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Zooplankton podgrzanych wód zbiornika zaporowego w Rybniku w latach 1975—1976*

Zooplankton of heated water of the Rybnik dam reservoir in 1975—1976

Wpłynęło 21 grudnia 1978 r.

Abstract — The qualitative composition of zooplankton and the dynamics of its settlement and biomass were investigated in the Rybnik dam reservoir in the years 1975—1976. The noxious effect of the cooling system on animals flowing through it and the influence of warm water discharge on their vertical distribution were observed.

In power plant cooling reservoirs, the degree of water heating, apart from the geographical position of the given water body, its limnological index, and method of water exchange, markedly affects the qualitative composition, numbers, domination relations, and the trophic level of zooplankton. The discharge of heated water from a power plant to the cooling reservoir causes the inflow of considerable amounts of additional heat energy, ranging from tens to hundreds of millions of kilogram-calories per year, which increase the water temperature by 8—10°C.

The increase in water temperature brings about an increased biological production, a shortening of life cycles, and above all a lengthening of the vegetation period, this leading to a greater number of generations. Under certain environmental condition zooplankton organisms, being heterothermal, reveal great adaptation ability. However, many authors (e. g., Krylova 1969, Žitenova, Nikanorova 1972), regard 25 centigrades as the threshold temperature for the maintenance of zooplankton community equilibrium.

* Praca wykonana w problemie węzłowym nr 10. 2.

Stations and method

The investigation was carried out from February 1975 to October 1976 at 4-month intervals. There were five stations until August 1976 and 4 after this date.

Station 1 in the upper part of the impoundment near the mouth of the River Ruda, at a depth of 3—4 m, was characterized by considerably cooler water layers close to the bottom, especially in early spring, late autumn and in winter (2.2—9.2°C) as compared with surface layers. At this station the transparency ranged from 0.85—2.10, except for August 1975, when flood waters decreased it to 0.35. Since this station represented an inconsiderable part of the impoundment and was in a great measure affected by the polluted River Ruda, the collection of samples was discontinued in April 1976.

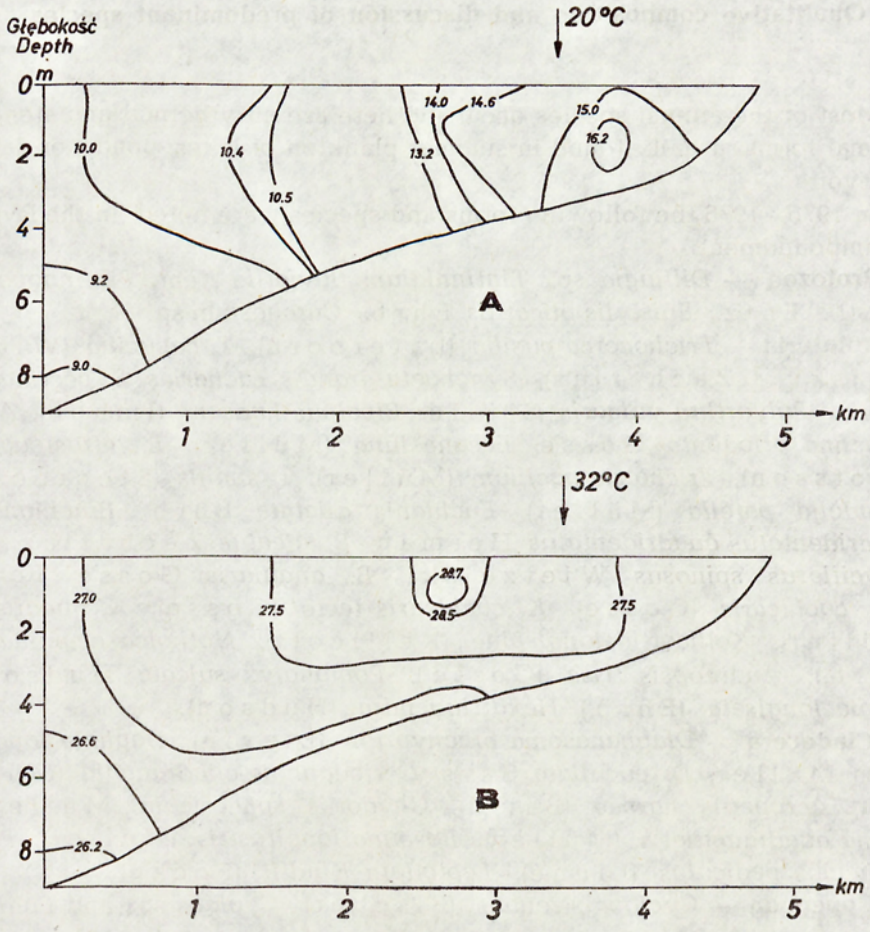
Station II was found in the current of heated waters discharged at a distance of about 50 m from the power plant. This unusual position greatly differentiated it from the other stations. It was characterized by a relatively rapid water current and little depth (not more than 2.5 m) as well as by the highest temperatures, equal in the whole water column and amounting to 17°C in December 1976, up to 32°C on July 18th, 1975.

