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Struktura ugrupowań zoobentosu drobnoziarnistego podłoża rzeki Łyny

The structure of zoobenthos communities of a fine-grained substrate of the River Łyna

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A b s t r a c t — A description of the structure of benthofauna communities of a fine-grained substrate, along the longitudinal profile of the River Łyna, is given. Of the 130 taxons recorded, *Oligochaeta* and *Chironomidae* were found to predominate. Changes in the taxonomic-quantitative structure of the zoobenthos were observed; among other places, they were noted at a station affected by wastes. A correlation between the benthofauna numbers and some physico-chemical factors was determined. On the basis of 71 species and groups of *Chironomidae* forms, changes in the domination of the main species and similarities between the neighbouring stations were determined, cenological criteria of the natural division of the set having been taken into consideration.

As it appears from Polish hydrobiological literature, the benthofauna of lowland rivers in Poland has not been sufficiently elaborated so far. Among the physiographic-ecological studies of bottom invertebrates the works of Szczepański (1953), Kajak (1959), Mikulski and Tarwid (1951) deserve special mention. The analyses of changes occurring in the composition of species or in the quantitative structure of biocenotic communities in the ecosystems degraded by antropogenic effects seem particularly interesting. A number of potamological works was published dealing with the influence of pollution on benthofauna communities (among others Niedźwiecki 1970, Rybak 1962, Zięba, Zaćwilichowska 1966).

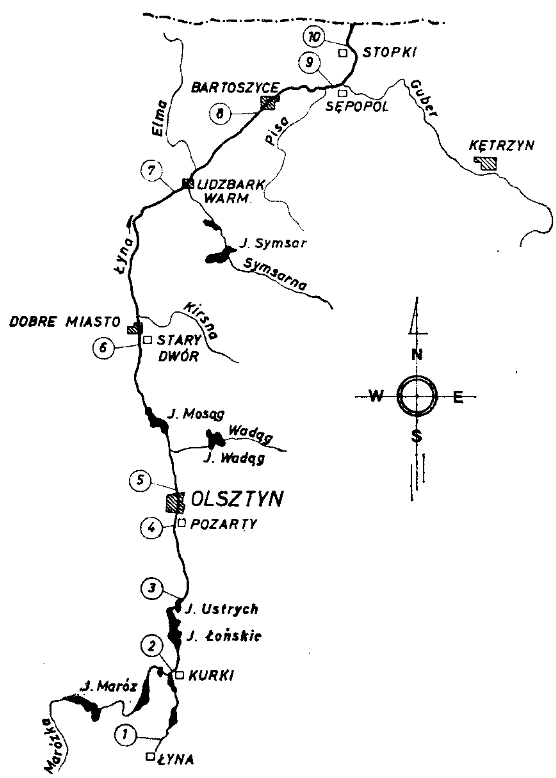
In spite of the fact that the Łyna is the largest river of the Mazurian Lake District, its zoobenthos has not been elaborated in detail.

The aim of the present work was to determine the taxonomic composition and the quantitative structure of benthofauna communities in the longitudinal profile of the river. On the basis of a general tendency to variability shown by the character of these communities, the interpretation of the mutual similarities between the stations with regard to *Chironomidae* was presented.

Territory, material, and method

The total length of the River Łyna is 289.4 kilometres. There are 217 kilometres of the river course and 5773 square kilometres of the river basin are found on Polish territory.

The Łyna flows through picturesque forests, meadows, and lakes; a fine landscape of great touristic value. This is particularly true about the catchment area of the upper Łyna which includes 610 square kilometres and lies in the south-west part of the Mazurian Lake District, in the Olsztyn Lake District. Here the river basin is about 7—16 kilometres in



Ryc. 1. Lokalizacja stanowisk. J — jeziora

Fig. 1. Localization of sampling stations. *J* — lakes

Tabela I. Charakterystyka przepływu wody (m^3/sek.) w rzece Łynie (Według danych IMGW w Białymstoku) a – maksimum; b – minimum; c – średni

Table I. Characteristics of water flow (m^3/sec) in the River Łyna (According to the data of IMGW in Białystok) a – maximum; b – minimum; c – mean

Miesiąc Month	Przepływ wody Water flow	Olsztyn 1972	Olsztyn 1973	Olsztyn 1974	Bukwałd 1972	Bukwałd 1973	Bukwałd 1974	Smołowe 1972	Smołowe 1973	Smołowe 1974
I	a		4.16	4.72		18.4	19.5		16.3	19.7
	b		3.85	3.12		5.85	7.24		10.9	12.8
	c		3.99	4.00		11.4	13.4		13.6	15.7
II	a		4.90	4.97		20.9	36.6		23.1	33.6
	b		3.95	4.06		5.69	12.5		11.2	18.3
	c		4.40	4.53		13.8	20.4		17.8	25.5
III	a		4.84	4.55		20.2	22.0		21.5	21.8
	b		4.37	3.71		9.80	9.80		14.6	15.6
	c		4.57	4.17		15.4	14.6		19.2	18.0
IV	a		5.03	4.00		19.6	16.9		19.8	16.3
	b		4.26	3.50		9.30	3.12		15.1	7.36
	c		4.61	3.72		14.5	10.3		17.5	12.9
V	a	4.72	4.51	9.91	17.6	17.7	16.5	16.5	18.1	16.3
	b	3.45	3.65	3.15	5.87	5.61	3.75	8.0	10.7	7.65
	c	3.75	4.20	3.52	11.6	12.3	9.79	13.3	15.0	12.3
VI	a	4.78	4.30	5.61	13.2	15.2	17.0	15.3	16.0	19.4
	b	3.22	2.56	3.25	6.70	4.98	4.56	8.85	8.35	7.65
	c	3.67	3.46	3.90	10.3	9.75	10.1	12.4	11.8	12.5
VII	a	4.14	2.66	5.51	14.9	13.7	24.6	17.1	13.6	23.3
	b	3.38	2.06	4.36	5.20	4.72	10.6	7.0	6.86	16.4
	c	3.76	2.35	4.78	10.8	8.44	15.8	12.7	9.54	20.3
VIII	a	4.30	3.78	5.56	15.0	11.7	23.8	15.7	11.0	23.5
	b	3.18	2.40	3.69	6.55	4.60	10.5	9.08	7.41	13.5
	c	3.76	2.94	4.63	10.8	8.27	15.3	13.0	9.29	17.2
IX	a	5.78	3.67	4.05	20.5	10.3	12.7	20.6	10.4	13.0
	b	4.78	2.73	3.04	8.70	4.35	7.28	12.3	7.41	10.6
	c	5.22	3.03	3.38	13.9	7.14	10.2	16.7	9.16	11.7
X	a	5.80	3.45	5.54	24.2	13.9	26.0	20.8	12.5	34.0
	b	5.22	3.00	3.26	10.6	5.29	8.58	16.7	8.0	10.4
	c	5.52	3.25	4.28	15.9	8.76	15.6	19.1	10.2	21.0
XI	a	6.32	5.03	6.67	20.0	18.5	46.4	20.9	19.1	49.5
	b	5.74	3.40	5.65	13.9	5.45	9.20	19.3	9.24	28.1
	c	5.03	4.18	6.06	16.4	11.5	28.9	20.0	14.1	37.9
XII	a	5.23	4.84	6.85	21.8	18.5	49.4	21.8	18.0	38.7
	b	4.16	4.25	6.00	5.05	6.25	4.40	11.0	11.4	27.5
	c	4.50	4.63	6.48	15.3	12.6	21.3	17.8	14.3	31.5

