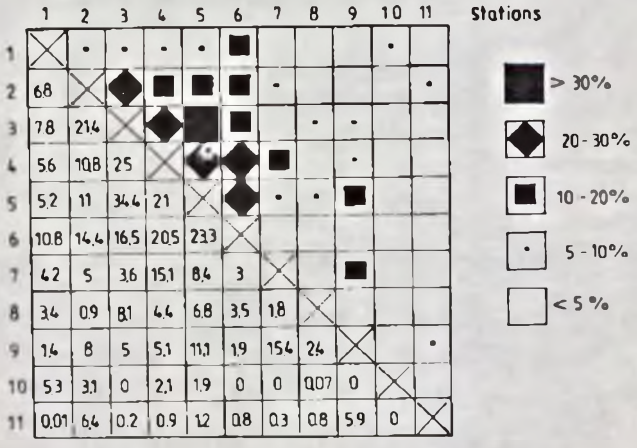

Fig. 5. Faunistic similarity between stations expressed percentage and in graphs

The problem of the zonal distribution of Trichoptera in the longitudinal profile was also investigated in the aspect of the character of the substratum (fig. 4). The largest number of caddis fly larvae were collected at Station 1 from stagnant waters and gravelly bottom and at Stations 2—6 and 9, from a gravelly and stony bottom. At Station 7 Trichoptera were most numerous in stagnant waters and in sand. At Stations 8 and 11 larvae caught among plants and in stagnant waters prevailed.

The faunistic similarity between stations was examined and the results were presented in Czekanowski's diagram, the order of the stations being preserved (fig. 5). The block of Stations 2—6 was very distinctly separate. Stations 1, 7 and 9 being less similar to them. Stations 8, 10, and 11 differed most with regard to the caddis fly fauna.

5. Discussion

73 taxa of caddis flies were found in the River Pasłęka. This number is fairly large in comparison with other lowland rivers. In the River Łyna Wielgosz (1979) found 9 species of Trichoptera, 5 of which were in common with the Pasłęka. In the River Widawka 32 species were caught, 17 in common with the Pasłęka (Kopytek, Majecki 1986), while in the Nida 28 species were noted (Szczęsny, personal information). In the Volga Delta of the 33 species caught (Emelina 1981) 10 also appeared in the Pasłęka. In the Hungarian part of the River Danube Chantaramongkol (1983) found 47 Trichoptera species, among them 14 in common with the Pasłęka. In the Belgian River Flavion and its tributaries Stroot (1984) caught 45 species of caddis fly (17 in common with the River Pasłęka) while in the rivers of southern England Cooling (1982) found 64 species (20 of which were also noted in the Pasłęka). In a small Swedish river, to Kaltisjok, as many as 83 species of Trichoptera larvae occurred, in the River Kalbach 70, and in the Messaure canal 78 (Tobias W., D. Tobias 1983). Altogether 30 species from that region were found in the River Pasłęka.

The great abundance of caddis flies in the Pasłęka may have several causes. This as a large and fairly pure river which has preserved the natural character of its riverbed over a considerable length and hence is ecologically differentiated to a very great degree. Moreover, the relatively long period of the investigation (three seasons) permitted identification not only of the dominant species but also of a considerable number of fortuitous ones. This is shown by the large number of recedents. Most species of the genus *Limnephilus* may be regarded as fortuitous since they are characteristic for stagnant waters (e.g., *Limnephilus griseus* is typical for shallow stagnant waters of the spring season). However, it is not clear whether they originate from valley water bodies or whether the stagnant river sectors present a marginal environment of their occurrence.

In the River Pasłęka 58% of the species occurring in the Mazurian Lake District were found, among them 12 not hitherto reported from this region. This shows that the knowledge of caddis flies in the lowland parts of Poland is far from complete.

