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Makrofauna denna zbiornika zaporowego w Goczałkowicach w latach 1970—1975*

Bottom macrofauna of the dam reservoir at Goczałkowice in the years 1970—1975

Wpłynęło 8 grudnia 1975 r.

A b s t r a c t — The work contains a description of the bottom macrofauna in the dam reservoir at Goczałkowice in the years 1970—1975. It is a continuation of studies carried out by the author since 1961 and chiefly involves a record of the quantitative changes and qualitative composition of the leading animal groups. The investigation on biomass was introduced in 1971. In the period of investigation progress in stabilization (with the exception of 1973) was observed both with regard to average numbers and to the composition of taxons. The mean annual number of the macrofauna ranged from 1098—2245 specimens/m² and the biomass from 314167—720604 mg/m², over 90% of the latter being composed of molluscs. During the whole period of investigation the leading group were *Chironomidae* larvae. Genus *Procladius* dominated, occupying the bottom environment of the water body. *Oligochaeta*, *Ceratopogonidae*, and *Mollusca* occurred in great numbers. Variability in the formation of the communities of the bottom macrofauna resulted from natural changes in the bottom environment but also from other factors, such as great variations in the water level.

Numerous hydrobiological works concerning dam reservoirs have already been carried out. The Soviet literature is especially rich, a number of comprehensive monographs (Kijevskoje vodochr. 1972, Rybinskoje vodochr. 1972) having been published lately. Many elaborations deal with the bottom macrofauna, of which some are concerned only with certain fragments of it, while others cover all changes in this group of

* Praca została wykonana w ramach problemu węzłowego Nr 09.1.7.

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animals on the basis of many years of investigation (among others Morduchaj-Boltovskoj 1961, Ioffe 1961, Ljachov 1974).

Polish studies on dam reservoirs have also resulted in numerous publications. Some of them describe the process of formation of the bottom macrofauna (among others Grzybowska 1965, Krzyżanek 1970, 1973).

Since rich scientific documentation concerning the dam reservoirs is already available, more nad more frequently, besides the typical recording investigations, studies have been undertaken on the function of individual organisms (Izviekova 1972, Krzyżanek 1976) or on the influence of changes in the environment of dam reservoirs on the bottom macrofauna (Tajdaš 1968, Poddubnaja 1971).

The dam reservoirs are distributed in different geographical regions and serve various purposes. The differences occuring among them are also manifested in the formation of the bottom macrofauna. They are chiefly concerned with:

1. The rate of settlement of the bottom by new groups of animals.
2. The domination of the chief group of animals in particular periods of the existence of the reservoir.
3. The period of stabilization of the reservoir.
4. The succession in the domination of leading species in separate groups.
5. The period of intense development of the bottom macrofauna during the first years after filling the reservoir. However, in general the bottom macrofauna of dam reservoirs has a number of common characters:

1. A general tendency of quantitative changes, i.e. an intense development in the first years after filling the reservoir, a decrease and again an increase until the stabilization of the bottom zoocenosis characteristic for the reservoir.

2. The domination of 3 basic groups: *Chironomidae*, *Oligochaeta*, and *Mollusca*, the *Chironomidae* larvae and *Oligochaeta* appearing first, and then *Mollusca*, which play a tremendous role in some reservoirs.

3. In the first period of the existence of a reservoir the prevalence of ubiquist species among *Chironomidae*, with *Chironomus plumosus* as a very frequent dominant. As the bottom sediments are formed, the development of species characteristic for the corresponding types of sediments. The characteristic trait of the domination of predatory forms, chiefly of the genera *Procladius* and *Cryptochironomus* in the successive stages of formation of the bottom macrofauna.

The present work concerns the bottom macrofauna of the dam reservoir at Goczałkowice, whose chief purpose is retention and water supply for Silesia. It was elaborated on the basis of investigations carried out in the years 1970—1975. In this reservoir investigations have been carried out from the beginning of its existence, i.e. since 1955. As far

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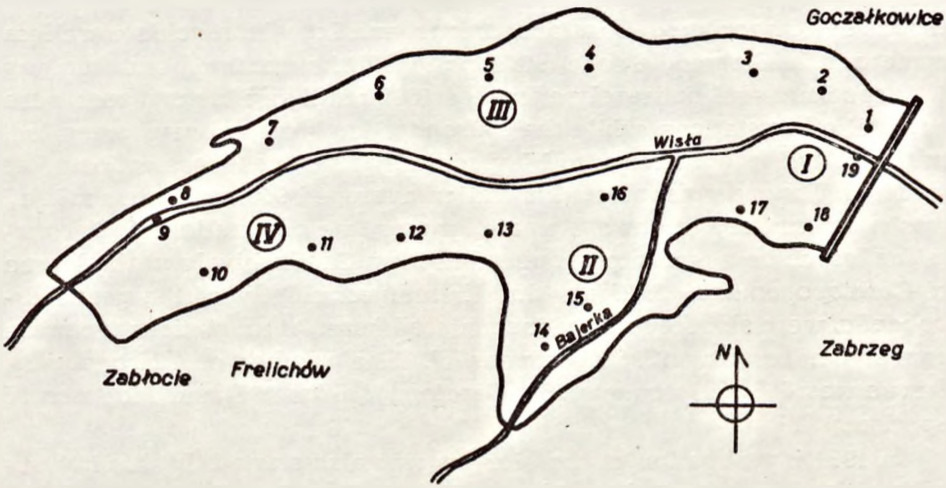
as the bottom macrofauna is concerned, data were published in the years 1955—1969 (Grzybowska 1957, Krzyżanek 1965, 1966, 1970, 1973, 1975, Kysela 1957, 1958, Zaćwilichowska 1965a, 1965b, 1965c). The investigations in 1970—1975 were a continuation of the earlier ones, the determination of biomass being supplementarily introduced. The collection of samples was carried out at 19 temporary stations (fig. 1) four times a year and at 4 permanent stations (I, II, III, IV) at monthly intervals. The stations included both littoral and middle zone.



Ryc. 1. Plan sytuacyjny stałych (I—IV) i okresowych (1—19) stanowisk poboru prób
Fig. 1. Situation scheme of permanent (I—IV) and temporary (1—19) sampling stations

The samples were collected with an Ekman dredge (225 cm²), 2—4 dredges for 1 sample. The material was washed in a net of 0,5 mm mesh and preserved in 4% formalin. The results of the investigation carried out in this reservoir from the very beginning show that in dam reservoirs the process of formation of the bottom zoocenosis depends on many factors. Among them are also the changes in water level brought about both by hydrobiological conditions and by exploitation of the reservoir and a great transport of mineral suspensions and their sedimentation in it. Therefore, great attention was paid to the correlation between the development of the bottom macrofauna and the water balance in the reservoir, taking advantage of a significant lowering of the water level in 1972.

