ACTA HYDROBIOL.	20	3	215—232	KRAKÓW 1978

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Wpływ niektórych fizykochemicznych właściwości wody i osadów dennych rzeki Nidy na rozmieszczenie i liczebność skąposzczetów (*Oligochaeta*)*

The influence of physico-chemical properties of water and bottom sediments in the River Nida on the distribution and numbers of *Oligochaeta*

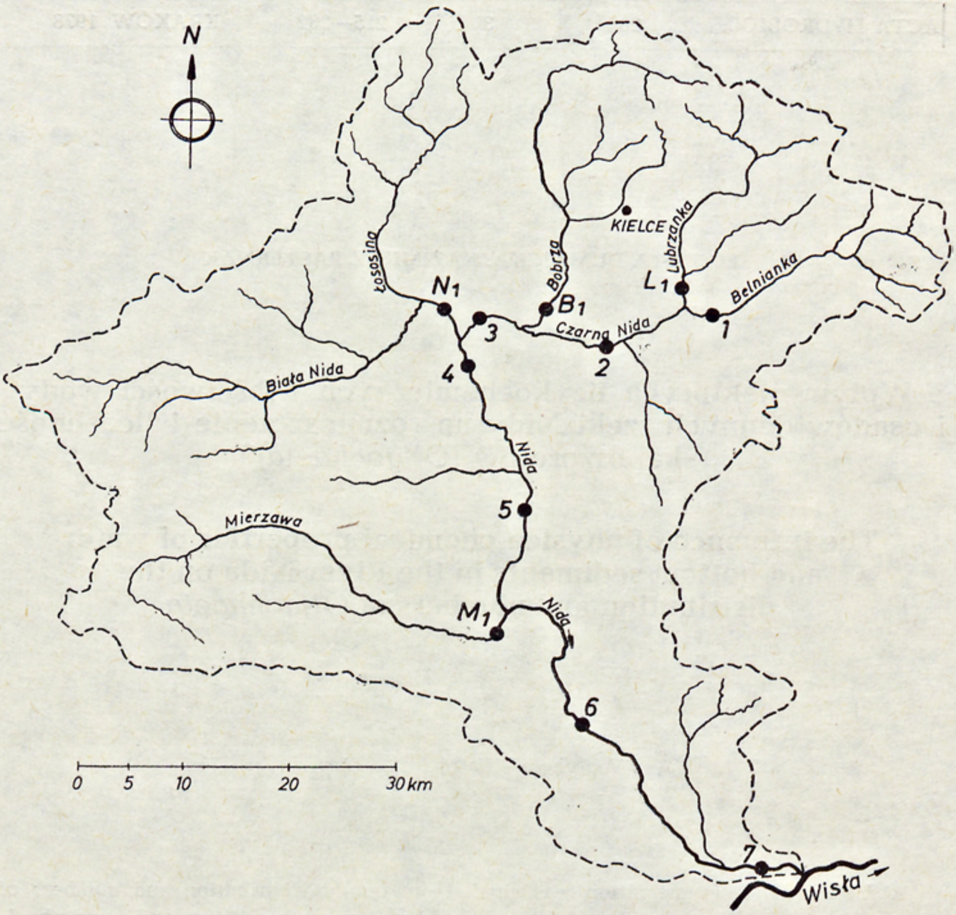
Wpłynęło 4 listopada 1977 r.

Abstract — Investigation was carried out on the distribution and numbers of 13 species of *Oligochaeta* as depending on the character of the bottom and some physico-chemical properties of water in the River Nida and its affluents. The limits of variability of these factors, at which separate species occurred are quoted. The numbers are compared with results obtained in different rivers of Poland.

The River Nida was the subject of complex hydrobiological investigations. The chemism of water and bottom sediments was elaborated by Pasternak (1973, 1977a, 1977b), bacteriological analysis of the river was carried out by Starzecka (1977), the bottom fauna with special consideration to *Chironomidae* was characterized by Srokosz (1977), and the composition and structure of *Oligochaeta* communities by Dumnicka (1978).

The samples were collected at 11 stations of which 7 lay along the River Nida and the remaining 4 in its chief tributaries (fig. 1).

* Praca wykonana w ramach problemu węzłowego 10.2.