width and about 50 kilometres in length. The lakes of the upper basin cover 42 square kilometres (i.e. 7% of the basin area) and by levelling the surface drainage, control the regularity of river yields. The catchment basin of the lower Łyna includes agricultural land but also forests, meadows, pastures, and moors. In this sector the river receives a number of affluents, chiefly the right-side ones, such as the Wadąg, Kirsjana, Symsarna, Pisa, and Guber, which drain numerous Mazurian lakes. The mean unitary gradient of the Łyna is 0.525‰.

The town of Olsztyn is the most important source of municipal and industrial wastes discharged directly to the river. Other sources of pollution are towns lying along the course of the River Łyna (fig. 1).

Table I contains values of river yields in the analysed period. Physico-chemical properties of the Łyna water are given in Table II.

The observations were carried out at 10 stations (fig. 1) Table III contains detailed descriptions of the stations. *Epiphyta* were identified by Miss Danuta Chudyba, MSc. Field investigations were realized from May 1972 to March 1974 at 2-month intervals. Samples of the

Tabela II. Wybrane czynniki fizyczno-chemiczne wody rzeki Łyny
a - zakres wahań; b - średnie; (w oparciu o pracę Pietrowskiej i Więcławskiego 1976)

Table II. Selected physico-chemical factors of water in the Łyna River
a - range of oscillations; b - average; (according to Pietrowska and Więcławski 1976)

Czynniki - Factors		Stanowiska - Stations								
		2	3	4	5	6	7	8	9	10
Temperatura wody Temperature of water	°C	1.9-26.0[a)] 10.6[b)]	1.9-26.8 10.6	1.9-26.5 10.3	2.6-23.4 10.1	3.0-24.3 10.2	1.8-23.3 9.2	0.9-22.4 9.1	1.0-22.5 8.9	1.0-25.2 9.8
pH		7.6-8.5 8.0	7.7-8.5 8.1	7.4-8.2 7.9	7.2-8.1 7.6	7.3-8.0 7.7	7.5-8.1 7.1	7.6-8.2 7.2	7.6-8.1 7.2	7.6-8.2 7.9
Tlen rozpuszczony Dissolved oxygen	O_2 mg/dm^3	14.9-8.6 12.3	10.1-18.6 12.5	7.8-13.1 11.1	0.6-11.4 7.8	3.5-10.6 7.2	6.4-11.5 8.3	6.5-13.4 9.3	5.8-12.2 9.0	5.4-15.0 10.1
Nasycenie wody Saturation oxygen	O_2 %	83.4-122.7 99.6	88.2-142.1 109.1	78.7-119.4 95.8	6.9-86.3 69.8	36.1-96.2 61.2	71.8-97.9 72.2	44.8-108.4 77.8	74.0-98.0 69.7	62.4-114.0 85.6
Zawiesiny ogólne Total suspension	mg/dm^3	0.9-9.8 3.9	0.2-5.6 2.4	1.3-8.7 4.6	1.0-66.0 21.1	2.7-17.2 7.7	3.8-24.4 12.3	3.5-25.4 15.1	4.8-31.2 13.0	3.0-36.2 16.9
BZT_5 BOD_5	O_2 mg/dm^3	1.9-4.5 2.8	5.0-1.6 3.4	1.3-4.6 2.7	9.0-31.0 14.7	1.4-9.6 4.2	1.6-6.1 3.1	1.4-5.9 3.1	1.1-6.6 3.4	3.0-6.2 4.4
Fosfor ogólny Total phosphorus	P mg/dm^3	0.04-0.38 0.10	0.01-0.23 0.07	0.04-0.23 0.12	0.17-1.68 2.00	0.12-0.78 0.51	0.11-0.66 0.41	0.12-0.95 0.43	0.12-0.88 0.39	0.18-0.93 0.50
Azot amonowy Ammonia nitrogen	N mg/dm^3	0.05-0.16 0.08	0.04-0.20 0.09	0.05-0.36 0.15	0.34-5.00 1.62	0.22-0.81 0.54	0.03-0.83 0.34	0.05-0.62 0.34	0.18-0.67 0.29	0.10-0.57 0.36
Azot azotynowy Nitrite nitrogen	N mg/dm^3	0.003-0.011 0.009	0.000-0.004 0.003	0.002-0.011 0.006	0.01-0.07 0.023	0.009-0.15 0.037	0.007-0.08 0.022	0.008-0.06 0.02	0.009-0.065 0.021	0.012-0.12 0.036
Azot azotanowy Nitrate nitrogen	N mg/dm^3	0.02-0.18 0.06	0.02-0.14 0.06	0.03-0.17 0.08	0.04-0.16 0.10	0.03-0.47 0.27	0.35-0.70 0.44	0.43-0.90 0.55	0.37-0.78 0.62	0.36-0.90 0.72
Chlorki Chloride	Cl mg/dm^3	9-16 11.2	10-12 11.0	9-13 11.1	15-36 18.5	13-23 16.8	14-21 15.8	13-21 15.7	13-21 16.3	16-29 20.0
Twardość węglanowa Carbonate hardnes	°n °g	3.4-9.5 7.6	3.1-7.8 6.5	5.6-8.7 6.8	7.0-9.5 8.6	9.0-10.1 9.4	9.2-12.2 8.3	9.0-10.9 9.3	10.1-12.0 10.0	11.2-12.3 11.6
Żelazo Iron	Fe mg/dm^3	0.01-0.27 0.14	0.04-0.29 0.16	0.11-1.06 0.33	0.24-0.60 0.49	0.08-0.52 0.34	0.16-0.56 0.37	0.11-0.76 0.40	0.19-0.90 0.42	0.31-0.62 0.59

