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Zooplankton (*Rotatoria*, *Cladocera*, *Copepoda*) in Pruszków Ponds Supplied with Post-waste Waters

Zooplankton (*Rotatoria*, *Cladocera*, *Copepoda*) stawów w Pruszkowie, zasilanych wodą pościekową

Зоопланктон (*Rotatoria*, *Cladocera*, *Copepoda*) прушкувских прудов, питаемых послесточной водой

INTRODUCTION

In order to get acquainted thoroughly with the species composition of zooplankton and abundance of individual populations living in waters differently polluted, experiments were carried out in four Pruszków ponds supplied with post-waste waters reclaimed through the process of mechanical and biological clarification of municipal and industrial wastes. Three basic zooplankton groups: *Rotatoria*, *Cladocera* and *Copepoda* were examined.

AREA

The studies were carried out in the area of municipal-industrial water purifying plant at Pruszków near Warsaw in four ponds connected in series marked with letters A, B, C, D, of total area 9.4 hectares (Fig. 1).

The ponds differ in shape, size and retention time (Table 1). They are shallow in the central part, not exceeding 0.60 m and their depth near the bank ranged from 1 to 1.2 m. All the ponds were connected with the help of sluice-gates. Pond A

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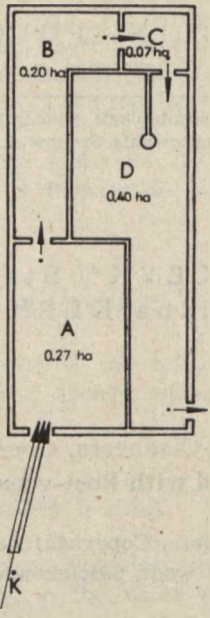


Fig. 1. Situation plan of ponds in Pruszków near Warsaw

and B with the rectangular sluice-gate of 2 m long making it possible for the surface water to float from the depth of 0.15 m. The remaining reservoirs were connected with outlet boxes through which the water floated on the surface.

The investigated ponds were supplied with post-waste waters taken from the sediment trap containing activated sludge. First it was directed to pond A in three pipes and from there it went gravitationally to pond B. Its further flow to ponds C and D was forced which made the water lie stagnant in them. From the last pond D the water was drained off in a ditch to the river Warta (Fig. 1).

MATERIALS AND METHODS

Planktonic materials were collected in the years 1978—1980 at two-week intervals from the stationary stations situated at the outlet of each pond.

A sampler of Patalas type was used for quantitative sampling (16). From each station one 20 dm^3 sample was taken and condensed in the planktonic net from

Table 1. Some morphometric features of Pruszków ponds

Pond	Area /m^2/	Retention time /h/		
		1978	1979	1980
A	2747	34	32	-
B	2046	39	34	42
C	675	14	12	15
D	4025	113	74	92

0.055 mm to 0.1 dm^3 in diameter. Then they were poured into 0.125 dm^3 containers and fixed in 4% formalin. In the quantitative samples the species composition and abundance of zooplankton were determined with the help of the planktonic microscope of Utermöhl type. The data are shown as the number of individuals in 1 dm^3 of water and presented in Tables 2 and 3 and Figs. 2A—D, 3 and 4.