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Characteristics of the bottom macrofauna in particular years

In 1970 the investigation included only the numbers of the bottom macrofauna, the results being similar to those obtained in 1969. The mean number for the whole year showed an increase in the share of *Chironomidae* and *Ceratopogonidae* larvae at the cost of *Oligochaeta*. The most numerous bottom macrofauna was found in the bay of the River Bajerka (fig. 1, stations 14, 15, II) where the maximum numbers amounted to 2177 specimens/m², the annual mean being 1908 specimens/m² (Table I). *Chironomidae* larvae prevailed, their annual mean amounting to 983 specimens/m². *Oligochaeta*, *Ceratopogonidae*, and *Lamellibranchia* were less numerous. In the middle zone (stations 16, 19) the maximum number was 1793 specimens/m² but rarely exceeded 1000 ; still smaller numbers were noted at other stations, while the *Chironomidae* larvae always prevailed. In the period from January to May additional samples were collected at station I. The macrofauna of this station averaged 960 specimens/m² and was composed of various systematic groups, the domination of *Chironomidae* larvae being more pronounced in May. Snails, bivalves, the larvae of *Ceratopogonidae*, *Sialidae*, and *Hirudinea*, chiefly of the genus *Erpobdella*, were also frequently encountered here. At all stations the mean annual number was 1395 specimens/m². The number of *Chironomidae* larvae was 888, *Oligochaeta* 350, *Ceratopogonidae* 108, and *Mollusca* 25 specimens/m².

In 1971 investigation of the biomass was also started. In this investigation the biomass of the molluscs included to the whole animal, including the shell which amounted to over 90% of its weight. The mean annual biomass was 455223 mg/m² and in this the biomass of *Mollusca* was 452050 mg/m². In the middle zone of the reservoir the bottom macrofauna showed the lowest values of number and biomass within the so-called soft benthos, excluding *Mollusca*. A small number of *Mollusca* gave over 90% of the biomass. The most numerous groups were pelophilous larvae of *Chironomidae*, of the genera *Procladius*, *Cryptochironomus*, and *Chironomus*. In this zone a small number of *Oligochaeta* were encountered while in some periods *Ceratopogonidae* larvae were more numerous. The mean annual number of the bottom macrofauna was 1222 specimens/m² and the biomass 429011 mg/m² (Table I). At the stations lying in the bay of the River Bajerka with the bottom covered with a thick layer of detritus, the bottom macrofauna was more numerous and the molluscs, chiefly of the genus *Unio*, contributed to an increase in biomass.

In number, the *Chironomidae* larvae prevailed, while in their differentiated composition the genus *Procladius* dominated. Larvae of the genera *Cryptochironomus*, *Chironomus*, *Glyptotendipes*, *Polypedilum*, and *Limnochironomus* were also frequently encountered. In the upper west

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zone of the reservoir the bottom macrofauna was more numerous (an annual mean of 2952 specimens/m²), the biomass amounting to 15114 mg/m². *Chironomidae* prevailed, though their numbers did not exceed 1000 specimens/m². This zone was also characterized by the presence of other groups of animals not occurring in any other zone of the reservoir, chiefly the larvae of *Trichoptera* and *Ephemeroptera*.

In 1972 the samples were collected up to July. In this month for the second time in the history of the reservoir the water level was lowered by over 1.5 m, this being connected with maintenance work on the technical installations of the dam. In consequence of reducing the water level, the bottom emerged on an area of about 6 km². A detailed investigation on the bivalves of the family *Unionidae* was carried out here. A similar investigation was carried out by diving in the filled part of the reservoir. The investigation showed that the reservoir was settled by 106 million molluscs with a biomass of 5038 tons (Krzyżanek 1976). Similarly as in 1971, the stations lying in the upper zone of the reservoir were richest in bottom macrofauna. Slightly smaller numbers were found in the north-western part, followed by the bay of the River Bajerka, and the middle zone. The mean number for the whole reservoir was 1942 specimens/m² with a biomass of 720604 mg/m². The *Chironomidae* larvae (1063 specimens/m², biomass of 3093 mg/m²) dominated. The numbers of *Gastropoda* increased, probably as a result of the not too precise positioning of sampling stations in connection with frequent changes in the water level.

In 1973 the mean numbers and biomass decreased in the whole reservoir. This was probably connected with the lower water level in 1972 and with two strong, flood level, rises. A decrease was noted in all groups of bottom organisms, especially in *Gastropoda* and *Oligochaeta*. The mean number of bottom macrofauna was 1098 specimens/m² with a biomass of 318319 mg/m², in which *Chironomidae* numbered 833, *Oligochaeta* 127, *Ceratopogonidae* 89, and *Mollusca* only 30 specimens/m² with a biomass of 316964 mg/m².

In 1974—1975, especially in 1975, an increase in the numbers and biomass of the bottom macrofauna was noted, except for the molluscs of the family *Unionidae* which were less numerous in 1975.

The investigation carried out in 1974 showed maximum numbers of bottom macrofauna in the upper zone of the reservoir. These amounted to over 5000 specimens/m² (station III) while the biomass was 7192878 mg/m². Smaller numbers of bottom macrofauna were noted in the lower north-eastern zone of the reservoir, the mean value for the whole reservoir being 1928 specimens/m² with a biomass of 557083 mg/m².

Similar values were found in 1975. The greatest numbers and biomass were noted at the stations of the upper zone of the reservoir. In some periods the numbers reached over 8000 specimens/m² with a biomass of

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over 1 million mg/m². The mean number was 2249 specimens/m² with a biomass of 314167 mg/m². The average numbers and biomass as well as the distribution of the bottom macrofauna in the whole reservoir show that in recent years stabilization has taken place in the faunistic relations in the bottom of the reservoir and changes have occurred which show its eutrophication.

Characteristics of the bottom macrofauna in the indvidual zones of the reservoir

The Goczałkowice reservoir is a lowland water body which at present, at the highest admissible level of damming (up to the ordinate of 257 m above sea level) covers an area of 3200 ha and has a volume of 162.4 million m³ (collective work 1970). At average damming 27 per cent of its area has a depth of less than 2 m, the mean of the whole reservoir being 4.1 m. Lying on the east-west axis, the reservoir is permanently under the influence of strong winds from the Moravian Gate. The maximum wind velocity of 20 m/sec raises waves of 2.5 m and in consequence the northern, windward, parts of the bank, built from dust formations, are continually damaged. Particularly strong damage to the bank was observed during the first years of existence of the reservoir (P a s t e r n a k 1964). The reservoir is overgrown by higher plants on 6 % of its area, i.e. on about 178 ha. The greatest area of vegetation is covered by communities of land plants, littoral and marshy plants, and by the vegetation of damp places lying mainly in the bay of the River Bajerka (fig. 1, stations 14. 15. II) and in the whole western zone of the reservoir (stations 6—12). Their total area is 130 ha. The remaining part is composed of submersed vegetation with the prevailing species *Potamogeton crispus* (K u f l i k o w s k i, 1977).