From May 1976 samples were also collected at station IIa, at the point where heated discharge waters mixed with the impoundment water. The station 3—4 m deep, was characterized by fairly high water temperatures, but a certain vertical stratification was observed (the differences between the surface and bottom water temperatures amounting to 5—6° on the average). Stations III and IV (fig. 5) situated in the central part of the reservoir had mean depths of 4 and 6 m respectively. The greater was their distance from the power plant water discharge, the lower was the water temperature and the greater was the transparency at a given moment.

At station 5, situated in the deepest part of the reservoir (8—9 m) by the dam, the effect of heated water was least visible. This station was characterized by the lowest water temperature in the impoundment, e. g., on January 27th, 1976, when at the station near the heated water discharge a temperature of 19°C was noted, a mean of 5.2°C was recorded at station 5. Also in summer, the waters at this station were by a few (6—9) centigrades cooler than at other stations (fig. 1).

Quantitative samples were taken at every station in the vertical section at the following depths: 0, 1.0, 2.5, 5.0, and 8.0 m.

In biomass calculations of rotifers fresh weight given by Kosova (1961) for the respective species was used while the fresh weight of plankton crustaceans was calculated according to Pečen's (1965) and Ščerbakov's (1952) formulae which took into consideration the



Ryc. 1. Rozkład temperatury w wodzie w zbiorniku Rybnik w okresie zimowym (A — 25.II.1975) i letnim (B — 12.VII.1975). ↓ — miejsce zrzutu podgrzanych wód z elektrowni

Fig. 1. Distribution of temperatures in the Rybnik reservoir waters in winter (A — 25th February, 1975) and summer (B — 12th July, 1975). ↓ — the point of heated waters discharge from the power plant

weight dependencies on body length, as well as to tables given by Starmach (1955) and Kiselev (1956). In the calculation of zooplankton biomass in the investigated impoundment the *Protozoa* biomass was not included since their insignificant numbers and body weight (10^{-5} mg magnitude order) had almost no bearing on the results obtained in the present work. Both the biomass and the population density were calculated for the individual samples and the mean values for each station during the individual sampling dates were used in the analysis of results.

Qualitative composition and discussion of predominant species

Most of the animal species occurring here are eurythermal and stenothermal forms, usually found in summer plankton of lakes, ponds, or dam reservoirs.

In 1975—1976 the following forms and species were noted in the Rybnik impoundment:

Protozoa — *Difflugia* sp., *Tintinnidium fluviatile Kent, Tintinnopsis lacustris* Entz., *Epistylis plicatilis* Ehrb., *Carchesium* sp.