On the basis of data from the Environmental Research and Control Centre at Olsztyn the chief sources of pollution were identified. In the

upper and middle river sector no distinct effect of pollution was observed on the Trichoptera fauna. It is true that at Stations 2, 3, and 4 there appeared a distinct increase in the number of Hydropsychidae but it is not clear whether this resulted directly from the inflow of municipal sewage of low toxicity or from the influence of lakes lying above these stations. Hydropsychidae are caddis flies of mesosaprobic waters. They occur abundantly in waters slighty polluted with organic wastes (Szczęsny 1975) or in those increased turbidity (Glapska 1968), thus in waters with a large content of seston. Both the lakes in the river course and the low concentrations of organic wastes increase the content of suspension, hence, in the opinion of Szczęsny (1975) and Glapska (1986), they should favour an increased abundance of filtrators.

At Station 10, situated below the inflow of municipal and industrial wastes practically no caddis fly fauna was observed, this being the result of pollution of the river with sewage from the town of Braniewo. A certain increase in the numbers of Trichoptera larvae at Station 11 (the mouth sector) may be on the one hand associated with the self-purification of the river and on the other with the inflow of waters from the Vistula Haff.

By generalizing all analyses concerning the distribution of Trichoptera in the longitudinal profile of the River Pasłęka, the river may be divided into several zones. The sectors lying below Pierzchalskie Lake presented certain difficulties since disturbances in the zonal distribution of caddis flies were observed there, brought about by considerable pollution and by the flow through a lake.

Zone A — Station 1. This sector was characterized by fairly small numbers of caddis fly larvae and an average number of species. In the habitat structure larvae living in stagnant waters and a gravely bottom dominated. Larvae of the family Rhyacophilidae (*Rhyacophila obliterata* and *R. fasciata*) prevailed. *Rhyacophila obliterata, R. vulgaris, Potamophylax nigricornis, Chaetopterygopsis maclachlani,* and *Lithax obscurus* were found solely in this sector.

Zone B1 — Stations 2, 3, and 4. This zone was characterized by the most abundant and most numerous fauna of caddis flies. Numerous larvae of the family Hydropsychidae suggested a large content of seston. Caddis flies caught among stones and gravel were most numerous. The decided prevailing species were *Hydropsyche pellucidula, H. siltalai,* and *Cheumatopsyche lepida,* and in the lower class of dominance *Brachycentrus subnubilus, Lepidostoma hirtum, Lasiocephala basalis,* and *Potamophylax latipennis.* Apart from the above species *Polycentropus flavomaculatus* and *Halesus* sp. showed a fairly high constancy. In this zone the greatest frequency was shown by species of the families Leptoceridae and Polycentropodidae. *Polycentropus irroratus, Plectrocnemia conspersa, Athripsodes bilineatus, Ceraclea alboguttata, C. nigronervo-*

sa, Leptocerus tineiformis, Sericostome sp., and *Rhyacophila nubila* were caught only in this sector of the river.

Zone B2 — Stations 5 and 6. The sector was characterized by large numbers and differentiation in the species composition. In contrast to zone B1 an increase in the frequency of species of the families Brachycentridae and Lepidostomatidae and a decrease in Hydropsychidae and Polycentropodidae were observed here. The dominant species were *Brachycentrus subnubilus, Hydropsyche pellucidula, Lepidostoma hirtum, Lasiocephala basalis,* and *Cheumatopsyche lepida* and the exclusive ones *Drusus biguttatus* and *Silo pallipes.*

Zone C — Station 7. Small numbers both of caddis flies and species were found here, larvae caught in stagnant waters and in sand being most numerous. *Chaetopterygini, Lepidostoma hirtum,* and *Brachycentrus subnubilis* dominated, the last two species also being distinguished by the greatest constancy. No exclusive species were identified.