Tabela III. Charakterystyka stanowisk badawczych
Table III. Characteristics of sampling stations

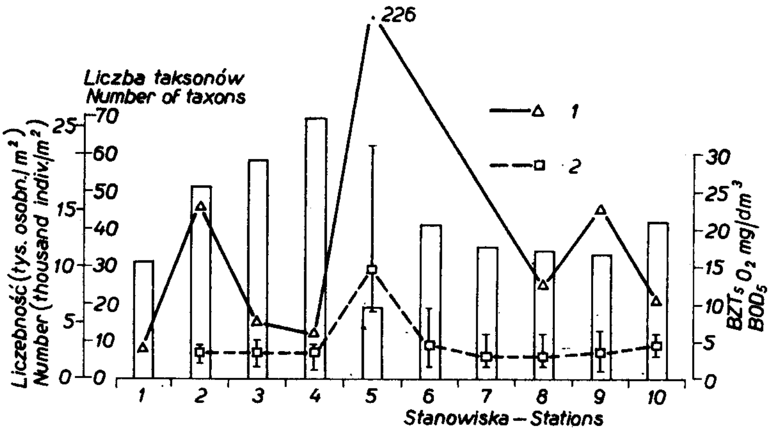
Stanowisko Station	Usytuowanie Locality	Rodzaj terenu Kind of terrain	Szerokość koryta rzeki Breadth of river bottom (m)	Głębokość Depth (m)	Charakter osadów dna Character of bottom sediments	Roślinność wodna Aquatic plants	Gąbki, bakterie nitkowate, grzyby Spongia, filamentous bacteria, fungi
1	poniżej źródeł Łyny, w pobliżu wsi Orłowo below Łyna springs, near the village of Orłowo	łąki meadows	1- 1.5	0.3-0.5	piasek sand	Fontinalis antipyretica L., Pseudochantrasia pygmea Kuetz., Ulotrix zonata Kuetz.	
2	poniżej jeziora Kernoz below Lake Kernoz	łąki, luźna zabudowa wiejska meadows, dispersed village buildings	8-12	0.4-1.5	żwir, piasek, muł gravel, sand, mud	Potamogeton crispus L., P. lucens L., Juncus Sp., Phragmites communis Trin., Lemna trisulca L., L. minor L., Nuphar luteum (L.) Sm., Hydrodictyon reticulatum (L.) Lagerh., Ulotrix zonata Kuetz., Draparnaldia glomerata (Vauscher), Spirogyra Sp., Cladophora glomerata (L.) Kuetz.	
3	poniżej jeziora Ustrych below Lake Ustrych	las liściasto-iglasty deciduous coniferous forest	10-14	0.5-1.0	żwir, piasek, rozdrobnione skorupy Mollusca gravel, sand, broken Mollusc shells	Fontinalis sp., Cladophora glomerata, Chaetophora elegans (Roth.) Ag.	
4	poniżej Olsztyna (Pozorty) below Olsztyn (Pozorty)	łąki, grunty nie zagospodarowane meadow, waste land	8-12	0.5-2.5	piasek, muł, fragmenty roślin wodnych sand, mud, fragments of aquatic plants	Batrachospermum moniliformae Roth., Sagittaria sagittifolia L., Elodea canadensis Rich., Potamogeton perfoliatus L., Phragmites communis, Glyceria aquatica (L.) Wahlb., Acorus calamus L., Nuphar luteum, Ceratophyllum demersum L.	Spongilla (S.) lacustris (L.) Vejd.
5	w Olsztynie in Olsztyn	las liściasto-iglasty deciduous coniferous forest	10-15	1.5-2.0	piasek, muł sand, mud	Potamogeton pectinatus L., Glyceria aquatica, Acorus calamus	Sphaerotilus natans Kuetz., Beggiatoa alba (Vauscher) Trevisan, Leptomitus lacteus Ag.
6	przed Dobrym Miastem above the locality of Dobre Miasto	łąki meadows	10-15	0.3-2.0	piasek, muł, fragmenty roślin wodnych sand, mud, fragments of aquatic plants	Sagittaria sagittifolia, Elodea canadensis, Potamogeton crispus, P. perfoliatus, Glyceria aquatica, Acorus calamus, Nuphar luteum, Ceratophyllum demersum	
7	przed Lidzbarkiem Warmińskim above the locality of Lidzbark Warmiński	łąki meadows	12-15	0.3-2.0	piasek, muł sand, mud	Sagittaria sagittifolia, Fontinalis antipyretica, Vaucheria sp.	
8	przed Bartoszycami above the locality of Bartoszyce	łąki, luźna zabudowa miejska meadows, dispersed town houses	12-15	0.3-1.5	piasek, muł, fragmenty roślin wodnych sand, mud, fragments of aquatic plants	Sagittaria sagittifolia, Potamogeton pectinatus, Stigeoclonium tenue (Agardh) Kuetz.	
9	przed Sępopolem above the locality of Sępopól	las liściasty deciduous forest	12-15	0.5-2.5	piasek, muł, glina sand, mud, loam	Sagittaria sagittifolia, Potamogeton sp.	
10	Stopki na granicy Polski Stopki at the state border	łąki, pojedyncze zabudowania wiejskie meadows, scattered country houses	25-50	0.3-1.5	muł, piasek mud, sand	Sagittaria sagittifolia, Nuphar luteum, Juncus sp., Phragmites communis, Acoruc calamus, Ceratophyllum demersum, Myriophyllum sp.	

benthofauna were collected with Szczepański's tubular bottom sampler with a 10-cm^2 catching surface. The upper opening of the sampler was covered with a net of 0.5×0.5 mm mesh gauze. A series consisted of 10—30 samplings at every station. In the littoral zone the catches were performed at a depth of 20—30 cm and as near to the middle of the river as it was possible. The author tried also to ensure a uniform spatial distribution of samples, particularly if greater sampling series were conducted, in order to eliminate the sampling from previously exploited stations, the mixing up of sediments etc. Habitats were determined on the basis of comparable features of the substrate in the longitudinal profile of the river (Illies, Botosaneanu 1963, Ulfstrand 1967). In this case this was the dominating homogenous fine-grained substratum with a similar structure of sediments granulation. The determination of this type of habitat made it possible, upon analysing the changes occurring in the fauna communities along the river course, to eliminate the error which would result if animal communities developing on various substrates were taken together. Any other approach would illustrate not so much the faunistic zonation of the river as differences among the habitats. The samples were washed on a sieve of 0.25×0.25 mm mesh, this being the condition of catching all juvenile forms of benthos animals. The samples were collected in vivo, selected specimens being preserved in 4% formalin. Only *Oligochaeta* which should serve for the calculation of biomass were fixed in 10% formalin (according to Howmiller's suggestions, 1972) and weighed exact to 1 mg. The mathematical interpretation was based on estimated values (i.e., the percent share of a taxon in relation to the whole invertebrate community at a given station) and relative values (i.e., average numbers of a taxon per surface unit).