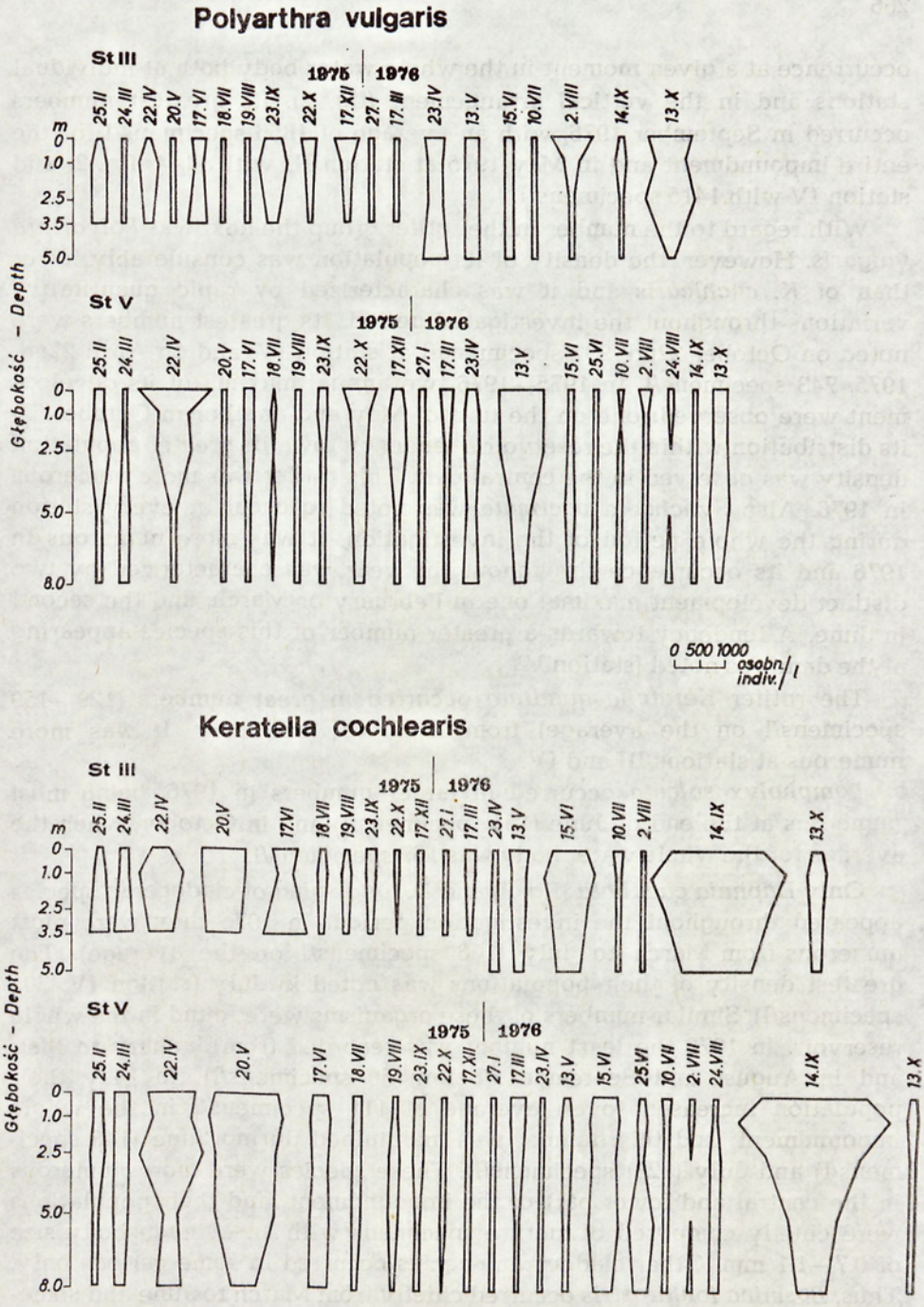
Rotatoria — *Trichocerca pusilla* (Laterborn), *T. capucina* (Wierzejski et Zacharias), *Synchaeta grandis Zacharias, S. pectinata* Ehrb., *Polyarthra vulgaris* Carlin, *Bipalpus hudsoni* (Imhof.), *Asplanchna priodonta* Gosse, *Lecane luna* (Müller), *L. intrasinuata* (Olofsson), *Trichotria pocillum* (Müller), *T. similis* (Stenroos), *Lepadella patella* (Müller), *Euchlanis dilatata* Ehrb., *Brachionus quadridentatus quadridentatus* Herman, *B. falcatus* Zacharias, *B. calyciflorus spinosus* Wierzejski, *B. angularis* Gosse, *Keratella cochlearis* (Gosse), *K. cochlearis tecta* (Gosse), *K. quadrata* (Müller), *Kellicottia longispina* (Kellicott), *Notholca acuminata* (Ehrb.), *Anureopsis fissa* (Gosse), *Pompholyx sulcata* Hudson, *Filinia longiseta* (Ehrb.) *Hexarthra mira* (Hudson).