The 20-year period of existence of the reservoir has already given rise to the formation of auto- and allochtonic sediments characteristic for this water body. Their thickness was variable, the greatest occurring in the lower zone of the reservoir. Observations on the content of nitrogen and phosphorous in them (K a s z a, 1977) showed that no differences in nitrogen content occurred at stations I, III, and IV or in phosphorous content at stations I, II, and III. The investigations showed that in certain zones occurring in the reservoir the formation of the bottom macrofauna depended on all of the above-mentioned factors. The upper western zone of the reservoir, and particularly its north-western part (Table I, fig. 1, stations 5—9, III), had the richest bottom macrofauna in the period of the investigation. The *Chironomidae* larvae dominated with regard to numbers, followed by *Oligochaeta*. In some periods the animal groups rarely found in other zones of the reservoir, such as the larvae of *Tri-*

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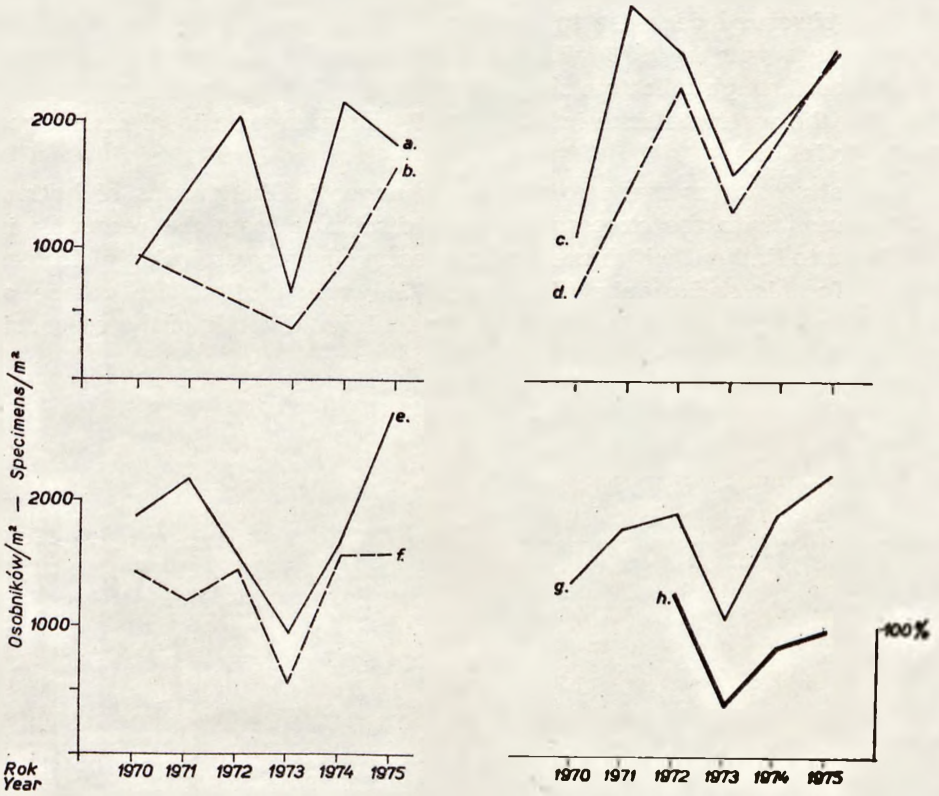
choptera, Ephemeroptera, Hirudinea, and *Coleoptera,* were fairly numerous. The south-western part (Table I, fig. 1, stations 10—13, IV) had slightly less numerous bottom macrofauna, the variation in numbers being greater. In some periods a greater share of the *Chironomidae* larvae was observed, with maximum numbers of 1929 specimens/m² in 1975. The numbers of *Ceratopogonidae* larvae and *Oligochaeta* were similar, while the numbers of *Mollusca,* especially of *Lamellibranchia,* were greater than in the preceding part.

The bottom macrofauna at the stations in the bay of the River Bajerka (Table I, fig. 1, stations 14, 15, and II) was only slightly poorer. The most numerous bottom macrofauna was found here in 1975. The numbers of



Ryc. 2. Wykres zmian liczebności makrofauny dennej w poszczególnych strefach zbiornika: a) północno-wschodnia; b) południowo-wschodnia; c) północno-zachodnia; d) południowo-zachodnia; e) zatoka rzeki Bajerki; f) centralna; g) średnie dla całego zbiornika; h) procent odprowadzenia wody ze zbiornika w stosunku do dopływów (bilans wodny)

Fig. 2. Graph showing the variations in numbers of bottom macrofauna in individual zones of the reservoir: a) north-east; b) south-east; c) north-west; d) south-west; e) the bay of the River Bajerka; f) middle; g) means for the whole reservoir; h) percentage of water discharge from the reservoir in relation to inflow (water balance)

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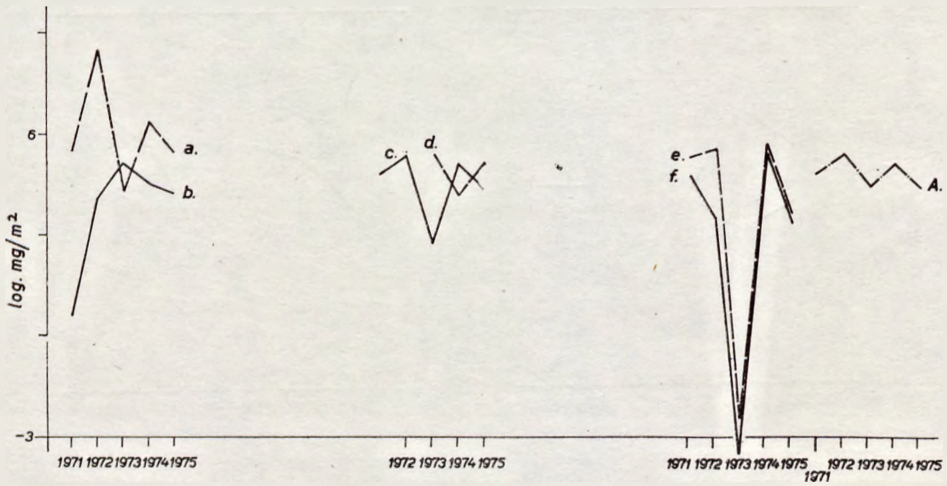
Chironomidae larvae were highest, while *Oligochaeta* and *Ceratopogonidae* were numerous in certain periods. The presence of large molluscs contributed to a great biomass in some periods. The middle zone (Table I, fig. 1, stations 16, 19, and I) had a bottom macrofauna rarely exceeding 1500 specimens/m² but the amplitude of its variation was smallest, with the exception of 1973. The larvae of *Chironomidae* and then *Oligochaeta* dominated.

The lower western zone of the reservoir, especially its south-eastern part (Table I, fig. 1, stations 17 and 18) had poor bottom macrofauna, the variation in numbers being great. Also in this zone a decrease in numbers and biomass was observed in 1973, this being particularly pronounced with *Oligochaeta* and *Mollusca*.

The observed decrease in numbers and biomass in almost all parts of the reservoir in 1973 was brought about by an excessive water discharge through a bottom sluice in 1972. Fig. 2-h presents a graph illustrating the water balance in 1972—1975 (percentage ratio of discharged water to inflow).