THE RESULTS AND DISCUSSION

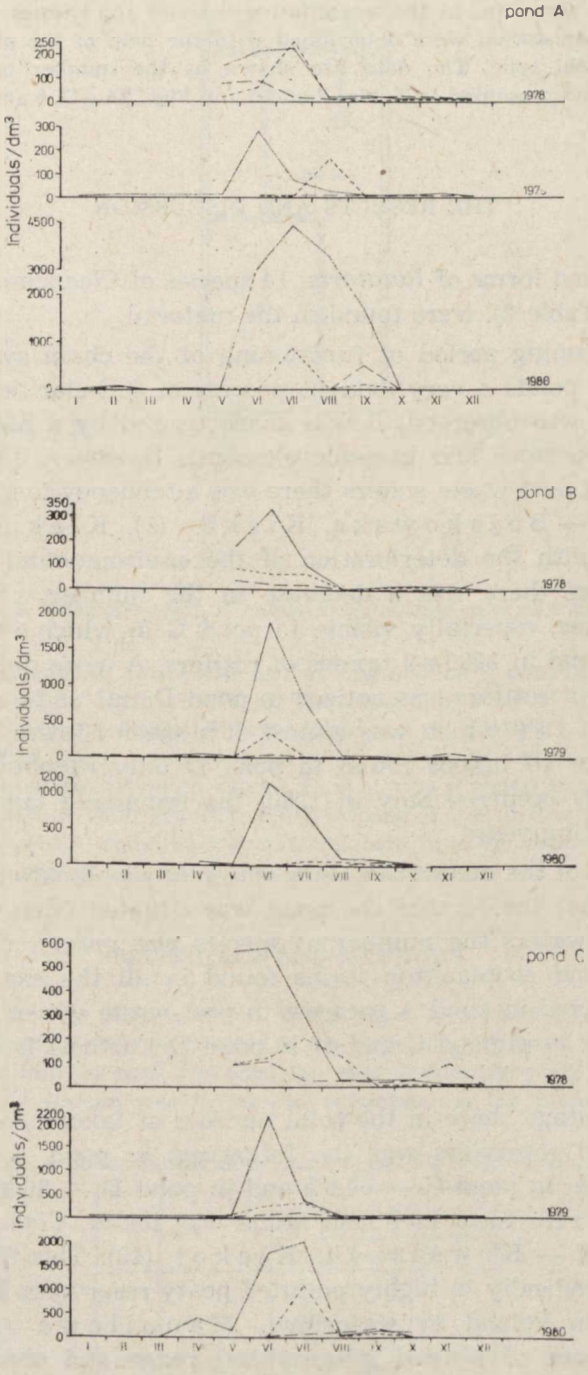
30 species and forms of *Rotatoria*, 14 species of *Cladocera* and 9 species of *Copepoda* (Table 2), were found in the material.

In the beginning period of functioning of the chain system of clarification in the ponds a very evident process of self-clarification of post-waste waters was observed. It was characterized by a high decrease in the organic substance and biogenic elements. However, due to the continuous inlet of post-waste waters there was a tendency to a slower course of the process — Bojakowska, Klekot (1), Klekot, Misztak (8). Together with the deterioration of the environmental conditions in successive years there was a decrease in the number of zooplankton (Table 3). It was, especially visible in pond C in which 14 taxons were found in 1979 and in 1980—9 taxons of rotifers. A more definite decrease in the number of rotifers was noticed in pond D, out of 24 taxons in 1978 to 10 taxons in 1980 which was almost 60% species fewer than in 1978.

Out of these 10 taxons found in pond D only *Epiphanes senta* and *Filinia longiseta* occurred only in 1980, the remaining taxons were also noted in preceding years.

Comparison of the qualitative composition of zooplankton in individual ponds shows that the further the pond was situated from the source of inlet of waste waters the number of species was greater (Table 2). Out of 53 species and zooplankton forms found in all the examined ponds, 21 taxons occurred in pond A (nearest to post-waste waters inlet), 22 taxons in pond B, 34 in pond C and 47 in pond D (furthest from post-waste waters inlet).

Their percentage share in the total number of taxons occurring in all the investigated reservoirs was the following: in pond A — 39.9%, in pond B — 41.8%, in pond C — 64.6% and in pond D — 89.0%. In pond D in 1978 a very rare form in Polish fauna was found, *Cladocera — Scaphaloberis kingi* — Kowalczyk, Klekot (12). This *Cladocera* was found only sporadically in highly polluted peaty reservoirs. It might have been brought to Poland by waterfowl. Manuilowa (14) considers it to be a species of limited geographical range and characteristic of tropical waters. It is a cructacean occurring in small water reservoirs


pond A
pond B
pond C
Individuals/dm³
1978
1979
1980
I II III IV V VI VII VIII IX X XI XII