Ryc. 1. Plan rozmieszczenia stanowisk na rzece Nidzie i jej dopływach

Fig. 1. Distribution of stations at the River Nida and its tributaries

Many authors stress the importance of the type of bottom for the distribution of *Oligochaeta* (Fomenko 1972, Kasprzak, Szczęsny 1976, Wachs 1967, and others), while the importance of other physico-chemical factors of the environment for the distribution of these animals has rarely been investigated yet. The dependence of the occurrence of *Oligochaeta* on the grain composition of the substratum and the content of organic matter was the subject of investigations carried out by Wagner (1968), Cvetova (1972), and Gurvič et al. (1972); however, in their publications *Oligochaeta* were treated on general lines only, as constituents of the benthos. The above-mentioned authors found a distinct positive correlation between the content of organic matter in sediments and the number of *Oligochaeta*. Van Hov e n (1975) investigated the correlation between the occurrence of several species (*Limnodrilus hoffmeisteri, Ilyodrilus templetoni, Branchiura sowerbyi,* and *Dero nivea*) and the chemical factors in an environment different from that characterized in the present work (South Africa). His results showed that these dependences were poor. The influence of the chemism of polluted waters on the occurrence of *Tubifex tubifex* and *Limnodrilus* sp. was examined by Z e l i n k a (1962) who found that these animals occurred at the minimum amount of 0.2 mg/l of oxygen and 0.1—1.1 mg/l of NH_4.

The chief aim of the present investigation has been to determine the effect of various physico-chemical factors of the polluted and pure environment of the River Nida and its tributaries on the distribution and number of 13 species of *Oligochaeta* occurring there.

Method

Thirteen species dominating in the communities found in the River Nida and its tributaries (D u m n i c k a 1978) were selected for the investigation, the domination index being computed according to the formula of K o w n a c k i (1971). The species were differentiated in their saprobic and biotopic requirements. *Limnodrilus udekemianus, L. hoffmeisteri, Tubifex tubifex,* and *Lumbricillus rivalis* most *numerously* oc-

Tabela I. Fizyko-chemiczne właściwości wody i osadów rzeki Nidy i jej dopływów - średnie wartości za okres badań

Table I. Physical and chemical properties of the water and sediments of the River Nida and its tributaries - average values for the period of investigations

Czynniki - Factors	Nr. stanowiska - No. of station										
	N1	L1	1	2	B1	3	4	5	6	7	M1
Nasycenie tlenem Oxygen saturation %	98.25	99.74	94.06	99.14	26.49	50.36	45.61	77.70	82.47	88.80	95.48
BZT_5 BOD_5	2.56	3.12	3.92	2.44	14.59	6.53	5.11	5.58	3.71	4.06	2.70
NH_4 mg/l	0.327	0.258	0.235	0.241	9.740	2.682	2.397	1.008	0.599	0.387	0.168
PO_4 mg/l	0.89	0.097	0.129	0.087	1.325	0.881	0.864	0.516	0.326	0.308	0.280
Twardość °n Hardness °G	10.3	7.6	7.5	9.1	11.7	10.7	10.8	10.9	13.0	13.5	16.2
Ca mg/l	62.51	39.54	37.16	48.07	62.68	53.76	56.57	66.10	79.69	85.16	104.87
Mg mg/l	6.6	8.0	10.1	9.8	12.5	11.5	12.6	7.4	6.7	6.8	6.4
Temperatura Temperature °C	9.25	9.25	9.90	9.35	11.02	10.06	10.31	9.46	9.70	9.87	8.35
Materia organiczna w osadach Organic matter in sediments %	2.29	1.76	1.52	2.17	5.40	3.59	3.07	1.74	3.04	3.46	4.69

Tabela II. Srednie wartości chemicznych właściwości wody i osadów porównywanych rzek ↓dopływ ścieków

Table II. Average values of the chemical properties of the water and sediments of rivers under comparison. ↓inflow of sewage

Rzeka River	Nr stanowiska No. of station	Czynniki - Factors		
		BZT_5 - BOD_5	nasycenie tlenem oxygen saturation %	materia organiczna w osadach organic matter in sediments %
Nida	N1	2.56	99.25	2.29
	L1	3.12	99.74	1.76
	1	3.92	94.06	1.52
	2	2.44	99.14	2.17
	B1↓	14.59	26.49	5.40
	3	6.53	50.36	3.59
	4	5.11	45.61	3.07
	5	5.58	77.70	1.74
	6	3.71	82.47	3.04
	7	4.06	88.80	3.46
	M1	2.70	95.48	4.69
Kryniczanka	1	0-10	87.20	3.54
(wg. Szczęsnego according to Szczęsny 1974)	2	1-4	84.00	-
	3	2-11	91.30	5.86
	4 ↓	20-124	58.00	38.40
	5	13-76	54.00	30.00
	6	7-28	64.30	13.90
	7	4-42	76.40	12.70
Prądnik	1	-	-	
(wg Dratnala according to Dratnal 1976)	2	2.30	87.88	
	3 ↓	13.26	77.73	
	4	3.58	75.26	
	5	2.76	85.30	
	6	-	-	
	7	-	-	
Raba	1	-		
(wg Bombówna according to Bombówna 1968)	2	-		
	3	-		
	4	-		
	5	-		
	6 ↓	1.72	103.90	
	7	-		
	8 ↓	2.07	103.30	
	9	2.04	103.60	
	10 ↓	1.84	97.30	