An attempt was made to connect changes in the groups of bottom macrofauna with the excessive water discharge from the reservoir in 1972 and to find out which zone of the reservoir was particularly affected by it. To this end graphs (figs. 2 and 3) were plotted, the course of changes in numbers and biomass in the individual zones of the reservoir



Ryc. 3. Wykres zmian biomasy (w skali logarytmicznej) w poszczególnych strefach zbiornika: a) południowo-zachodnia; b) północno-zachodnia; c) północno-wschodnia; d) południowo-wschodnia; e) zatoka rzeki Bajerki; f) centralna; A) średnie dla całego zbiornika

Fig. 3. Graph showing the variations in biomass (in the logarithmic scale) in individual zones of the reservoir: a) south-west; b) north-west; d) south-east; e) the bay of the River Bajerka; f) middle; A) means for the whole reservoir

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being presented (in the logarithmic scale); a comparative graph is also given showing the mean values for the whole reservoir. In the course of the quantitative curves a great similarity between all zones was noted, the graph for the middle zone and the bay of the River Bajerka being most approximate to the graphs of means for the whole reservoir. Only the south-western zone differed from the others. In 1973 the greatest decrease in biomass occurred in the middle zone and in the bay of the River Bajerka. This may be explained by the transport of large molluscs to the littoral zone in consequence of the refilling of the reservoir in 1973. In this period molluscs were not encountered in the middle zone (Table I). In 1973 the water balance was very unfavourable: in relation to the inflow, 130 % of water was discharged from the reservoir, moreover, two strong floods occurred. This great outflow of water rich in nutrients unfavourably influenced the bottom macrofauna, especially in the middle zone, i.e. where the sampling stations lay in the immediate neighbourhood of activity of the sluice. The problem of the effect of discharge of bottom waters on animal communities was discussed by Krzanowski (1977) in his investigations on the zooplankton. The accordance of the variation in numbers of the bottom macrofauna in particular years with the variation in the water balance results from the fact that the amount of water discharged from the reservoir influences the communities of the bottom macrofauna in the following year. In the development of the bottom macrofauna a great role is played by the amount of organic matter occurring in the surface layers of bottom sediments. A comparison of the distribution of organic matter at individual stations (Wróbel 1975) showed its positive correlation with the bottom macrofauna.

Characteristics of the individual groups of bottom macrofauna

The *Chironomidae* larvae are the dominant group in the bottom macrofauna of the Goczałkowice reservoir (fig. 4, Table II). Particularly in the last year of the investigation, their share in the benthos grew. 46 taxonomic units were identified, chiefly of the subfamilies *Chironomidae* and *Tanypodinae*. A decisive dominance of the genus *Procladius* should be stressed. In the middle zone the share of the larvae of this genus amounted to over 80% in the number of *Chironomidae*, with a maximum of 920 specimens/m². In the littoral zone, especially in the south-western part of the reservoir, its numbers reached 930 specimens/m². It appeared numerously in 1974, amounting to 66% of the population. The dynamics of changes among *Chironomidae* always depended on the changes in the numbers of this genus. The next representative of *Chironominae* was *Chironomus plumosus* in the middle zone, its average

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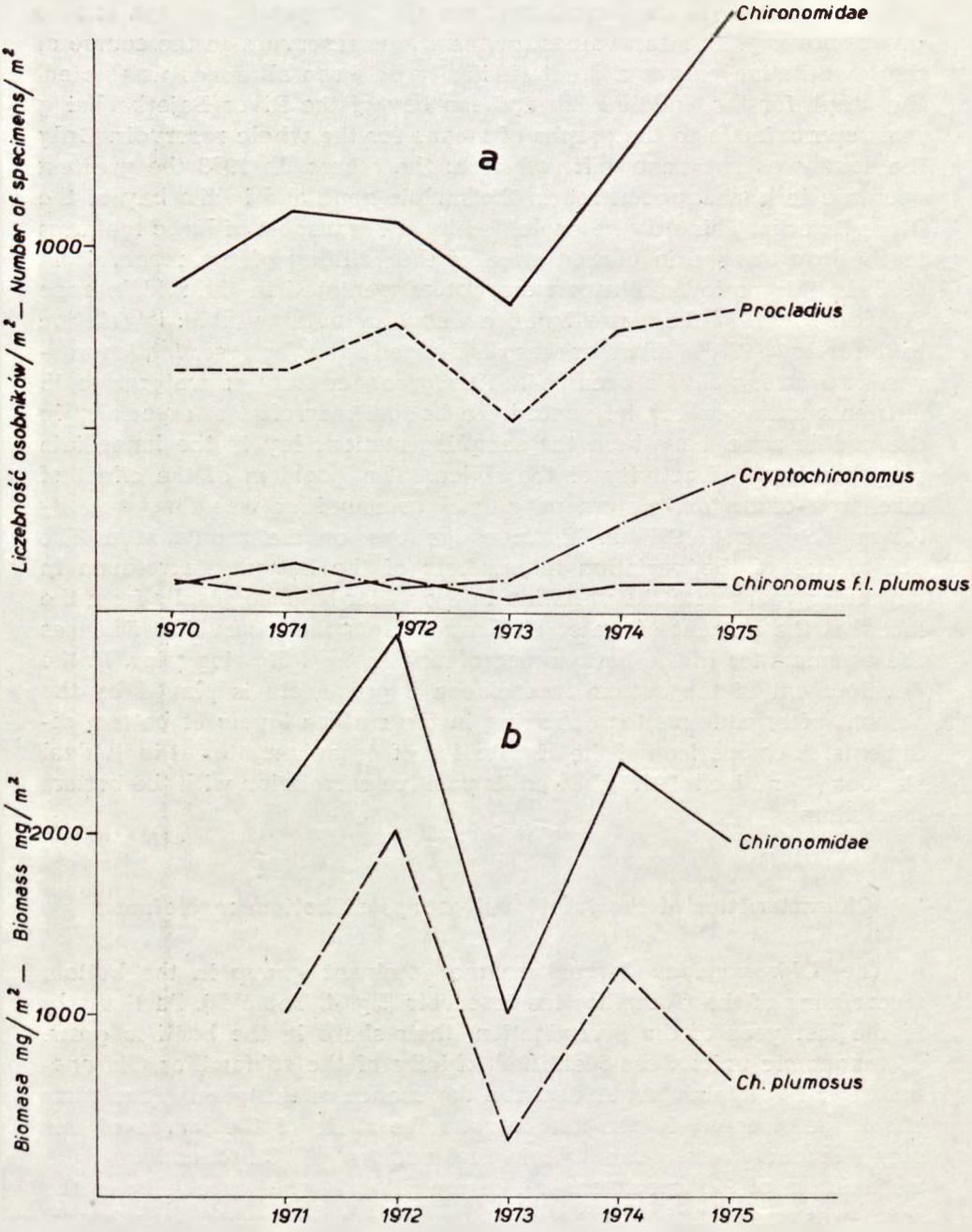

Ryc. 4. Zmiany liczebności (a) i biomasy (b) larw *Chironomidae*
Fig. 4. Changes in numbers (a) and biomass (b) of *Chironomidae* larvae