Cladocera — *Diaphanasoma brachyurum* (Lievin), *Daphnia longispina* Müller, *D. cucullata* Sars, *Ceriodaphnia quadrangula* (Müller), *Acroperus harpae* (Baird), *Chydorus sphaericum* (Müller), *Alona quadrangularis* (Müller), *Bosmina longirostris* (Müller), *Polyphemus pediculus* (Linné), *Leptodora Kindtii* (Focke).

Copepoda — *Cyclopa strenuus* (Fischer), *Cyclops* sp., and *Eudiaptomus gracilis* Sars.

At the respective stations no great differences were found in the qualitative composition. A few sporadically occurring species were not noted at stations I and II. Among them were: the rotifers *Brachionus calyciflorus* spinosus and *Trichotria pocillum,* and a predatory cladoceran *Leptodora Kindtii.* A cladoceran *Acroperus harpae* occurred at station I in May 1975. Most of the species were noted in small numbers and through limited periods of occurrence, e. g., some warm stenothermal rotifers such as the stenothermal *Anureopsis fissa,* a pelagial predator *Bipalpus hudsoni* or *Pompholyx sulcata* and *Trichocerca similis* were noted in summer. *Hexarthra mira* occurred only in September. Of cladocerans the pronounced occurrence of a litoral form *Chydorus sphaericus* in the pelagial zone of the reservoir should be mentioned since this might indicate its great abundance in the litoral part of the reservoir.

In the period of the investigation the predominant rotifer species was the eurythermal *Keratella cochlearis.* It was characterized by a uniform



Ryc. 2. Pionowe rozmieszczenie dominujących gatunków *Rotatoria* w badanym okresie na stanowisku (st.) III i V

Fig. 2. Vertical distribution of predominating *Rotatoria* species in the period of the investigation stations (st.) III and V

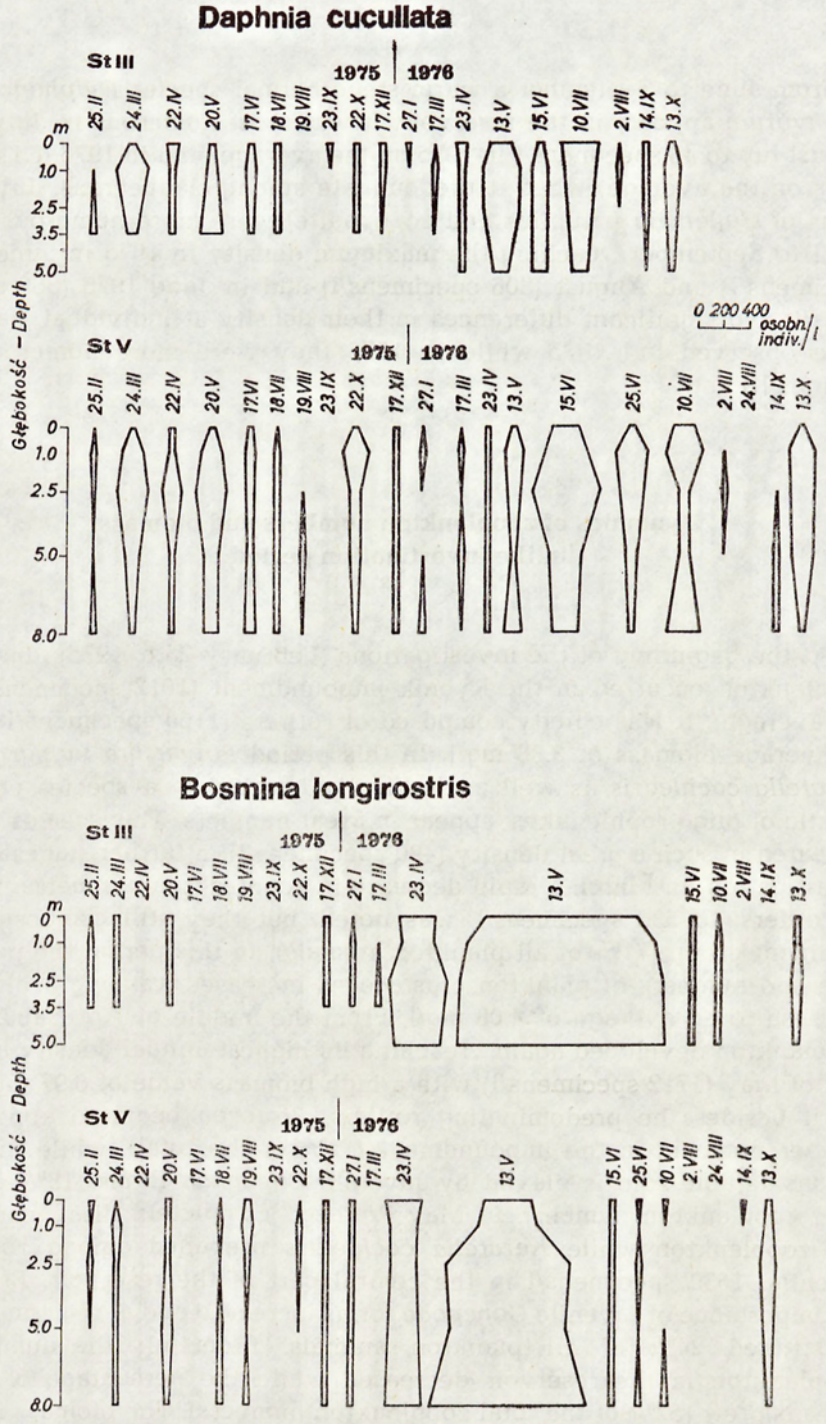
occurrence at a given moment in the whole water body both at individual stations and in the vertical arrangement (fig. 2). Its greatest numbers occurred in September 1976, with an average of 1856 specimens/l for the entire impoundment and in May 1975 at station III with 1144 (fig. 2) and station IV with 1415 specimens/l.