cur in strongly polluted waters, chiefly in slimy bottoms (M o s z y ń k a 1962). *Limnodrilus profundicola, Nais elinguis,* and *N. barbata* chiefly occur in moderately polluted waters, *L. profundicola* being a pelophilous species, while *N. elinguis* and *N. barbata* are rheophilous species. The remaining species live in pure waters. *Propappus volki* and *Nais bretscheri* are psammo- and rheophilous species (F o m e n k o 1972, Ž a d i n 1964). *Specaria josinae* is a rheophilous species living in slimy sand (F o m e n k o 1972). *Tubifex ignotus* also lives in slimy sand but it usually chooses a slower water current (a limnorheophilous species)

(F o m e n k o 1972). *Aulodrilus pluriseta* is a limnophilous species, occurring in slimy sand and in mud (**F o m e n k o 1972, Ž a d i n 1964**), while *Stylaria lacustris* is a phytorheophilous species (Ž a d i n 1964).

Of the physico-chemical factors selected for the present investigation some characterized the degree of water purity (BOD_5, O_2 content, NH_4, PO_4, and organic matter) while others depended chiefly on the substratum of the river (hardness, Ca and Mg content) or on the season of the year (temperature). Mean values of these chemical factors for the period of the investigation were listed in Table I.

Chemical results were compared with similar investigations carried out in other rivers of Poland (Raba, Kryniczanka, and Prądnik: D r a t n a l 1976, K a s p r z a k 1976a, K a s p r z a k, S z c z ę s n y 1976, S z c z ę s n y 1974). Mean values of the chemical properties of water and sediments of all the rivers compared were shown in Table II.

The correlation coefficient r (O k t a b a 1971) was computed as determining the influence of the physico-chemical factors on the occurrence of species. The correlation coefficient is always quoted with the reservation for what ranges of variability of the given factor it was computed. E.g. for *Nais bretscheri* a positive correlation with BOD_5 was found but only within 0.32—7.2 mg O_2/l. At higher BOD_5 values *N. bretscheri* did not occur.

Results

Tubifex tubifex (M ü l l e r, 1773): for this species a positive correlation was only found with the content of organic matter in the sediments (Table III). In the River Nida it was most numerous at pure stations in the slimy bottom and in polluted sectors, also in the sandy bottom (Table IV). In the Kryniczanka stream (S z c z ę s n y 1974), in a strongly polluted sector this species was equally numerous in the stony bottom and in the slime. In a moderately polluted sector of this stream (stations 1 and 2) it was more numerous in the slimy bottom. Similar distribution was found by K a s p r z a k (1976a) in the Prądnik stream.

Limnodrilus hoffmeisteri (C l a p e r è d e 1862) and *L. udekemianus* (C l a p e r è d e 1862): for these species a positive correlation with BOD_5 within 0.32—74.2 mg O_2/l and with NH_4 within 0.1—11.8 mg/l was found. The above-quoted ranges also include maximum values of these chemical factors noted in the Nida and its affluents. The content of organic matter also positively influenced the occurrence of these species, hence the greatest numbers were found in the slimy bottom. In polluted waters containing great amounts of organic matter, they can also occur in great

Tabela III. Wartości współczynnika korelacji r i zakresy zmian wybranych czynników chemicznych przy których stwierdzono obecność danego gatunku.

Table III. Values of the correlation coefficient r and ranges of changes of selected chemical factors where the given species was found.