The systematic classification of taxons developed by Illies (1967) was used in the work, except for *Chironomidae* which were classified as follows: sub-family *Tanypodinae* (according to Fittkau 1962), *Orthocladiinae* (Pankratova 1970), and *Chironominae* (Romaniszyn 1958). In the identification of the chironomids numerous source works and revisions were applied: Beck and Beck (1969), Černovskij (1949), Fittkau (1962), Hirvenoja (1973), Lenz (1954—1962), Pankratova (1970), Romaniszyn (1958), Thienemann (1944, 1952), Zavřel (1939), and Zavřel and Thienemann (1921). The taxonomic synonymy of *Chironomidae* larve was used as in Fittkau's work (Fittkau et al. 1967).

Distribution of taxons in the longitudinal profile of the river

The analysis of changes in the domination of taxons along the river course was carried out by comparing the systematic-quantitative structure of zoobenthos communities in the separate stations (Table IV).



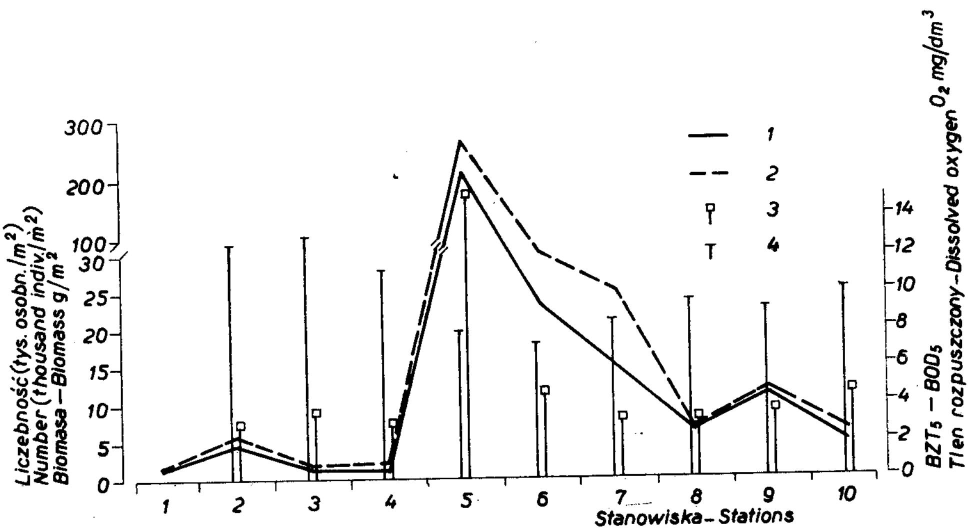
Ryc. 2. Liczba taksonów (kolumny) i średnia liczebność bentofauny (1) na kolejnych stanowiskach w powiązaniu ze zmianami BZT_5 (2)

Fig. 2. Number of taxons (columns) and average density (1) of bottom fauna at successive stations with reference to BOD_5 changes (2)

In comparing the variable numbers of taxons in the longitudinal profile of the river, a particularly rich composition of taxonomic units (69) was found to occur at station 4. At station 5 discharged wastes reduced the number of taxons by 72%. In the further profile of the river the taxons numbers were at an almost constant level (fig. 2).

Among the identified systematic groups, *Chironomidae* showed changes in species numbers which were most similar to the benthofauna variation, this resulting from the fairly great numbers of *Chironomidae* (63% of all taxons, on the average) and, simultaneously, from their considerable influence on the taxonomic character of zoobenthos communities. The remaining groups, i.e. *Trichoptera, Plecoptera,* and *Gastropoda* show similar tendencies to increased numbers of systematic units at stations 1—4, and similarly, by the reduction of forms, react to the inflow of wastes.

The most numerous groups in the longitudinal profile of the river were *Oligochaeta* and *Chironomidae*. It was only at station 2 that *Bythinella austriaca* (43.3% of the whole community on the average) and at station 3 *Dreissena polymorpha* (23.6%) dominated. Changes in numbers and in biomass of *Oligochaeta* correlated with BOD_5 are shown in fig 3.



Ryc. 3. Średnia liczebność (1) i biomasa (2) *Oligochaeta* w podłużnym profilu rzeki w korelacji ze zmianami BZT_5 (3) i tlenu rozpuszczonego (4)

Fig. 3. Average number (1) and biomass (2) of *Oligochaeta* along the longitudinal profile of the river with reference to BOD_5 (3) and dissolved oxygen (4)

It was found that an increase in numbers and biomass (up to 200 g/m² at station 5) was correlated with increased BOD_5 and inversely correlated with oxygen content. Similar dependences were observed by Gross (1976). It seems that the domination system of *Oligochaeta* and *Chironomidae* communities is among the most significant elements of invertebrate variability in the longitudinal profile of the river. At station 4 the former were less numerous than the latter (38% of the community) while at the remaining stations *Oligochaeta* prevailed (particularly at station 5—89.2%). Besides the above mentioned groups a considerable share of *Plecoptera, Ephemeroptera,* and *Dicranota* sp. was noted at station 1, *Trichoptera* at station 2, *Dreissena polymorpha* and *Heteroptera* at station 3, *Gastropoda, Rivulogammarus pulex,* and *Ephemera vulgata* at station 4, *Hirudinea* and *Leptocerus interruptus* at station 8, and *Viviparus viviparus* et *fasciatus, Bithynia tentaculata, Sphaeriidae* spp., and *Asellus aquaticus* at station 9 (Table IV).