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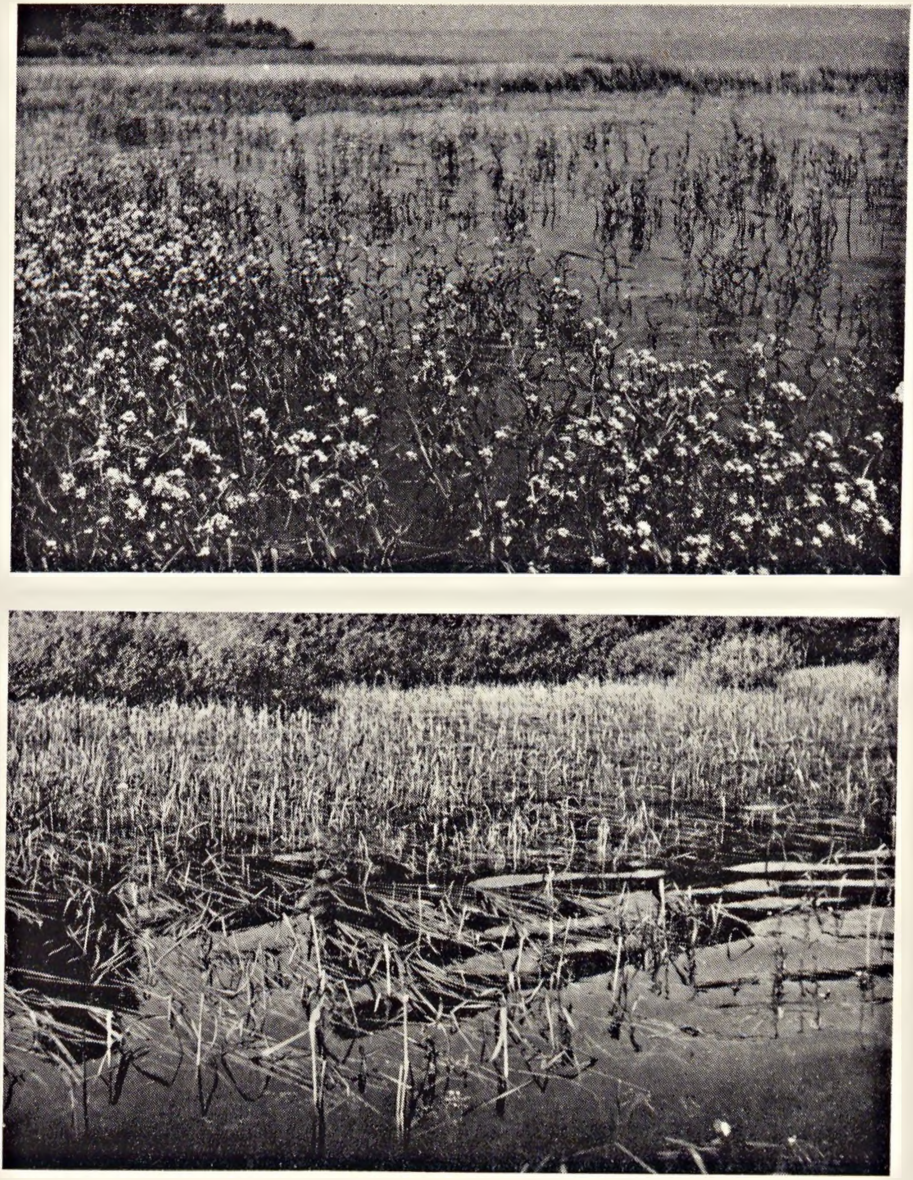

Ryc. 5. Fragmenty strefy przybrzeżnej w południowej części zbiornika
Fig. 5. Parts of the littoral zone in the southern part of the reservoir

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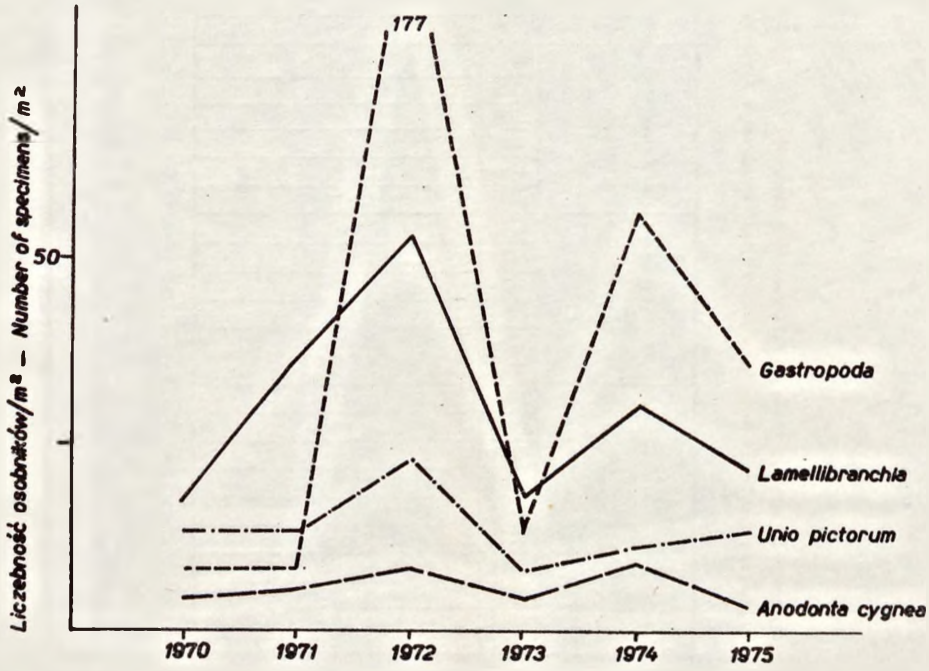
number being 5—100 specimens/m². Since among the *Chironomidae* its larvae have the greatest dimensions, it forms a great percentage of their biomass. In 1974 and 1975, especially in summer, *Harnischia conjugens* and *Cryptochironomus defectus* were frequently noted in this zone. In the littoral zone, especially at the stations lying in the south-western part of the reservoir, *Chironomus plumosus, Cryptochironomus defectus, Harnischia conjugens,* and *Tanytarsus gregarius* were fairly numerous. In some periods, especially at stations overgrown with plants (fig. 5) *Limnochironomus nervosus, Glyptotendipes gripekoveni,* and *Cricotopus algarum* were noted and at the remaining ones also *Polypedilum nubeculosum, P. scalaenum, Tanytarsus gregarius, Harnischia fuscimana,* and



Ryc. 6. Zmiany liczebności *Mollusca*
Fig. 6. Changes in numbers of *Mollusca*

Tanypus punctipennis. Other species were encountered in small numbers, though in some periods they exceeded 50 specimens/m² *(Psectrocladius psilopterus* and *Cryptochironomus vulneratus)*.

Oligochaeta were the next group with regard to number in the bottom macrofauna. The mean annual number in this group ranged from 309—422 specimens/m², only in 1973 decreasing to 127 specimens/m², this being connected with the general decrease in number and biomass of the whole benthos. They were most numerous in the middle zone of the reservoir.