[ ] - korelacje omówione w tekście - correlations discussed in the text

Gatunek / Species Czynniki / Factors	Tubifex tubifex	Limnodrilus hoffmeisteri	Limnodrilus udekemianus	Limnodrilus profundicola	Lumbricillus rivalis	Nais elinguis	Nais barbata	Nais bretscheri	Stylaria lacustris	Aulodrilus pluriseta	Tubifex ignotus	Propappus volki	Specaria josinae
BZT_5 BOD_5	0.32-74.2 0.09	0.32-74.2 [0.33]	0.32-74.2 [0.48]	2.08-74.2 -0.04	3.04-19.08 [0.31]	0.32-9.24 [0.26]	0.32-8.48 [0.34]	0.32-7.2 [0.26]	0.64-8.48 [0.35]	0.96-5.92 0.09	0.64-7.68 0.04	0.32-9.24 0.13	0.64-7.04 0.15
Nasycenie O_2 Oxygen saturation %	1.56- -110.7 -0.16	1.56- -116.94 -0.09	1.56- -104.23 -0.19	1.56- -109.23 [-0.35]	1.56- -75.07 [0.23]	22.46- -114.29 [-0.29]	22.46- -141.98 [-0.24]	68.18- -141.98 [0.26]	73.42- -141.98 [-0.20]	68.18- -141.98 [0.26]	72.26- -141.98 [0.35]	26.06- -141.98 [0.33]	69.05- -141.98 0.19
Twardość °n Hardness °G	5.9-17.2 -0.03	5.4-17.2 -0.01	5.9-17.2 -0.09	5.4-15.9 0.03	7.0-13.7 [-0.20]	6.6-16.4 -0.01	6.8-15.9 0.05	6.8-15.9 0.03	6.4-15.5 -0.09	6.3-17.2 [-0.43]	5.4-17.2 [-0.20]	5.4-16.6 [-0.36]	5.6-16.4 0.05
Ca mg/l	32.16- -113.67 -0.03	28.6- -113.67 -0.03	32.16- -113.67 -0.11	28.6- -104.35 -0.03	30.73- -72.9 -0.05	35.74- -107.2 0.02	34.3- -105.8 0.08	34.3- -105.8 0.06	31.8- -100.77 -0.08	32.16- -113.67 [-0.34]	28.6- -113.67 [-0.33]	28.6- -107.2 [-0.29]	25.02- -106.5 0.03
NH_4 mg/l	0.02-11.8 -0.03	0.1-11.8 [0.33]	0.1-11.8 [0.33]	0.17-10.12 [0.26]	0.1-10.88 0.02	0.02-6.32 -0.02	0.02-2.8 -0.12	0.02-1.78 -0.04	0.26-2.72 [-0.28]	0.04-0.7 0.11	0.02-1.43 -0.07	0.1-2.72 -0.10	0.02-1.78 0.14
PO_4 mg/l	0.01-2.0 -0.03	0.01-2.0 0.09	0.01-2.0 0.08	0.01-2.0 -0.01	0.16-2.0 -0.12	0.01-2.0 0.02	0.01-2.0 0.02	0.01-0.73 [0.47]	0.01-1.19 [-0.26]	0.01-0.47 [-0.27]	0.01-0.73 [-0.32]	0.01-2.0 [-0.26]	0.01-1.18 0.05
Temperatura °C Temperature	0.3-20.6 0.06	0.3-20.6 -0.06	0.3-20.6 -0.03	1.8-20.6 [0.28]	3.9-11.6 [-0.31]	0.3-20.6 [0.30]	0.3-20.6 [0.37]	0.4-20.4 [0.34]	1.6-20.6 [0.39]	0.9-18.7 0.08	0.3-18.3 -0.04	0.4-20.4 [0.23]	0.4-20.6 -0.11
Materia organiczna w osadach Organic matter in sediments	0.26-34.82 [0.32]	0.08-34.82 0.18	0.08-34.82 [0.27]									0.02-1.88 [-0.34]	
Mg mg/l					6.5-22.12 [-0.21]								

Tabela IV. Rozmieszczenie Tubifex tubifex w różnych siedliskach porównywanych rzek
↓dopływ ścieków

Table IV. Distribution of Tubifex tubifex in the different habitats of rivers under comparison
↓inflow of sewage

Rzeka River	Jednostki Units	Siedlisko Habitat	Nr stanowiska - No. of station										
			N1	L1	1	2	↓B1	3	4	5	6	7	M1
Nida	wskaźnik dominacji indice of dominance	piasek sand / muł mud	+ / 1.0	+ /	+ /	/ +	1.3 / 1.2	1.1 / 10.7	10.1 / 8.5	1.4 / 6.9	/ 24.4	+ / 13.5	+ /
Kryniczanka				1	2	3	↓4	5	6	7			
	udział procentowy percentage share	kamienie stones / muł mud		1.3 / 5.6	20.0 / 41.3	16.6 / 16.7	67.7 / 59.8	64.5 / 68.9	69.6 / 74.6	86.2 / 80.7			
Prądnik					1	2	↓3	4	5	6	7		
	klasy liczebności I-VIII wg Kasprzaka (1976) number classes I-VIII according to Kasprzak (1976)	kamienie stones / muł mud			I / V	V / VIII	/ VI	VIII / V	II / IV	II / III	I / IV		

Tabela V. Rozmieszczenie Limnodrilus hoffmeisteri w różnych siedliskach porównywanych rzek
↓dopływ ścieków

Tabela V. Distribution of Limnodrilus hoffmeisteri in the different habitats of rivers under comparison
↓inflow of sewage