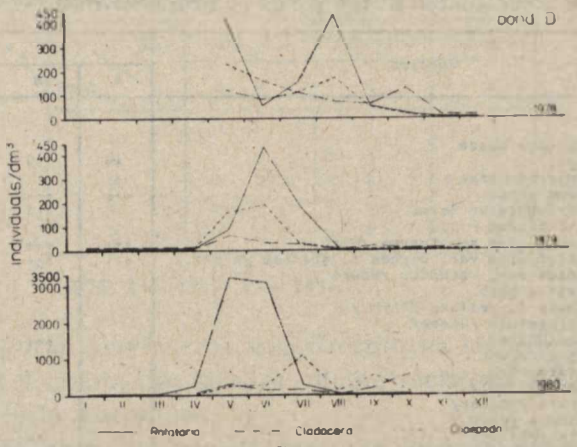


Fig. 2A—D. Abundance of *Rotatoria, Cladocera* and *Copepoda* in the ponds of Pruszków in the following years

such as marshes and ponds and in canals, at times tolerating waters of low *pH*, even down to *pH* 3.

Looking at the role played by the Pruszków ponds in the system of post-waste water clarification it appeared that most of the polluted substances were precipitated from the water in ponds A and B, where sedimentation processes played the main role — Bojakowska, Klekot (1). The chemical composition of bottom sediments shows that in these reservoirs such elements as lead, zinc, copper and chromium, and moreover potassium and phosphorus were settled to the bottom in great quantities. The consequence of the accumulation of these elements in the bottom sediments of the first two ponds was a relatively poor qualitative structure of the zooplankton groups studied there.

The efficiency of the post-waste water clarification system and the role played by each pond in the chain model are proved by the fact that the species composition of zooplankton occurring in the ponds situated at the furthest area from the source of pollution — in pond C, and especially in pond D is very similar to the composition fauna living in non-polluted ponds — Fereńska (2), Grygierek (3, 4), Hajduk (5). But after a longer period, three years in this case, of this system functioning, there was a decline in the possibilities of selfpurification going on in these ponds. This is confirmed by a decrease in the number of rotifer, cladocera and copepoda taxons in the last year of investigations.

The analysis of the species composition of zooplankton in the Pruszków ponds from the point of view of its role played in the determination of the saprobity degree points to the fact that only few of them can be included in the saprobical group. 2 taxons of rotifers belong to it: *Bra-*

Table 2. Zooplankton in the ponds of Pruszków (near Warsaw)

No.	Species	Pond			
		A	B	C	D
I	Rotatoria:				
1	Asplanchna priodonta Gosse			+	+
2	Bdeloidea n. det.	++	++	++	+++
3	Brachionus angularis Gosse	+			
4	Brachionus rubens Egrb.	+++	+++	+++	+++
5	Brachionus quadridentatus Herm.			+++	+
6	Brachionus calyciflorus Pall.				+++
7	Brachionus calyciflorus amphiceros /Ehrb./	+++	+++	+++	+++
8	Brachionus cylicyflorus var. dorcas f. spinosa /Wierz./	+++	+++	+++	+++
9	Brachionus leydigi var. rotundus /Roura./				+
10	Colurella adriatica Ehrb.			+	+
11	Colurella uncinata f. deflexa /Ehrb./				+
12	Diplauchlanis propatula /Gosse/				+
13	Epiphanes senta /Müller/		+++	+++	+++
14	Epiphanes pelagica /Jenn./			+	
15	Euchlanis dilatata Ehrb.				+
16	Filinia longiseta /Ehrb./				+
17	Keratella quadrata /Müller/		+		
18	Lepadella acuminata /Ehrb./				+
19	Lepadella ovalis /Müller/	+	++	++	++
20	Lepadella patella /Müller/			++	++
21	Monostyla closterocerca /Schm./			+	+
22	Monostyla lunaris /Ehrb./			+	+
23	Mytilina mucronata /Müller/	++	+	+	+
24	Mytilina ventralis /Ehrb./			+	+
25	Monommata sp.		+		+
26	Polyarthra vulgaris Carl.	++			+++
27	Platyas quadricornis var. pentagona Wulf.			+	+
28	Rotatoria rotatoria /Pall./ —			+	++
29	Synchaeta pectinata Ehrb.				+
30	Testudinella patina /Herm./	+			+
	Number of species	9	9	17	27
II	Cladocera:				
1	Alona tenuicaudis Sars	+		+	+
2	Bosmina longirostris /O. F. Müller/				+
3	Ceriodaphnia quadrangula /O. F. Müller/	+	+	++	+
4	Chydorus sphaericus /O. F. Müller/	+	+	+	++
5	Daphnia cucullata Sars				+
6	Daphnia longispina O. F. Müller				++
7	Daphnia magna Straus	+	+	+++	+++
8	Daphnia pulex Leydig	+++	++	+++	+++
9	Moina rectirostris /Leydig/	+++	+++	+++	+++
10	Pleuroxus aduncus /Jurine/	+	+	+	++
11	Pleuroxus trigonellus Sars	+		+	
12	Scapholeberis kingi Sars				+
13	Scapholeberis microcephala Sars				+
14	Simocephalus vetulus /O. F. Müller/			+	
	Number of species	7	6	9	12
III	Copepoda:				
1	Acanthocyclops languidus /Sars/				+
2	Acanthocyclops viridis /Jurine/		+	+	+
3	Cyclops strenuus Fisher	+	+	+	+
4	Cyclops vicinus Uljanin		+	+	++
5	Eucyclops serrulatus /Fisher/	+++	+++	++	++
6	Macrocyclops albidus /Jurine/	+	++	++	+
7	Microcyclops minutus /Claus/	+	++	++	+
8	Paracyclops affinis /Sars/	+	+	+	+
9	Paracyclops fimbriatus /Fisher/	+		+	+
	Number of species	5	7	8	8