Zone D — Station 9. Also this sector was characterized by a small number of species and scanty numbers of caddis fly larvae. *Hydropsyche pellucidula* and *Chaetopterygini* dominated, while in the lower class of dominance there appeared *Polycentropus flavomaculatus* and *Brachycentrus subnubilus.* With regard to the dominance structure, this station resembled zone B1. The species exclusive for this station were *Cyrnus trimaculatus, Holocentrophus dubius, H. stagnalis, Holocentrophus* sp., *Ceraclea* sp., *Limnephilus vittatus, L. marmoratus,* and *L. fusciformis.*

Zone E — Station 11. This zone showed a small number of species and scarce number of caddis flies. Most of the larvae were caught among plants and in stagnant waters. The dominants were *Brachycentrus subnubilus* and *Cheumatopsyche lepida,* this making zone E similar to zone C. One species, the limnophilous *Phryganea bipunctata,* was found only at Station 11. Also *Triaenodes bicolor* and *Molanna angustata* demonstrated considerable share among species of stagnant waters.

Zone F — the dam lake, Station 8. Species typical for stagnant waters dominated here, i.e. *Anabolia laevis, Mystacides longicornis,* and *Limnephilus* sp. Exclusive to this station were: *Grammotaulius* sp., *Cyrnus flavidus, Mystacides longicornis, Trichostegia minor, Phryganea grandis,* and *Limnephilus stigma.* The discussed zone contributed to the mosaic character of Trichoptera communities of the River Pasłęka and disturbed the continuity of the zonal distribution of larvae.

Zone G — Station 10. This was a strongly polluted sector and practically without caddis flies.

It seems that the changes in communities and zones have a clinal character. This is most distinct in the upper river sector (zones B1, B2, and C). The fairly great specificity of the Trichoptera fauna of zone A in relation to lower sectors of the river may result from rapid but constant

non-qualitative faunistic changes. A larger number of stations on this sector of the River Pasłęka would probably supply documentary evidence for the continuity of faunistic transformations. Only Pierzchalskie Lake (Station 8) has a fairly specific fauna of caddis flies. Thus, distinct borderlines between the biocenoses of flow-through lakes and the river may be expected.

Apart from caddis flies, beetles and midges of the River Pasłęka have been elaborated. On the basis of the Coleoptera fauna, Kordylas (1989) distinguished as most similar the sector composed of Stations 3—6. This corresponds to zones B1 and B2. In a study on Chironomidae, Likszo (unpubl. data) found Station 1 to be most specific (zone A). The greatest similarity of the fauna of midges was found at Stations 2, 3, 4, and 6 (zones B1 and B2). The remaining Stations (8—11) were characterized by individual and separate fauna of midges. This is in large measure in agreement with findings concerned with Trichoptera. Thus, it may be concluded that the differentiated zones do objectively exist and that the same distribution zones of other invertebrates of the River Pasłęka may be expected.

In Poland the problem of the zonal structure of rivers based on the fauna of caddis flies has been thoroughly investigated only in the Carpathians (Szczęsny 1986). Also the communities of Trichoptera larvae in streams and rivers of this region are well known. However, such studies on the lowland part of Poland are lacking and those concerning other lowland areas of Europe are also scarce. Nevertheless, even on the basis of these limited data differences between lowland and montane regions may be found. In lowland rivers the zonal structure is to a greater degree effaced by such inter-zonal phenomena as flow-through lakes, point sources of pollution, and exchange of fauna with valley reservoirs. In spite of these disturbances of the zonal character certain regularities may be observed. The family Rhyacophilidae occurs in the upper spring sectors of lowland rivers (e.g., the Pasłęka, Łyna, Flavion, and Kaltisjokk). In these sectors the prevalence of erosion processes over accumulation favours the formation of habitats suitable for these species (a stony-gravelly bottom). Potamophilous species of the families Polycentropodidae and Leptoceridae are most numerous in streams, small rivers, and the upper and middle sectors of large rivers. In the lower sectors of lowland rivers species of the families Lepidostomatidae and Brachycentridae are very numerous, an increase in the number of limnophilous species of the families Limnephilidae, Leptoceridae, and Phryganeidae also being observed.

The communities of caddis flies of the River Pasłęka little resemble those in Carpathians. The species composition is most similar to that in other lowland rivers of Europe. In this respect the Swedish Rivers Kaltisjokk and Kalbach (Tobias, Tobias 1983) and the River Widawka

in the Bełchatów Region (K o p y t e k, M a j e c k i 1986) show the greatest similarity.