Rzeka River	Jednostki Units	Siedlisko Habitat	Nr stanowiska - No. of station										
			N1	L1	1	2	↓B1	3	4	5	6	7	M1
Nida	wskaźnik dominacji index of dominance	piasek sand / muł mud	+ / 12.6	+ / 10.5	1.1 /	/ 2.0	+ / 1.3	2.1 / 4.4	+ / 9.1	+ / 1.6	11.7 / 3.5	5.2 / 16.1	+ /
Kryni-czanka				1	2	3	↓4	5	6	7			
	udział procentowy percentage share	kamienie stones / muł mud		0.1 / 0.6	0.8 / 44.8	1.8 / 8.3	8.7 / 9.9	7.5 / 15.8	25.2 / 19.7	11.8 / 14.6			
Prądnik					1	2	↓3	4	5	6	7		
	klasy liczebności I-VIII wg Kasprzaka (1976) number classes I-VIII according to Kasprzak (1976)	kamienie stones / muł mud			I / III	IV / VI	II / V	II / IV	I / IV	I / II	I / VII		

Tabela VI. Rozmieszczenie Limnodrilus udekemianus w różnych siedliskach porównywanych rzek
↓ dopływ ścieków

Table VI. Distribution of Limnodrilus udekemianus in the different habitats of rivers under comparison
↓ inflow of sewage

Rzeka River	Jednostki Units	Siedlisko Habitat	Nr stanowiska - No. of station										
			N1	L1	1	2	↓B1	3	4	5	6	7	M1
Nida	wskaźnik dominacji index of dominance	piasek sand / muł mud	+ / +	/ 17.4		/ +	44.1 / 64.7	18,5 / 54.8	4.5 / 45.0	1.8 / +	2.1 / 2.0	+ / 2.6	+ / -
Kryni-czanka				1	2	3	↓4	5	6	7			
	udział procentowy percentage share	kamienie stones / muł mud		0.9 /	/ 4.1	4.9 / 63.2	11.6 / 12.1	7.4 / 7,4	2.9 / 2.2	0.8 / 2.5			
Prądnik					1	2	↓3	4	5	6	7		
	klasy liczebności I-VIII wg Kasprzaka (1976) number classes I-VIII according to Kasprzak (1976)	kamienie stones / muł mud			I / I	III / V	/ IV	/ I		/ IV	/ VI		

numbers in the sandy bottom. The remaining factors, i.e. variability in the Ca content, hardness, or temperature had no impact on changes in the numbers of these species. *Limnodrilus hoffmeisteri* cannot be regarded as a good indicator of pollution, since its numbers often rapidly change in a short sector of the river, without any correspondence with changes in water pollution (Table V). In the River Nida and the Kryniczanka stream as well as in the Stawianka (an affluent of the River Newa) (Finogenova 1968) variability in the numbers of *Limnodrilus udekemianus* was distinctly connected with changes in the degree of water pollution. However, this regularity was not distinctly manifested in the Prądnik stream (Table VI).

Limnodrilus profundicola (Verril, 1871): this species is negatively correlated with oxygen saturation of water in the range of 109.23 to 1.5 per cent, this showing its great hardness against the low oxygen content in water. Besides, with regard to this species a slightly positive correlation with NH_4 was found, ranging from 0.17 to 10.12 mg/l. At high NH_4 concentrations *L. profundicola* was not encountered. This species was most numerous in moderately polluted waters. Mature specimens chiefly occurred in warm seasons, hence a positive correlation coefficient for temperature was obtained. In the River Nida this species was characteristic of moderately polluted waters, but in other rivers of Poland (the streams Prądnik and Kryniczanka, the River Warta) it was found in scarce numbers (Biesiadka, Kasprzak 1977, Kasprzak 1976a, Szczęsny 1974).

Lumbricillus rivalis (Levinsen 1883, augm. Ditlevsen 1904): mature specimens which could be determined to species, chiefly occurred in winter, therefore a negative correlation with temperature was found. A positive correlation coefficient was found for BOD_5, ranging from 3.04 to 19.08 mg O_2/l, and for the oxygen saturation, from 1.56 to 75.07 per cent (Table III). This species was very numerous in the Nida, occurring in strongly polluted waters, rich in organic matter and at the same time in oxygen. Thus, it is possible that the maturation of specimens in the months with low temperature results from better oxygen conditions, since in such periods no oxygen declines occur. Moreover, the occurrence of *L. rivalis* is negatively correlated with water hardness in the range of 7.0—13.7 °n. Since the correlation coefficient for Ca content which is closely connected with water hardness, was found to be insignificant, the correlation coefficient for Mg content was additionally computed. It was also negative for the range from 6.5 to 22.12 mg/l. The species is characteristic of environments rich in organic matter (Nielsen, Christensen 1959), but it seems that other factors (water hardness or content of individual cations) can also affect its occurrence.