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Tabela III. Skład procentowy poszczególnych gatunków Lamellibranchia w zbiorniku Goczałkowice w latach 1970 - 1975

Table III. Percentage of individual species of Lamellibranchia in the Goczałkowice Reservoir in the years 1970 - 1975

Strefa / Zone	A. Górna - Upper												B. Zatoka rzeki Bajerki / B. Bay of River Bajerka						C. Centralna / C. Middle						D. Dolna - Lower											
	a) część północno-zachodnia / a) North-Western section						b) część południowo zachodnia / b) South-Western section																		a) część północno-wschodnia / a) North-Eastern section						b) część południowo-wschodnia / b) South-Eastern section					
Rok - Year	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975
Unio pictorum L.	66	100	52	43	59	38	73		57	53	54	75	63	67	77		67	52	53	28	50				76		29	50	23	67	100			40	60	100
- tumidus Phlps.				5	3	15				32	8	13	3	5				24	7	7	24				12		3		4					20	40	
Anodonta anatina L.				2		4				15			7				16	24	7									13	13	12						
- cygnaea L.	34			28	30	31	27		29		23	12	27	24	23		17		20	40					12		19	13	32	21				40		
Pisidium amnicum Müll.			24	2		8			14		8			2					7	8	13						19		11							
- casertanum Poli			24		3															3								12	11							
- nitidium Jen.				5		4															13									2						
- subtruncatum Malm.				10	5						7			2					6	12							19		4							
Pisidium sp.				5																2							11	12							

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Tabela I. Liczebność i biomasa makrofauny dennej zbiornika Goczałkowice w latach 1970-1975 (w poszczególnych strefach)

Table I. Numbers and biomass of bottom fauna in the Goczałkowice Reservoir in the years 1970-1975 (in the particular zones)

Grupy Groups	Strefa Zone	Górna - Upper												B - Strefa zatoki rzeki Bajerki B - Bay of River Bajerka (stanowiska: 14,15,11) (stations:						A - Centralna A - Middle (stanowiska: I,16,19) (stations:						Dolna - Lower											
		a) Część północno - zachodnia a) North - Western section (stanowiska: III,5,6,7,8,9) (stations:						b) Część południowo - zachodnia b) South - Western section (stanowiska: IV,10,11,12,13) (stations:																		a) Część północno-wschodnia a) North-Eastern section (stanowiska: 1,2,3,4) (stations:						b) Część południowo-wschodnia b) South-Eastern section (stanowiska: 17,18) (stations:					
	Rok - Year	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975
MAKROFAUNA DENNA Bottom MACROFAUNA Total	Liczebność-Number oksz. indiv./m^2	1132	2952	2600	1640	2087	2594	658	1576	2398	1332	1304	2601	1908	2203	1576	960	1697	2716	1435	1222	1480	566	1574	1596	884	1382	2057	639	2108	1856	979			377	924	1638
	Biomasa Biomass mg/m^2	-	15113	226249	514990	328385	245148	-	650467	6073507	257594	1280614	649981	-	646107	770382	1562	807362	104355	-	429011	157952	796	739364	138306	-	480500	593714	76148	523418	295092	-			648183	244400	528066
CHIRONOMIDAE	Liczebność-Number oksz. indiv./m^2	715	840	1573	1268	1422	1437	380	1027	1848	992	792	1929	983	1298	1027	572	791	2091	1149	976	1253	484	941	1187	471	712	458	495	1414	1514	440			263	526	1288
	Biomasa Biomass mg/m^2	-	3780	2461	1465	1521	1726	-	1465	4235	1356	1352	2940	-	2927	2085	1055	1027	2458	-	1284	6856	663	2062	2058	-	952	862	428	3653	1319	-			513	507	1127
OLIGOCHAETA	Liczebność-Number oksz. indiv./m^2	298	563	380	167	377	686	174	322	264	249	184	385	578	425	322	90	276	131	223	123	165	69	526	263	299	484	755	83	415	241	495			54	123	189
	Biomasa Biomass mg/m^2	-	330	346	295	653	1430	-	673	484	172	340	439	-	603	673	55	717	283	-	108	244	94	708	420	-	904	1327	114	904	448	-			105	272	252
GASTEROPODA	Liczebność-Number oksz. indiv./m^2	16	13	11	23	40	58	36	21	88	11	68	81	4	12	8	6	21	14	2	4	13	-	19	-	-	84	550	8	84	14	-			-	17	28
	Biomasa Biomass mg/m^2	-	369	313	1134	1251	25098	-	672	957	338	2744	2988	-	555	96	67	1157	425	-	68	253	-	423	-	-	2800	22308	282	2800	378	-			-	35898	567
LAMELLIBRANCHIA	Liczebność-Number oksz. indiv./m^2	8	9	10	26	18	26	9	46	154	28	52	22	176	39	46	-	28	11	19	40	18	-	22	19	40	40	99	7	37	25	22			22	28	28
	Biomasa Biomass mg/m^2	-	10318	222768	511883	313094	212960	-	647511	6067655	255615	1276034	643440	-	641471	767214	-	803668	179978	-	427425	150568	-	735899	135567	-	475660	568975	75244	515690	292815	-			647511	206713	302570
CERATOPOGONIDAE	Liczebność-Number oksz. indiv./m^2	47	867	620	118	203	154	45	154	44	47	204	154	265	612	161	287	388	411	34	60	22	4	42	61	44	40	194	40	132	39	22			22	168	35
	Biomasa Biomass mg/m^2	-	232	349	104	255	172	-	128	176	81	128	235	-	535	289	363	656	664	-	56	5	8	101	143	-	67	242	49	201	67	-			32	196	63
INNE OTHERS	Liczebność-Number oksz. indiv./m^2	47	18	5	36	27	130	12	10	-	4	4	31	35	16	10	4	10	53	11	18	9	9	17	28	31	22	-	6	105	22	-			15	61	70
	Biomasa Biomass mg/m^2	-	65	11	107	71	3762	-	18	-	31	16	89	-	54	33	10	38	395	-	79	24	31	143	117	-	117	-	31	169	64	-			21	812	357

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Tabela II. Skład procentowy poszczególnych gatunków Chironomidae w zbiorniku Goczałkowice w latach 1970-1975

Table II. Percentage of individual species of Chironomidae in the Goczałkowice Reservoir in the years 1970-1975