Explanation: + — single, ++ — numerous, +++ — very numerous.

Table 3. Number of species in the ponds of Pruszków in the following years

Year / Pond	Rotatoria			Cladocera			Copepoda		
	1	2	3	1	2	3	1	2	3
A	7	5	7	7	4	3	5	3	2
B	6	9	5	5	5	3	5	3	5
C	12	14	9	6	6	4	6	5	2
D	24	12	10	5	5	7	6	6	4

Explanation: 1 — 1978; 2 — 1979; 3 — 1980.

chionus calyciflorus amphiceros and *Brachionus calyciflorus* var. *dorcas f. spinosa*, and 4 crustacean species: *Moina rectirostris*, *Daphnia magna*, *D. pulex* and *Cyclops strenuus*.

These zooplankters are regarded as the leading forms in alphameso saprobical waters, 3 other, also saprobical species of crustacea: *Chydorus sphaericus*, *Simocephalus vetulus* and *Eucyclops serrulatus* are numerous in the investigated post-waste waters but they are thought to be the forms characteristic of less polluted waters-betameso-saprobic — Šramek-Hušek et al. (18).

But the majority of species occurring in the plankton of the investigated ponds belong to the eurytopic forms nevertheless preferring waters rich in biogenos, thus waters of eutrophic type — Pejler (15), Klimowicz (10), Kowalczyk (11), Radwan (17), Klekot and Klimowicz (6). Seasonal changes of abundance in individual zooplankton groups were typical of this kind of water reservoirs — Fereńska (2), Klimowicz (9), Grygierek (4), Kyselowa (13). In all the four ponds the abundance maxima of crustaceans were preceded by a significant increase in the number of rotifers (Figs. 2A—D). Most of the abundance maxima of rotifers, throughout the investigation period were in June and the beginning of July and the highest number was found in July 1980 in pond A (Fig. 2A). Among them, *Brachionus calyciflorus* var. *dorcas* was absolutely predominating reaching 4010 individuals/dm^3. The decisive effect on such high abundance of plankton had probably the fact of complete isolation of pond A from the post-waste waters that year. At that time, in order to keep this pond from the total degradation, post-waste waters were directed to pond B, making it in this way the first sedimentation reservoir. At the same time pond E (behind pond D) was connected with the whole system. This deprived pond A of the post-water supply which created better environmental conditions for a more intensive growth of water organisms.