Nais elinguis (Müller 1773): the occurrence of this species is positively correlated with BOD_5 in the range from 0.32 to 9.24 mg O_2/l but negatively with O_2 content expressed as percentage of the oxygen saturation within 22.46—114.29 per cent. Moreover, the occurrence of a positive correlation with temperature was found. The species finds the best conditions of development in moderately oxygenated and fertile waters, but not in strongly polluted ones, since at BOD_5 values higher than 9.24 its presence was not observed. In the Kryniczanka stream (Table VII) *Nais elinguis* occurred in great numbers along the whole course of the stream, even in strongly polluted waters, but probably better oxygenation of the water enables its development. Moreover, in the Kryniczanka stream it was most numerous in winter months when the BOD_5 values of the water were lower and the oxygen content higher (Szczęsny 1974). In the Prądnik the greatest numbers of this species occurred below the discharge of wastes. In the River Raba an increase in its number was found at stations below the towns (Mszana, Myślenice, and Bochnia), although chemical data did not suggest any distinct pollution of the water or sediments (Bombówna 1969, Pasternak 1969). Thus *Nais elinguis* is a very sensitive indicator of any slight pollution or even eutrophication of water. This species did not show any allegiance to specific types of habitat, since is was equally numerous in stony, sandy, and slimy bottoms.

Nais barbata (Müller 1773): the species lives in conditions similar to those described above for *Nais elinguis*. A positive correlation with BOD_5 was found for the range from 0.32 to 8.48 mg O_2/l and a negative correlation with oxygen for the range from 22.46 to 141.98 per cent. It seems that other factors (except for temperature) do not affect the occurrence and number of the two above-discussed species, this suggesting that at the investigated stations the range of their variability was within the limits of the species tolerance. In the River Raba *N. barbata* was not numerous (Kasprzak, Szczęsny 1976), probably owing to poor ability of living in a rapid current, while in the Kryniczanka (Szczęsny 1974) and Prądnik streams (Kasprzak 1976) it chiefly occurred at moderately polluted stations in the sectors with weaker current.

Nais bretscheri (Michaelsen 1899): the occurrence of this species is most strongly correlated with the PO_4 content in the range from 0.01 to 0.73 mg/l. It is the only case of a positive correlation with this factor. To explain this fact, further laboratory investigation is needed. Moreover, a dependence was found between the occurrence of *N. bretscheri* and the temperature, BOD_5, and the oxygen content. It is a polyrheophilous species, living in well oxygenated waters, hence a positive correlation with O_2 was found within 68.18 to 141.98 per cent. A positive correlation with BOD_5 in the range from 0.32 to 7.2 mg O_2/l results from the nutritive requirements of this species with regard to the organic matter. The species was most numerous in a current habitat, but in the

Tabela VII. Rozmieszczenie Nais elinguis w różnych siedliskach porównywanych rzek
↓dopływ ścieków

Table VII. Distribution of Nais elinguis in the different habitats of rivers under comparison
↓inflow of sewage

Rzeka River	Jednostki Units	Siedlisko Habitat	Nr stanowiska - No of station										
			N1	L1	1	2	↓B1	3	4	5	6	7	M1
Nida	wskaźnik dominacji index of dominance	piasek sand / muł mud		/ +	+ /		+ / +	22.9 / +	4.1 / 8.5	31.4 / 34.7	1.2 / +	+ / +	+ /
Kryni-czanka		(station)		1	2	3	↓4	5	6	7			
	udział procentowy percentage share	kamienie stones / muł mud		79.3 / 82.7	53.7 / 6.9	45.0 / 90.0	87.5 / 90.1	90.9 / 97.0	85.4 / 93.2	95.3 / 93.8			
Prądnik		(station)			1	2	↓3	4	5	6	7		
	klasy liczebności I-VIII wg Kasprzaka (1976) number classes I-VIII according to Kasprzak (1976)	kamienie stones / muł mud			I /	IV / III	I /	VIII / V	IV / I	I /			
Raba		(station)	1	2	3	4	5	↓6	7	↓8	9	↓10	
	udział procentowy percentage share	kamienie stones / różne various				0.1 /	1.3 / 0.3	12.9 / 45.3	10.4 / 1.0	33.9 / 17.6	0.05 / 0.6	13.0 / 1.5	

River Raba it was also numerous on stones in habitats without water current (Kasprzak, Szczęsny 1976).