Strefa / Zone	A - Górna - Upper												B - Zatoka rzeki Bajerki / B - Bay of River Bajerka						C - Centralna / C - Middle						D - Dolna - Lower											
	a) część północno-zachodnia / a) North - Western section						b) część południowo-zachodnia / b) South-Western section																		a) część północno-wschodnia / a) North-Eastern section						b) część południowo-wschodnia / b) South-Eastern section					
Taksony - Taxons / Rok Year	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975	1970	1971	1972	1973	1974	1975
Ablabesmyia mobilis L.												0.5	0.8																							
Procladius Skuse	49.1	75.4	78.3	68.6	66.4	48.4	54.8		77.4	42.7	47.6	41.2	54.1	52.4	77.8	62.9	72.5	53.3	75.2	74.7	73.5	83.3	76.5	60.1	58.9		55.1	69.5	55.4	41.7	75.2			43.2	70.2	52.7
Tanypus kraatzi (K.)			1.1	0.1						0.4		5.6																							
- punctipennis (Meig.)	0.7				0.3	0.3	6.5		8.3	2.2	1.0	3.5	3.4			2.3			0.3									0.4	1.1							
- vilipennis (K.)				0.3						0.4																										
Cricotopus algarum (K.)		2.6	0.2		0.2	3.9						0.4																0.2							
- sylvestris (Fabr.)		1.1	0.2		0.4	2.7						2.7				2.3		1.6		4.4															
Cricotopus sp.						0.8						0.8																								
Diamesa sp.				0.2																								0.1								
Orthocladius sp.						0.3												0.1																		
Prodiamesa olivacea (Mg.)					0.1																															
- bathyphila K.																												0.2								
Psectrocladius psilopterus K.				0.3		0.9	6.1					3.9		0.6						0.2					1.9		6.3		0.9							
Chironomus plumosus L.	19.5	8.9	4.0	2.2	2.1	4.9	9.7		2.4	4.9	4.0	8.7	7.6	5.4	2.7	1.6	2.2	5.0	10.8	5.0	20.4	8.1	6.4	8.9	3.6		2.4	1.0	9.1	2.0				25.8		3.8
Chironomus sp.							1.1												0.4								0.8							5.5		
Cryptochironomus defectus K.	11.4	3.7	2.4	3.2	6.3	6.7	5.5			2.7	26.8	13.2	8.4	4.3	2.7		4.7	13.2	2.4	3.0	1.4		0.8	5.2	8.5		0.9	8.5	7.2	10.4	4.1				9.5	18.5
- vulneratus (Zett.)	6.0	4.2	3.5	0.6								0.5			1.7		0.6	1.2	1.0	1.5								2.0	0.6		5.2				3.3
Cryptochironomus sp.				0.8						2.2										0.1										0.5						
Demicryptochironomus rupifes L.														1.0				0.4		0.6																
Einfeldia sp.				0.5							1.5												0.3													
Endochironomus dispar (Mg.)				0.4	0.4												0.6	1.5																	
- tendens (Fabr.)				0.6	0.2	3.5						1.0																0.3								
Glyptotendipes gripekoveni K.	1.3				2.2				1.2		1.0	8.3		0.7			0.4		0.6	0.3					2.8								2.2	1.1	
Harnischia conjungens K.	7.6	2.1	4.1	4.2	2.3	6.2	0.8		3.6		5.5	3.5	17.0	3.8	4.9	16.8	3.5	10.1	8.5	3.2	0.3		6.6	7.6	9.4		1.5	4.6	3.2	15.0	5.2			6.4	7.6	7.1
- fuscimana K.		1.5		0.1	2.6	5.8							0.2	0.8	2.1		1.0	0.8		2.9		0.9	4.2	2.3	3.6			1.6		8.7					2.1	4.2
- viridula (L.)				1.1	0.2	0.3				0.4				0.3															0.2	1.3				3.6	4.2	5.0
Limnochironomus nervosus (Staeg.)				2.4	1.7	3.1	0.8		4.7	19.6		4.6	1.9	1.5	1.1		1.9	1.6	0.4	0.6			2.3		2.8		5.7	0.6	1.2		5.2			3.9	3.2	
- tritomus K.				0.3	0.1	1.3										7.3	0.4	1.9										3.8	0.2					6.8		
Microtendipes chloris (Mg.				0.4	0.6	0.4							0.4	0.6						0.3		0.9							0.4							
Parachironomus pararostratus Har.																														0.7						
Paracladopelma camptolabis K.																													0.1	1.6						
Polypedilum aberrans Tsh.				0.3																																
- convictum (Walk.)					0.1	0.9					2.5												0.8						0.3							
- nubeculosum (Mg.)			1.1	7.3	5.1	2.6	4.4			22.2	3.0	1.2	1.7	1.5	2.7	5.2	2.8	1.5		1.7	0.3			11.1		5.7			10.1	2.0			1.3		
- pedestre (Mg.)					0.1																															
- scalaenum Schr.			1.1	2.4			1.5				2.0					1.6	4.7	0.9						2.1				4.4	0.1				1.3		
Polypedilum sp.				2.0	0.4	1.3				0.9												0.7						1.8	0.4	1.5						
Sergentia coracina (Zett.)																				0.2																
- longiventris K.																													0.1							
Sergentia sp.																		0.9																		
Xenochironomus xenolabis K.				0.1									0.2					0.7		0.3									0.1							
Micropsectra praecox Meig.					0.2								0.4	1.8									0.3	0.5												
Cladotanytarsus mancus (Walk.) Edw.				0.1	0.2	3.0				1.4		0.4	0.6	3.0				0.3		0.1		6.8			8.5		13.5		0.9	4.8	4.1					2.2
Tanytarsus gregarius (K.) Edw.	2.8		3.8	0.9	7.8	2.1	0.8				3.6		3.3	17.2	2.7		4.3	4.0	0.4	0.6	3.2		1.8	1.7			5.7	1.0	8.0	8.3					2.1	1.0
Tanytarsus sp.				0.1										1.8	0.5		0.4	0.6											0.1	0.4						2.2
Paratanytarsus lauterborni K.	1.6					0.6								1.8				0.4											0.1		1.0					
Poczwarki - Pupae non. det.		0.5		0.2					2.4					0.1	1.1					0.1	0.2			0.5			1.5	1.2	0.1							
Larwy - Larvae non. det.			0.2	0.3							1.5			1.5						0.2							0.9								

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Only three genera were identified, presumably with 5 species: *Tubifex tubifex, Tubifex* sp., *Limnodrilus hoffmeisteri,* and *Nais* sp.

Ceratopogonidae were the third group with regard to number, being particularly numerous in 1971 (the *genera Palpomyia* and *Stilobezzia*).

Mollusca (fig. 6, Table III) are the group having the greatest biomass in the bottom macrofauna. Their share in the samples of bottom macrofauna was fairly variable, this being connected with the method of collection, which was not always suitable for this group of animals. This is particularly true with regard to molluscs of the genera *Unio* and *Anodonta*. The number and biomass of snails were also greatly variable, the maximum numbers being noted in 1972. The most frequently encountered species belonged to the families *Valvatidae (Valvata piscinalis, V. piscinalis* f. *antiqua, V. pulchella, V. naticina), Limnaeidae (Radix limnosa, R. auricularia),* and *Planorbidae (Planorbis planorbis, Planorbarius corneus,* and *Anisus vortex).*

The greatest number and biomass of *Mollusca (Lamellibranchia)* were noted in 1972, while in other years they ranged from 17—36 specimens/ /m², with a biomass of 303487—549875 mg/m². They were represented in the reservoir by *Unio pictorum* (50% of this population) and *Anodonta cygnea* (20% of the population). *Unio tumidus* and *Anodonta anatina* were encountered more frequently than in the previous years of the investigation. Great numbers of these organisms noted in the reservoir prompted the author to carry out a more detailed investigation of *Mollusca* (Krzyżanek 1976). Throughout the whole period of investigation species of the genus *Pisidium,* chiefly *P. amnicum,* were noted (Table III).

The above-mentioned four groups of bottom organisms play a decisive role in the benthos of the reservoir. The other groups appearing in the bottom macrofauna are: *Trichoptera (Polycentropus flavomaculatus, Limnephilus* sp., *Mystacides azurea, M. nigra, Cyrnus flavidus,* and *Oecetis ochracea), Hirudinea (Helobdella stagnalis, Glossiphonia complanata, Hemiclepsis marginata,* and *Erpobdella octoculata),* and *Ephemeroptera (Caenis moesta* and *Caenis* sp.). *Coleoptera, Crustacea, Odonata, Megaloptera, Culicidae,* and *Heteroptera* occurred only sporadically and at a few stations.