In the zooplankton of the investigated pond the rotifers predominated over the remaining groups throughout the investigation period (Fig. 3).

It is interesting to note that in the successive years the rotifers reached the highest abundance in another pond. In 1978 they reached the growth peak in pond C, in 1979 in pond B, and in 1980 in pond A. One can suspect

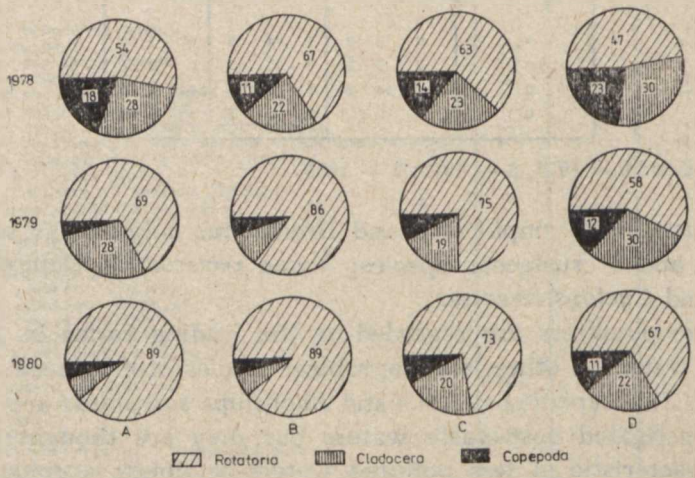


Fig. 3. Average numbers of *Rotatoria*, *Cladocera* and *Copepoda* in the ponds of Pruszków in the following years

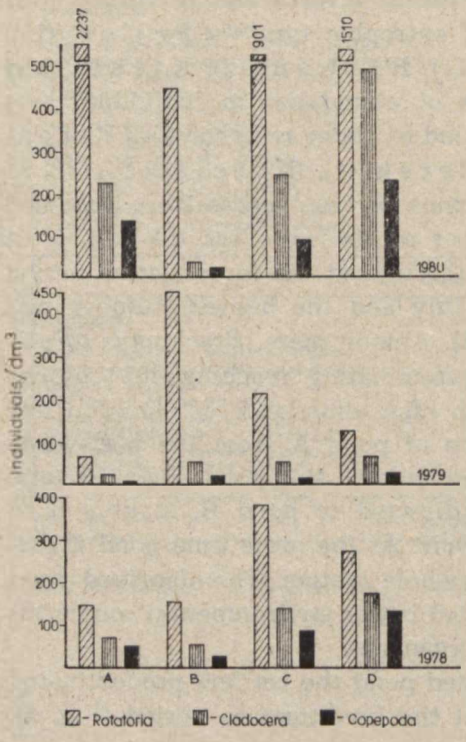


Fig. 4. Percentage share of *Rotatoria*, *Cladocera* and *Copepoda* in abundance of zooplankton in the ponds of Pruszków in the following years

that successive shifting of rotifers growth maxima in time and space was due to the progressive eutrophization in individual ponds (Fig. 4). It is known that rotifers predominate on environment in which there is a considerable amount of detritus and nannoplankton — Pejler (15), Radwan, Popiołek (16), Grygierek (4).

In the post-waste water flowing through the ponds of Pruszków, due to the process of self-clarification there came changes in the content of organic substance and biogenic elements (7) which had an effect on the differentiation of qualitative structure and abundance of individual zooplankton groups in each reservoir.