Stylaria lacustris (Linnaeus 1767): the occurrence of this phytophilous species was related to 5 factors, the positive influence of temperature and BOD_5 in the range from 0.64 to 8.48 mg O_2/l being most pronounced. Moreover, the occurrence of *S. lacustris* was negatively correlated with the oxygen content of 73.42 to 141.98 per cent, the NH_4 content within 0.26 to 2.72 mg/l, and the PO_4 content within 0.01 to 1.19 mg/l. The obtained numbers suggest that this species withstands fairly great concentrations of NH_4 and PO_4, though it is usually more numerous at low concentrations.

Specaria josinae (Vejdovsky 1883): this species occurred at unpolluted stations and always in small numbers; hence, no dependence on the investigated factors could be observed. The absence of mass appearance suggests that this species did not find suitable conditions of development in the environment of the investigated rivers, while the range of variation of chemical factors observed at the investigated stations enabled the maintainance and propagation of a small number of specimens.

Tubifex ignotus (Štolč 1886): the factors most important for the occurrence of this species are oxygen and PO_4 content, water hardness, and Ca content. A positive correlation with oxygen content was found in the range from 72.26 to 141.98 per cent this indicating great oxygen requirements of this species. Negative values were obtained for the correlation between the occurrence of *T. ignotus* and water hardness in the variability range from 5.4 to 17.2 °n and still more distinct for the Ca content (28.6—113.67 mg/l). Relatively great amounts of Ca in the water and, consequently, great water hardness may be thus regarded as an unfavourable factor for the development of this species. The sensitivity of *T. ignotus* for the presence of PO_4 is great since for a low and medium content of this compound (within 0.01—0.73 mg/l) the correlation coefficient is negative. These results show that *T. ignotus* does not tolerate polluted waters, although, for instance in the streams Prądnik and Kryniczanka, a very small number of specimens was found at the inflow of sewage (Kasprzak 1976, Szczęsny 1974).

Aulodrilus pluriseta (Piquet 1906): the occurrence of this species is correlated with the same factors as the occurrence of *T. ignotus*, while the negative correlation coefficient with the Ca content within 32.16 to 113.67 mg/l is more distinct than for *T. ignotus*. The sensitivity of *Aulodrilus pluriseta* to the PO_4 content is also similar to that of *Tubifex ignotus*, since this species occurs only at the concentrations ranging from 0.1 to 0.47 mg/l, the correlation coefficient for this factor being negative. In the Prądnik stream this species was fairly numerous at stations below the inflow of wastes, but in this stream the BOD_5 and

Tabela VIII. Rozmieszczenie Propappus volki w różnych siedliskach porównywanych rzek
↓dopływ ścieków

Table VIII. Distribution of Propappus volki in the different habitats of rivers under comparison
↓inflow of sewage

Rzeka River	Jednostki Units	Siedlisko Habitat	Nr stanowiska - No. of station										
			N1	L1	1	2	↓B1	3	4	5	6	7	M1
Nida	wskaźnik dominacji index of dominance	piasek sand / muł mud	79.1 / 11.5	92.0 /	73.0 /	/ 1.4		+ / +	+ /	+ /	9.7 / +	46.5 / +	58.6 /
			1	2	3	4	5	6	7	8	9	10	
Raba	udział procentowy percentage share	kamienie stones / różne various		5.2 /		19.5 / 1.4	1.9 / 2.1	0.9 / 0.7	4.7 / 3.5	17.1 / 1.8	86.4 / 63.8	16.0 / 43.3	
				1	2	3	↓4	5	6	7			
Kryniczanka	udział procentowy percentage share	kamienie stones / muł mud		33.3 / 34.0	43.6 / 2.8								

oxygenation corresponded to values found at moderately polluted stations in the River Nida, where *A. pluriseta* occurred.

Propappus volki (Michaelsen 1915): this species is positively correlated with the O_2 content in water within 26.06 to 141.98 per cent. A positive correlation was also found for the temperature. Negative correlations were computed for the following four factors: water hardness within 5.4 °n to 16.6 °n, Ca content in the range from 28.6 to 107.2 mg/l, PO_4 content from 0.01 to 2.0 mg/l, and organic matter content in bottom sediments from 0.25 to 1.88 per cent. The habitat requirements of this species are known (sandy bottom of pure waters of strong or moderate current), probably hence a positive correlation was found for the O_2 content and negative correlations for the organic matter content in bottom sediments and PO_4 content in water. *P. volki* is also numerous in the stony bottom of the River Raba, where the Ca content is low (Pasternak 1969) and at the pure stations in the Kryniczanka stream (Table VIII), while in the Prądnik stream the species does not occur, probably because of the high Ca content in water (Table II) (Oleksynowa 1966, Pasternak 1968). This species can occur, though not numerously, in poorly oxygenated waters, this being shown by its occurrence in the water with oxygen saturation amounting to 26.06 per cent. The dependence of *P. volki* on water hardness and Ca content has not been reported so far.