In analysing the absolute numbers of specimens and the numbers of taxons recorded at the successive stations in the river, it was found that, in most cases, increased animal density was connected with poorer taxonomic composition of invertebrates. This dependence was particularly pronounced at station 5 and may be regarded as an exponent of the determined one-sidedness of conditions which were created the river below the inflows of wastes. The discharge of organic wastes and conditions thus created (sliming of bottom, growth of *Sphaerotilus natans,*

Tabela IV. Procentowy udział taksonów w podłużnym profilu rzeki
(+ - przypadkowe i nieliczne formy i grupy form)

Table IV. Percentage share of taxons along the longitudinal profile of the river
(+ - accidental and rare forms and groups of forms)

Taksony - Taxons	Stanowiska - Stations									
	1	2	3	4	5	6	7	8	9	10
Hydrozoa n. d.	-		0.7							
Tricladida n. d.			1.0	1.0		+			0.1	
Nematomorpha n. d.		0.1								
Nematoda n. d.	0.7	0.1	0.5	0.2	0.1	0.1	0.3	0.1		0.
Theodoxus fluviatilis L.			0.7	0.2					0.2	
Viviparus viviparus L. et fasciatus Muell.			0.2	0.2					3.0	0.
Valvata piscinalis piscinalis Muell.				0.2						
Bythinella austriaca Frfl.		43.3	0.2							
Bithynia tentaculata L.				0.2					2.5	
Physa fontinalis L.						+				
Radix peregra Muell.		0.1								
Gastropoda n. d.		6.7	1.2	3.1	+	0.8	0.3	0.4	1.1	1.
Unio sp.							0.1			
Anodonta anatina L.							0.1			
Unionidae n. d.				0.2						
Sphaerium corneum L.				0.1						
Pisidium amnicum Muell.				0.6						
- sp.							0.5			
Sphaeriidae spp.	0.3	0.3	0.9			0.1	0.5	0.1	6.5	
Dreissena polymorpha Pall.			23.6							
Lamellibranchia n. d.		0.1								
Stylaria lacustris (L.)				0.4		0.7				0.
Lumbriculidae n. d.	0.7									
Oligochaeta n. d.	46.4	29.1	27.3	30.6	89.2	90.6	86.1	69.7	73.1	62.
Glossiphonia complanata (L.)		0.1								
Helobdella stagnalis (L.)		0.2	0.9	0.2	0.1	0.2			0.1	1.
Piscicola geometra (L.)			0.2			0.1	0.1	0.1		0.
Erpobdella octoculata (L.)				0.2	+					0.
Hirudinea spp. Juv.		1.3	2.4	1.4	+	0.3	0.4	2.5	1.2	0.
Hydracarina n. d.	1.0	0.3	0.5	1.8				0.2		
Asellus aquaticus L.	0.3		0.2	1.0		0.7	0.1	1.0	2.0	0.
Rivulogammarus pulex L.	0.3			4.3						
Potamanthus luteus L.									0.1	
Ephemera danica Muell.				0.2						
- vulgata L.			0.3	4.3		+				
Baetis rhodani Pict.			0.2							
Ephemeroptera spp.	2.3	0.7	2.0	1.8		0.5	0.3	0.3	0.6	0.
Plecoptera n. d.	4.2	0.1	2.7							
Onychogomphus sp.			0.5							
Anisoptera n. d.			0.9							
Zygoptera n. d.			0.2	0.2		+		0.1		0.
Odonata n. d.			0.3			+				
Nepa rubra L.				0.2				0.1		
Heteroptera n. d.		0.7	6.6	2.7			0.1	0.3	0.1	
Coleoptera n. d.		0.1		1.0		0.2	0.1	0.2	0.1	
Sialis lutaria L.				1.4						0.
Hydroptila sp.				0.8						
Hydropsyche spp.			0.2							
Polycentropus flavomaculatus Pict.			0.2							
Leptocerus interruptus Fbr.								5.5		
Trichoptera (larvae et pupae) n. d.		3.6	3.6	1.6		0.1	0.3	0.4	0.9	0.
Tipula spp.	0.7	0.1	0.9					0.1		
Dicranota spp.	2.9	0.1					0.1			
Psychoda alternata Say					+					
Simuliidae (larvae et pupae) n. d.	7.1					+				
Clinotanypus nervosus (Mg.)			0.2	1.0		+	0.1			0.
Tanypus kraatzi (K.)				0.2						0.
- punctipennis (Mg.)										0.
Psectrotanypus varius (Fabr.)					+					
Antopynia sp.	0.3									0.
Procladius sp.	1.6			5.3	+	0.1	0.2	0.1	0.1	3.
Thienemannimyia spp.		0.1	0.3							0.
Ablabesmyia gr. monilis (L.)				0.2						
Krenopelopia binotata (Wied.)				0.2						
Potthastia longimanus (K.)		0.6		0.2	+					
Monodiamesa bathyphila K.	0.7							0.2		

limited oxygen content, destruction of organic matter, etc.) are ecological factors which limit the variability and character of river bottom habitats (Olive 1976, Thorp, Lake 1973). The destruction of various biotopes and the uniformity of physical conditions resulted in cont. tab. IV