Discussion of results and general conclusions

The bottom macrofauna of the Goczałkowice dam reservoir in the years 1970—1975 may be characterized as follows:

1. The values of annual mean numbers strongly increased as compared with the period 1964—1969, though they were lower than those noted in the first nine years of existence of the reservoir. No important changes

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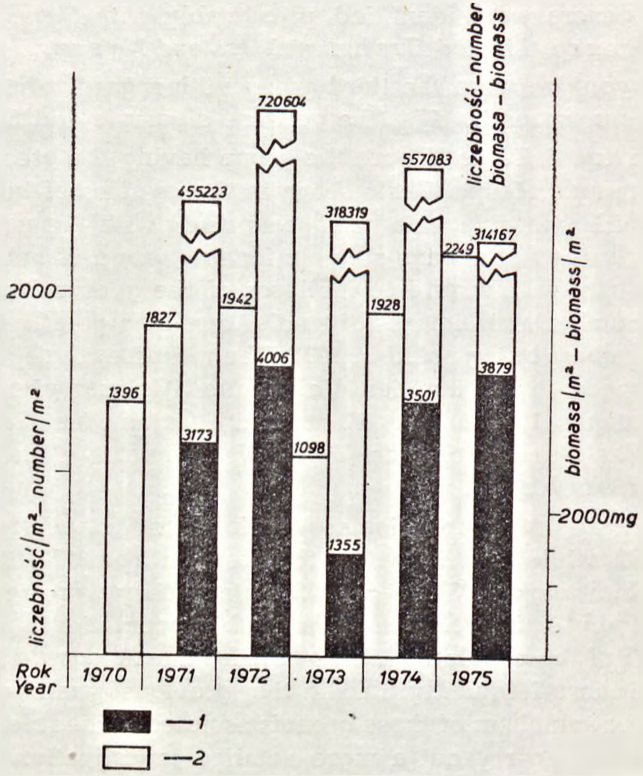

Ryc. 7. Zmiany liczebności i biomasy makrofauny dennej w latach 1970—1975. 1 — bez mięczaków; 2 — z mięczakami

Fig. 7. Changes in numbers and biomass of the bottom macrofauna in the years 1970—1975. 1 — excluding *Mollusca*; 2 — including *Mollusca*

were observed, with the exception of the year 1973, either in the reservoir as a whole or in the individual zones.

2. The biomass, whose investigation began in 1971, attained its maximum value in 1972 and was above all composed of large molluscs of the family *Unionidae*. In other years the mean values of the biomass were rather similar, with a decrease noted in 1973 and 1975. Excluding the molluscs, the biomass varied from 1000—4000 mg/m² (fig. 7).

3. In all periods the *Chironomidae* larvae were the leading group. The genera *Procladius* and *Cryptochironomus* prevailed and wholly dominated the bottom environment. Besides, in the middle zone, permanent constituents were the larvae of *Chironomus plumosus* and *Polypedilum nubeculosum*, and in the littoral zone *Harnischia conjugens*, *Tanytarsus gregarius*, *Limnochironomus nervosus*, and *Glyptotendipes gripekoveni* (Table II). In the genus *Cryptochironomus*, *C. defectus* dominated, other species, chielfy *C. vulneratus*, being also frequently noted.

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4. *Oligochaeta* were the second group with regard to number and were represented by the family *Tubificidae*.

5. *Lamellibranchia* were chiefly represented by *Unio pictorum* and *Anodonta cygnaea*. In the period of investigation the numbers of the genus *Unio* increased while the genus *Anodonta* had previously been more numerous. In this group of bottom organisms a characteristic succession in the dominance of the individual genera was observed, from the *Pisidium* in the first years of existence of the reservoir, through *Anodonta* in the years 1960—1965 to *Unio* in 1966—1975. The graph in fig. 6 shows changes in the numbers of *Gastropoda* and *Lamellibranchia* and *Unio pictorum* and *Anodonta cygnaea*. It may be seen that the fall in the water level and the floods in 1972 unfavourably influenced the two groups, particularly the *Gastropoda*, among which species of the family *Valvatidae* were most frequently encountered in the reservoir.

6. Changes in the water level brought about by greater discharges of water through the bottom sluice unfavourably influenced the bottom macrofauna. This may be seen particularly at the stations lying in the middle zone in the immediate neighourhood of the sluice.

In the years 1970—1975 certain changes appeared, suggesting the eutrophication of the reservoir. This is manifested in the mean number of macrofauna of the whole reservoir and in those from separate stations. The eutrophic character of the reservoir is also suggested by the qualitative composition of the *Chironomidae* larvae where, besides predatory forms of the genera *Procladius* and *Cryptochironomus*, the form *Chironomus plumosus* dominates. It is also consistent with the results of the investigation on plankton organisms and of chemical analyses of the basic nutritive components.

In spite of a certain stabilization attained by the bottom macrofauna, certain variations may be observed which depend on numerous factors, among others on the water balance, bottom sediments, and, especially, on the amounts of organic matter. Hence, special attention should be paid to these factors.

STRESZCZENIE

W latach 1970—1975 przeprowadzono badania makrofauny dennej w zbiorniku zaporowym w Goczałkowicach, które były kontynuacją badań prowadzonych w tym zbiorniku od początku jego istnienia, a od 1961 przez autora. Od 1971 r. oprócz liczebności oznaczano również biomasę całości bentosu oraz poszczególnych jego składników. Badania prowadzono na 19 stanowiskach cztery razy w roku oraz na stałych czterech stanowiskach (I, II, III, IV) raz w miesiącu metodą ilościową. Średnie wyniki liczbowe obejmujące liczebność oraz biomasę przedstawiono w tabeli nr I. Biomasę małży ważono łącznie z muszlą, która stanowi ponad 90% ich ciężaru. W 1972 r., w związku z pracami konserwacyjnymi urządzeń technicznych zapory, obniżono poziom zbiornika o ponad 1,5 m. Na odsłoniętym obszarze przeprowadzono szczegółowe badania małży. Po-

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dobne badania z zastosowaniem nurkowania przeprowadzono na zalanej części zbiornika. Badania wykazały, że cały zbiornik zasiedlony jest przez 106 mln małży o biomasie 5038 t, co w przeliczeniu na 1 m² daje 4 okazy o biomasie 200 g. Szczegółowe wyniki tych badań ujęto w osobnej pracy (K r z y ż a n e k, maszynopis).

Makrofauna denna zbiornika charakteryzuje się stabilizacją zarówno w odniesieniu do danych ilościowych (głównie liczebności) jak i składu gatunkowego przewodnich grup zwierzęcych. Średnia liczebność makrofauny dennej wahała się w latach 1970—1975 od 1098 do 2248 okazów/m². Przeważały *Chironomidae*, a w ich obrębie *Procladius* i *Cryptochironomus* (tabela I i II, ryc. 4). Wzrosła liczebność dużych małży z rodziny *Unionidae*, głównie *Unio pictorum*, które odgrywają olbrzymią rolę w biomasie bentosu. Obok tych dwóch grup zwierzęcych dużą rolę posiadają *Oligochaeta* i *Ceratopogonidae*. W 1973 r. stwierdzono znaczny spadek liczebności i biomasy mikrofauny dennej, zwłaszcza na stanowiskach strefy centralnej oraz zatoki rzeki Bajerki, który wywołany został jako konsekwencja dużych zrzutów wody w 1972 r. (ryc. 6—7).

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