Recapitulation

The obtained results suggest that the composition of *Oligochaeta* communities depends not only on the type of the bottom, speed of water current, and pollution carried by the river but also on some chemical properties of water which are connected with the substratum of the river bed, such as water hardness or Ca and Mg content. It seems that the degree of water purity is more important for the occurrence of some species of *Oligochaeta* in rivers and streams than the type of the bottom. E.g. in strongly polluted waters *Limnodrilus udekemianus* or *Tubifex tubifex* occur equally often in the stony or sandy bottom as in the slimy bottom which is regarded as the typical habitat of these species. The absence of habitat selectivity was also found with *Nais elinguis*.

On the other hand, habitat plays the least important role in the distribution of other species, such as *Stylaria lacustris* and *Propappus volki*. A correlation with several physico-chemical factors was found for them: hence it may be postulated that the greater the number of factors correlated with the occurrence of a species, the more precisely the habitat suitable for its development is defined.

It was also found that species of similar correlation coefficients usually occurred together, as it has been observed with *Nais elinguis* and *N. barbata* as well as *Aulodrilus pluriseta* and *Tubifex ignotus*.

STRESZCZENIE

W pracy obliczono współczynnik korelacji (Oktaba 1971) między dominującymi w Nidzie gatunkami skąposzczetów a wybranymi czynnikami fizykochemicznymi wody (tabela III).

Spośród badanych 13 gatunków, najwięcej, bo aż 9, wykazało korelację występowania z zawartością O_2 w wodzie, przy czym dla gatunków żyjących w wodach silnie zanieczyszczonych (poza *Lumbricillus rivalis*) stężenie tlenu jest obojętne w granicach notowanych w rzece Nidzie. Dodatnią korelację z zawartością tlenu w wodzie stwierdzono u polireofilnych gatunków *Propappus volki* i *Nais bretscheri* oraz u *Aulodrilus pluriseta* i *Tubifex ignotus*. Te dwa ostatnie gatunki mają wysokie wymagania tlenowe, choć żyją na dnie zamulonym. Często spotyka się je też wśród roślin wodnych (Čekanovskaja 1962), gdzie mogą przechodzić w poszukiwaniu lepszych warunków tlenowych.

Dla 4 gatunków: *Limnodrilus profundicola*, *Nais elinguis*, *N. barbata* i *Stylaria lacustris* współczynnik korelacji z zawartością tlenu w wodzie jest ujemny, ale różne są zakresy nasycenia wody tlenem, przy których występują te gatunki. *Stylaria lacustris* występuje tylko w wodzie dobrze natlenionej, pozostałe gatunki występują najliczniej w wodach o średniej zawartości O_2.

Dla 7 gatunków (tabela III) stwierdzono istnienie dodatniej korelacji z BZT_5 wody. Natomiast znacznie różniły się zakresy zmian tego czynnika, przy których występował dany gatunek. *Limnodrilus hoffmeisteri* występował przy BZT_5 od 0,32 do 74,2 mg O_2/l, a *Nais bretscheri* tylko przy BZT_5 od 0,32 do 7,2 mg O_2/l.

Korelację z zawartością PO_4 w wodzie stwierdzono u 5 gatunków (tabela III) żyjących w wodach czystych, przy czym u *Nais bretscheri* korelacja ta była dodatnia, przy takim samym zakresie zmian tego czynnika, który u innych gatunków wywoływał współzależność ujemną.

Dla 4 gatunków stwierdzono istnienie korelacji z zawartością jonów amonowych, przy czym dla 3 gatunków żyjących w wodach zanieczyszczonych (*Limnodrilus hoffmeisteri*, *L. udekemianus* i *L. profundicola*) była to korelacja dodatnia, a dla *Stylaria lacustris* — korelacja ujemna.

Odnotowanie, w odniesieniu do niektórych gatunków skąposzczetów, pewnych współzależności z twardością ogólną wody, zawartością w niej Ca i w jednym przypadku z zawartością Mg dowodzi, że charakter chemiczny podłoża i rodzaj gleby zlewni, z której te wody spływają, mają też wpływ na występowanie gatunków. Na podstawie otrzymanych wyników można przypuszczać, że nie tylko niskie, ale i wysokie zawartości wapnia mogą być czynnikiem ograniczającym występowanie i liczebność wielu gatunków skąposzczetów.

Współzależność występowania gatunków z procentową zawartością materii organicznej w osadach obliczono tylko dla kilku gatunków. Gatunki polisaprobowe wykazały dodatni współczynnik korelacji z tym czynnikiem, a *Propappus volki* ma wyraźnie ujemny współczynnik korelacji.

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