ксоny – Taxons	Stanewiska – Stations									
	1	2	3	4	5	6	7	8	9	10
odiamesa olivacea (Mg.)	9.7			0.6		0.1	0.5	1.2	0.2	
raffovitata G.								1.2		
illia modesta (Mg.)								0.2		
longifurca K.								0.3		
issocladius pothamophilus Tsch.		2.2	0.3		+	0.4	0.3	0.1	0.2	
sp. juv.		0.1								
terotrissocladius marcidus (Walk.)	2.3									
kiefferiella longicalcar (Potth.) et										
nor (Verr.)	0.7	0.1		0.2						
kiefferiella hospita Edw.	1.3		0.5							
sp.	2.6									
northocladius semivirens (K.)		0.1	0.2	0.2						
thocladius gr. saxicola (K.)		0.1		0.8						
icotopus bicinctus (Mg.)		0.1		0.4	+	+	0.1	0.1		0.2
Latidentatus Tsch.							0.1			
sp. juv.	0.3				0.1			0.2		
ocladius silvestris (Fabr.)			0.3			0.1				1.2
ectrocladius sp.		0.1								
eocricotopus gr. fuscipes K.			0.3							
anophyea prolongatus (K.)				0.4						0.7
pusillus Eat.			0.9	0.2					0.1	0.4
sp. (transcaucasicus ?) Tsch.				0.2		+				
spp. juv.	8.1	0.1	0.2	0.6		0.2		0.2		0.6
oicocladius ephemerae (K.)				0.8						
ienemanniella flaviforceps K.									0.1	
thocladiinae spp. juv.		0.3	0.2	0.8				0.2		0.2
dochironomus gr. signaticornis (K.)		0.1								0.4
gr. dispar (Mg.)		0.1								0.2
enochironomus gibbus Fabr.									0.1	
yptotendipes gr. gripekoveni K.		0.6				0.4				0.2
ironomus gr. plumosus L.					+	+				0.5
gr. thummi K.		0.3		0.4	10.6	0.9	0.4			16.2
nochironomus gr. nervosus (Staeg.)		0.1	0.7	0.8		0.3	0.1			0.4
tritomus K.		0.1								
nochironomus xenolagis K.									0.6	
rnischia fuscimana K.	0.7			0.2						
racladopelma camptolabis K.	0.3		0.7	.			0.1			
yptochironomus gr. defectus (K.)		0.2	0.2	0.4		0.2	0.1	0.2		
gr. vulneratus (Zett.)			1.0	0.4			0.1			
gr. conjugens (K.)						+				
gr. pararostratus Har.			0.5							
gr. (Ten. gen. Nr.) Lip.			0.7							
spp. juv.			0.3	0.2		0.2				
erotendipes gr. tarsalis (Walk.)	0.3		0.2							
gr. chloris (Mg.)		0.7	0.5	3.3		0.2				0.2
ictochironomus psammophilus Tsch.		1.6	1.2	0.2			0.1			
lypedilum gr. pedestre (Mg.)				0.2	+			0.1		
gr. nubeculosum (Mg.)	0.3	0.1		0.8		+	0.1		0.1	2.0
gr. convictum (Walk.)		0.1		0.2			0.1		0.1	1.0
breviantennatum Tsch.		2.4	0.3	1.7		2.2	7.0	11.9	4.3	0.4
gr. scalaenum Schr.				2.1		+	0.4	1.4	1.1	0.1
atapedilum exsectum K.				0.4	+		0.1			
ratendipes gr. albimanus Mg.	2.3	0.1	2.0	6.0		+	0.2	1.1	0.4	0.4
eropsectra gr. trivialis K.			0.7							
gr. praecox Mg.		0.2	0.3	2.3		0.1				
nytarsus gr. gregarius K.		0.6		2.9		0.1		0.1	0.2	0.2
gr. mancus (Walk.)	0.3	0.1	1.0	0.6						
gr. lauterborni K.		0.3	0.2	0.6					0.1	
gr. exiguus Joh.		0.2		0.8					0.2	
ironomidae (larvae) spp. juv.				0.6				0.1		
(pupae) n. d.		0.7	0.2	0.2	+	0.1			0.1	0.4
ratopogonidae n. d.	1.0	0.3	1.0	2.0			0.4		0.3	0.1
banus sp.	0.3	0.1	5.6	0.2						
ptera (imago) n. d.			0.2				0.1		0.1	0.1

the development of communities of poor species composition. Simultaneously, an increase in *Oligochaeta* numbers (exceeding 200 thousand specimens/m² on the average) was noted. Other groups were eliminated from the environment or their numbers and percent shares were reduced as compared to stations 1—4. At further stations, as the organic substances were being decomposed (a decrease in BOD_5, Table II), a reduction in the numbers of the fauna and, at the same time, an increasing number of zoobenthos taxons were observed.

Tabela V. Sezonowe zmiany zgrupowań zoobentosu rzeki Łyny. A - liczba taksonów; B - liczebność osobników (tys./m^2)

Table V. Seasonal changes of zoobenthos communities in the River Łyna. A - number of taxons; B - number of individuals (thousand/m^2)

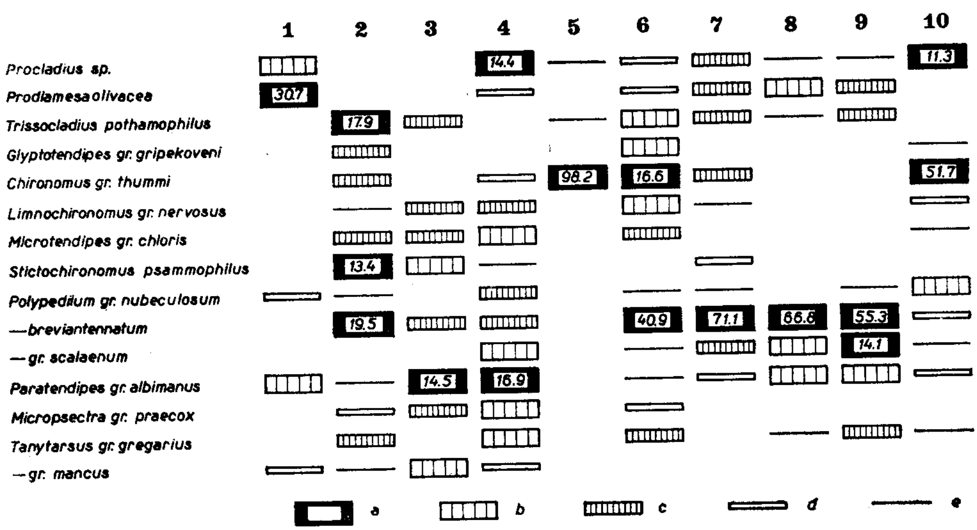
Termin badań Date	Stanowiska - Stations																			
	1		2		3		4		5		6		7		8		9		10	
	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B
4.V.1972	-	-	4	0.4	6	1.7	7	2.5	2	57.4	2	1.6	1	1.1	1	3.1	2	1.7	4	3.3
25.VII	1	1.6	1	0.2	9	1.4	2	0.4	1	364.3	2	43.2	6	7.6	6	15.3	7	12.5	1	5.7
22.IX	-	-	1	1.6	4	0.4	2	0.4	1	97.7	1	7.7	1	8.1	3	17.8	3	4.7	1	1.7
7.XI	1	0.4	8	3.6	8	1.9	8	2.5	4	232.7	3	7.3	3	3.2	4	3.8	6	1.1	2	4.8
11.I.1973	1	0.2	9	10.5	14	8.1	5	5.9	1	27.3	1	3.8	4	34.3	1	0.5	10	24.6	3	8.0
14.III	3	0.3	8	12.3	11	7.5	8	2.3	3	99.2	3	18.3	2	11.8	5	2.5	4	8.3	4	2.7
16.V	2	1.7	6	11.1	8	4.2	9	6.7	4	142.6	1	14.6	2	8.8	2	0.7	9	19.4	5	4.4
3.VII	4	0.8	3	32.5	7	4.3	1	0.1	3	506.3	8	54.4	2	4.7	2	0.5	5	19.6	4	3.3
19.IX	6	4.1	10	53.1	12	4.7	8	1.7	3	100.9	8	34.3	3	6.1	7	14.0	6	58.4	6	12.2
23.XI	3	1.6	2	20.9	8	5.1	5	4.1	3	209.0	8	46.8	2	2.2	5	6.8	3	3.5	5	3.0
25.I.1974	10	7.0	10	7.3	16	7.3	12	5.8	3	213.3	7	38.6	10	18.6	5	9.7	8	7.8	3	5.2
16.III	2	3.5	6	7.0	7	4.0	6	1.1	3	374.6	5	18.0	3	58.1	1	6.2	4	2.5	7	3.3

In view of the 2-month cycle of investigation, the present data cannot be used in a precise analysis of the seasonal changes of zoobenthos. However, the results plotted in Table V suggest two peaks in the numbers: a winter peak in January-March and a summer peak in July-September. On the basis of the present author's unpublished materials it was stated that the prolongation of the maximum occurrence, (e.g. of *Oligochaeta*) was connected with the hatching period of juvenile forms.