In zone B (the sceond one) S z c z ę s n y (1986) included *Drusus biguttatus*, which occurred in upper sectors of the Tatra streams above 900 m and in Beskid springs. To date this species has only once been reported from the lowlands (J a s k o w s k a 1961). In the River Pasłęka it was found in zones B1 and B2.

In S z c z ę s n y's community C there also occurred *Potamophylax nigricornis*. This community was found in springs and in the upper sectors of streams. The species was caught in lowland spring of the Rivers Łyna and Drwęca (C z a c h o r o w s k i unpubl.) and in the Pasłęka at Station 1 (zone A).

In the Carpathian community D *Rhyacophila obliterata* and *R. fasciata* (in the Pasłęka in zone A) and *Plectrocnemia conspersa* (zone B1 in the Pasłęka) occurred in large numbers. In the Carpathian this community is associated with the middle and lower sectors of streams.

Rhyacophila nubila and *Potamophylax latipennis* were found in the lower sectors of Carpathian streams, below villages or places distinctly affected by human activity. In the River Pasłęka these species were caught in zone B1 and B2.

Hydropsyche pellucidula, H. siltalai, Cheumatopsyche lepida, Rhyacophila nubila, and *Polycentropus flavomaculatus,* which occur in large streams on borderline sectors between a stream and a river in the Beskid Mts, were found in zones B1 and B2 of the River Pasłęka.

The scarse data concerning the zonal structure of lowland rivers found in the literature do not permit one to state whether the communities of Trichoptera larvae in the Pasłęka are typical for lowland rivers of Europe or have an individual, unique character. Studies carried out a larger number of lowland rivers may provide an answer to this question and create a basis for developing a general model of the zonal distribution of caddis fly larvae in such waters.

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6. Polish summary

Chruściki (Trichoptera) rzeki Pasłęki (Polska północna)

W latach 1984—1986 badano rozmieszczenie larw chruścików w rzece Pasłęce. Na 11 stanowiskach (ryc. 1) złowiono 9150 larw należących do 73 taksonów (tabela I).

Stwierdzono 12 gatunków nowych dla Pojezierza Mazurskiego: *Agapetus fuscipes* Curt., *Rhyacophila dorsalis* (Curt.), *Rh. obliterata* Maclachlan, *Rh. vulgaris* Pict., *Ithytrichia lamellaris* Eat., *Hydropsyche siltalai* Doeh., *Plectrocnemia conspersa* (Curt.), *Ceraclea alboguttata* (Hag.), *Oligostomis reticulata* (L.), *Drusus biguttatus* (Pict.), *Chaetopteryx villosa* (Fabr.) i *Chaetopterygopsis maclachlani* Stein. Prześledzono w profilu podłużnym zmiany liczebności larw (ryc. 2) oraz zmiany zasiedlenia dna (ryc. 4). Zbadano zasięgi występowania (tabela II), strukturę dominacji w profilu podłużnym oraz wyliczono podobieństwa faunistyczne pomiędzy stanowiskami (ryc. 5). Na podstawie tych analiz wyróżniono 8 stref w rzece Pasłęce. Dla przyźródłowego odcinka Pasłęki charakterystyczna była rodzina *Rhyacophilidae*, dla górnego i środkowego rodziny: *Polycentropodidae* i *Leptoceridae*, a dla dolnego — *Lepidostomatidae* i *Brachycentridae*. Poniżej jezior przepływowych wyraźnie wzrastała liczebność larw z rodziny *Hydropsychidae*. W jeziorze przepływowym dominowały larwy z rodzin *Limnephilidae* i *Leptoceridae*. Stwierdzono, że punktowe źródła zanieczyszczeń i jeziora przepływowe zakłócają strefowe rozmieszczenie chruścików w rzece Pasłęce, nadając biocenozom chruścików mozaikowy charakter. Również dolinne wody stojące mogą zacierać tę strefowość.

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