REFERENCES

1. Bojakowska I., Klekot L.: Chemical and Biological Changes in Model Ponds Supplied with Post-waste Waters. II Chemical Composition of Sediments. Ekol. Pol. 28, 479—489 (1980).
2. Fereńska M.: Zooplankton stawu rybnego „Księży" w Gołyszu. Acta Hydrobiol. 7, 59—70 (1965).
3. Grygierek E.: Formation of Fish Pond Biocenosis Exemplified by Planktonic Crustaceans. Ekol. Pol. 15, 155—181 (1967).
4. Grygierek E.: Plankton as an Ecological Indicator of the Influence of Farminy Measures on Pond Biocenosis. Pol. Ecol. Stud. 5, 77—140 (1979).
5. Hajduk Z.: Fauna *Cladocera* i *Copepoda* stawu rybnego w Szczodrem. Opol. Zesz. Przyr. 13, 69—84 (1973).
6. Klekot L., Klimowicz H.: Rotifer Communites of Ponds Supplied with Post-waste Water. Holarctic Ecology 4, 208—214 (1981).
7. Klekot L., Misztak B.: Chemical and Biological Changes in Model Ponds Supplied with Post-waste Water. Self-purification of Post-waste Water. Ecol. Pol. 28, 467—478 (1980).
8. Klekot L., Misztak B.: The Effect of Passing of Post-waste Waters Through Ponds. Pol. Arch. Hydrobiol. 28, 415—425 (1981).
9. Klimowicz H.: Occurrence of Rotifers (*Rotatoria*) in Sewage Pond. Pol. Arch. Hydrobiol. 15, 225—235 (1968).
10. Klimowicz H.: Wrotki (*Rotatoria*) wód astatycznych. Zesz. Nauk. Inst. Gosp. Kom. 30, 1—24 (1970).
11. Kowalczyk Cz.: Groups of Lakes of the Łęczna and Włodawa Lake District on the Basis of Composition and Biomass of *Cladocera* and *Copepoda*. Ann. Univ. Mariae Curie-Skłodowska, sectio C 31, 257—269 (1976).
12. Kowalczyk Cz., Klekot L.: *Scaphaleberis kingi* G. O. Sars — a Rare Representative of *Cladocera* in the Polish Fauna. Przegl. Zool. 25, 103—106 (1981).
13. Kyselowa K.: Plankton in Pond with Sugar Factory Wastes. Acta Hydrobiol. 15, 51—83 (1973).
14. Manuilowa E.: Ветвистоусые рацки фауны СССР. „Наука", Москва—Ленинград 1964.
15. Pejler B.: Regional-Zoological Studies of Swedish Fresh-Water Zooplankton. Zool. Bidr. Fran. (Uppsala) 36, 407—515 (1965).

16. Radwan S., Popiołek B.: Comparison of Biomass and Production of Some Species of Rotifers in Spring and Summer in the Pelagic Zone of Three Lakes in the Łęczna-Włodawa Region. Ann. Univ. Mariae Curie-Skłodowska, sectio C 32, 277—291 (1977).
17. Radwan S.: The Effect of Some Biotic and Abiotic Factors on the Fertility of Planktonic Rotifer Species. Hydrobiol. 73, 59—61 ,1980).
18. Šramek-Hušek R., Straskraba M., Brtek J.: Lupenonožci-Branchiopoda. [in:] Fauna CSSR, CAV, Praha 1962, 16.

STRESZCZENIE

Skład i liczebność *Rotatoria*, *Cladocera* i *Copepoda* odniesiono do stopnia czystości wody czterech stawów pruszkowskich (A, B, C, D) — ryc. 1, zasilanych wodą pościekową, odzyskaną w procesie mechaniczno-biologicznego oczyszczania. W próbach biologicznych, zebranych w latach 1978—1980, stwierdzono występowanie 30 gatunków i form *Rotatoria*, 19 gatunków *Cladocera* i 9 gatunków *Copepoda*. Stwierdzono również, iż w miarę upływu czasu we wszystkich czterech badanych stawach, w następstwie pogarszania się warunków siedliskowych, malała liczba gatunków *Rotatoria*, *Cladocera* i *Copepoda*.

РЕЗЮМЕ

Состав и численность *Rotatoria*, *Cladocera*, *Copepoda* соотносили со степенью чистоты воды четырех прудов в Прушкуве (A, B, C, D) — рис. 1, пополняемых сточной водой, очищенной при помощи механическо-биологического процесса. В биологических пробах, собранных в 1978—1980 гг., обнаружено 30 видов и форм *Rotatoria*, 19 видов *Cladocera* и 9 видов *Copepoda*. С течением времени во всех четырех прудах вследствие ухудшения условий местообитания число видов *Rotatoria*, *Cladocera* и *Copepoda* уменьшается.