Changes in the domination of *Chironomidae* leading forms

The percentage share of a given species was determined in relation to its systematic group, the results being presented in a 5-score scale: eu-dominants above 10.0%, dominants 5.1—10.0%, subdominants 2.1—5.0%, recedents 1.0—2.0%, subrecedents below 1.0%. Only the forms which at one station at least appeared in the minimum percentage of 1.0 (recedents) were included in the analysis.

In the investigated material 71 species and groups of *Chironomidae*



Ryc. 4. Zmiany udziału procentowego przewodnich form *Chironomidae* na kolejnych stanowiskach rzeki. Uwzględniono jedynie gatunki występujące średnio w minimum 1.0% na stanowisku (a — eudomonanci; b — dominanci; c — subdominanci; d — recedenci; e — subrecedenci)

Fig. 4. Changes of the percentage share of the leading forms of *Chironomidae* at successive stations of the river. Reference was made only to the species occurring on the average in minimum 1.0% at the given stations (a — eudominants; b — dominants; c — subdominants; d — recedents; e — subrecedents)

forms were identified. With reference to the changes in the average numbers of *Chironomidae* benthos forms in the longitudinal profile of the river, the following eu-dominants were determined: *Polypedilum breviantennatum, Chironomus thummi, Prodiamesa olivacea,* and *Paratendipes* gr. *albimanus* (fig. 4).

At station 5 the reduction in the numbers of forms was correlated with increased number of *Chironomidae* larvae. The observed growth of the percentage share of specimens was exclusively due to *Chironomus thummi* (98% of *Chironomidae* community). At other stations a reduction in the percentage share of *Chironomus thummi* was noted. The total numbers of *Chironomidae* (at stations 6—10) were influenced by eu-dominant forms in the natural sectors of the river: *Procladius* sp., *Prodiamesa olivacea, Trissocladius pothamophilus, Stictochironomus psammophilus, Polypedilum breviantennatum, P.* gr. *scalaeum,* and *Paratendipes* gr. *albimanus.*

In comparing the *Chironomidae* communities at individual stations, it was observed that station 1 stood distinctly apart. At this station *Prodiamesa olivacea* was found to eu-dominate while *Procladius* sp. and *Paratendipes* gr. *albimanus* dominated. This structure of domination compared with a poor taxonomic changeability (16 species) suggested an insignificant variation of environmental conditions. At the successive stations 2, 3, and 4, both the uniformity in the percentage shares of main forms of the community and the taxonomic differentiation increased: at station 2, 31 forms, at station 3, 27 forms, at station 4, 39 forms. On the other hand, the composition of the main communities, particularly of species attaining the greatest percentage share, greatly varied in the course of the river. The separateness of communities at stations 5 and 10 illustrates an only transitional variation in the extreme values of some physical factors affecting the environmental conditions. At these stations *Chironomus thummi* dominated. At stations 6—9 the communities markedly varied. At these stations *Polypedilum breviantennatum* attained the level of an eu-dominant, which was coupled with *Chironomus thummi* at station 6 and by *Polypedilum* gr. *scalaenum* at station 9. *Procladius* sp., *Microspectra* gr. *praecox,* and species of the genus *Tanytarsus,* caught in large numbers at station 4, were occasionally noted in scarce numbers at station 6. At stations 7—9 the changes proceeding in the structure of the communities seemed to suggest a uniformity of physical conditions, since the percentage share of the main species was less uniform, *Polypedilum breviantennatum,* the only eu-dominant, had a considerable share as compared with the eu-dominants from the previous stations and was accompanied by *Paratendipes* gr. *albimanus* at station 9. Changes in the structure of *Chironomidae* communities observed between stations 5 and 10 and stations 6—9 resulted from differences in water character and grain composition of bottom sediments (Tables II and III).

Determination of the similarity of stations on the basis of *Chironomidae* communities

The analysis of similarity was founded on the structure of *Chironomidae* communities, according to the definition of quantitative similarity (Marczewski, Steinhaus 1959):

$$P = \frac{w \cdot 100}{a+b-w},$$

where P = similarity of two comparable communities, w = total of specimens of a species common for the two communities, a = total of specimens of all species in the first community, and b = total of specimens of all species in the second community.

In comparing the stations on the criterion of the highest value of similarity (Table VI), the shortest dendrite of the stations was plotted (Florek et al. 1951). This method is used in the hydrobiological interpretation of lakes (Romaniszyn 1953, Giziński 1967, Leszczyński 1968).

In the present operation only taxonomic units in the rank of a species were taken into consideration. The data concerning unidentified juvenile forms (e.g. *Cricotopus* sp., *Cryptochironomus* spp.) of any of the identified and analysed species were ommited. Using the criteria offered by the mathematical formula of the natural division of the set, it was found that the dendrite (fig. 5) broke-up in 3, 4, 5, and 8 agglomerations. From the ecological point of view the following division into four agglomerations of stations seems most justified:

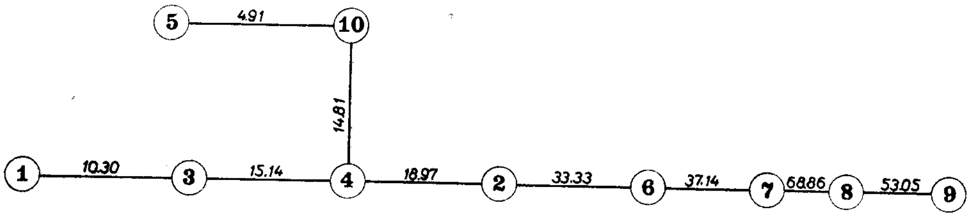
1. Station 1. Determined by the domination of *Prodiamesa olivacea*, *Procladius* sp., and *Paratendipes* gr. *albimanus*. This community also included *Heterotrissocladius marcidus*, *Eukiefferiella hospita*, *Eukiefferiella* sp., and *Limnophyes* sp. (Table IV).

2. Station 5. A monoculture of pelophilous larvae of *Chironomus*

Tabela VI. Podobieństwo stanowisk na tle gatunków larw Chironomidae

Table VI. Mutual resemblance of stations with respect to Chironomidae larvae

	1	2	3	4	5	6	7	8	9	10
1	100.00	1.55	10.30	9.15	0.06	2.75	7.56	10.17	6.98	3.41
2		100.00	9.08	18.97	0.33	33.33	20.00	15.37	20.47	5.95
3			100.00	15.74	0.04	8.41	5.78	6.45	7.44	5.46
4				100.00	0.34	12.80	12.32	12.51	15.19	14.87
5					100.00	1.09	0.48	0.13	0.07	4.91
6						100.00	37.14	31.21	37.00	13.90
7							100.00	68.86	45.57	6.14
8								100.00	53.05	2.42
9									100.00	3.70
10										100.00



Ryc. 5. Dendryt podobieństwa stanowisk (wykreślone na podstawie tabeli VI)

Fig. 5. Dendrite of similarity between the stations (according to Table VI)

thummi. Scarse numbers of *Procladius* sp. and *Trissocladius pothamophilus* were sporadically found.

3. Stations 3, 4, and 10. Domination of the leading forms, i.e. *Procladius* sp., *Chironomus thummi*, and *Paratendipes* gr. *albimanus*, and the proportions between the shares of separate taxons support the opinion that this agglomeration should be jointly treated. Numerous specimens of *Chironomus thummi* at station 10 seem to result from differences in the structure of the bottom between stations 3 and 4 and station 10.

4. Stations 2, 6, 7, 8, and 9. This agglomeration is above all determined by the eu-dominance of *Polypedilum breviantennatum*.

The list of agglomerations of the cenological similarity on the basis of *Chironomus* larvae communities supports the observation on the limiting effect of wastes on the structure of invertebrate communities (figs 2, 3).

Recapitulation

Of all the identified systematic groups (Table IV) the taxonomy of *Chironomidae* was examined in the greatest detail. In this group the presence of the following species, not described as yet for the Mazurian Lake District, was determined: *Monodiamesa bathyphila, Brillia modesta, Heterotrissocladius marcidus, Limnophyes prolongatus*, and *Xenochironomus xenolabis, Brillia longifurca* K. being the new species for the area of Polish lowlands.

The taxonomic fauna composition of the River Łyna showed a marked similarity with the benthofauna of the rivers Supraśl (Niedźwiecki 1970), Wkra (Rybak 1962), and Narew (Dusoge, Wiśniewski 1976). The similarity of the physiographic-faunistic character suggests that the Łyna is a typical lowland river.

In the fine-grained substrate of the River Łyna the most numerous systematic groups were *Oligochaeta* and *Chironomidae*. These groups, interchanging at the successive stations, determined one of the most significant elements of the faunistic variability of this habitat in the longitudinal profile of the river. A relatively significant share of *Bythinella austriaca* and *Dreissena polymorpha* in the numbers of the fauna was noted, while at some stations farily great numbers of *Ephemeroptera* (with *Ephemera vulgata*), *Rivulogammarus pulex, Asellus aquaticus, Trichoptera,* and *Plecoptera* were observed. In the natural sectors of the river (i.e. excluding station 5) the main representatives of *Chironomidae* were *Polypedilum breviantennatum, P.* gr. *scalaenum, Procladius* sp., *Prodiamesa olivacea, Trissocladius pothamophilus, Stictochironomus psammophilus,* and *Paratendipes* gr. *albimanus.* A tendency to the domination of *Polypedilum breviantennatum* or an increase in the numbers of *Chironomus thummi* larvae at the station considerably enriched with organic compounds illustrate the variability of the benthofauna along the river course. At station 5 the inflow of wastes reduced the number of taxons by 72%, *Trichoptera, Plecoptera,* and *Gastropoda* being eliminated from the bottom biocenosis, while growing numbers of *Oligochaeta* and *Chironomidae* (particularly of *Chironomus thummi*) were observed. The abundant occurrence of *Chironomus thummi* below the discharge of wastes was observed by Szczęsny (1974) in the Kryniczanka stream. At further stations of the river, as the decomposition of organic substances advanced, the numbers of the fauna decreased while the numbers of zoobenthos taxons increased.

The comparison of *Chironomidae* communities at the successive stations, chiefly in the aspect of tendencies in the domination of forms, enabled the author to observe a relative distinctness of station 1 (within the discussed proportions of the percentage shares). The community developed at station 5 illustrated the influence of wastes only. The determination of groups of similar stations was carried out on the basis of the structure of *Chironomidae* communities at successive stations, the number of species, and the cenological analysis.

STRESZCZENIE

Badania nad strukturą bentofauny drobnoziarnistego podłoża rzeki Łyny przeprowadzono od maja 1972 r. do marca 1974 r. — w odstępach dwumiesięcznych. Spośród zidentyfikowanych 130 taksonów dokładnie opracowano *Chironomidae.* Stwierdzono obecność szeregu gatunków *Chironomidae* dotychczas nie podawanych z terenu Pojezierza Mazurskiego.

Grupami najliczniej reprezentowanymi były *Oligochaeta* i *Chironomidae.* Określono zmiany liczby taksonów w podłużnym profilu rzeki (od 69 jednostek do 18). Średnie wartości zagęszczenia wynosiły od 18 tys. okazów/m^2 do 230 tys. okazów/m^2. Stwierdzono względną stabilność ugrupowania na kolejnych stanowiskach rzeki. Prześledzono zmiany dominacji przewodnich form *Chironomidae (Polypedilum breviantennatum, Chi-*

ronomus thummi, Prodiamesa olivacea i *Paratendipes* gr. *albimanus).* W podłużnym profilu rzeki w oparciu o analizy naturalnych ugrupowań zwierzęcych (stanowiska 1—4 i 6—10) stwierdzono dysproporcje, wynikające głównie z faktu udziału procentowego taksonów oraz zmian formacji dominantów. Na podstawie struktury ugrupowań *Chironomidae,* liczby gatunków oraz analizy cenologicznej przeprowadzono wydzielenie podobnych grup stanowisk.

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