With regard to the number in the rotifer group the next was *Polyarthra vulgaris*. However, the density of its population was considerably lower than of *K. cochlearis* and it was characterized by rapid quantitative variations throughout the investigated period. Its greatest numbers were noted on October 22nd, 992 specimens/l at station IV, and on April 22nd, 1975, 743 specimens/l. In 1975—1976 two annual maxima of its development were observed: one on the turn of May and another in October. In its distribution within the reservoir a tendency towards greater population density was observed in the central part. This rotifer was more numerous in 1976. Also *Synchaeta pectinata* was noted to occur at every station during the whole period of the investigation. It was more numerous in 1976 and its occurrence throughout the year was characterized by two distinct development maxima: one in February or March, and the second in June. A tendency towards a greater number of this species appearing at the dam was noted (station V).

The rotifer *Keratella quadrata* occurred in great numbers (129—159 specimens/l on the average) from April to June only. It was more numerous at stations III and IV.

Pompholyx sulcata occurred in larger numbers in 1976, being most numerous at the end of June (154 specimens/l) and in October, when the average for the whole water body was 167 specimens/l.

Only *Daphnia cucullata* (fig. 3) and *D. longispina* of cladoceran species appeared throughout the investigation period. In 1975 they were most numerous from March to July (106 specimens/l on the average). The greatest density of their populations was noted in July (station IV, 205 specimens/l). Similar numbers of these organisms were found in the whole reservoir. In 1976 the least number was recorded from January to May and in August and September (below 50 specimens/l). In May their population increased to an average of 111 specimens/l in the whole impoundment, and this number was maintained during June (146 specimens/l) and July (128) specimens/l). These species were more numerous in the central and lower part of the impoundment, and their populations were chiefly composed of mature specimens with an average body size of 0.7—1.1 mm. Other cladoceran species occurred in some periods only. Thus, *Bosmina longirostris* occurred chiefly from March to June and sometimes during the winter season (fig. 3). As a consequence of its appearance in the central part of the impoundment (1440 specimens/l) in May 1976 the highest zooplankton biomass of 22.497 mg/l as noted throughout the whole period of the investigation, was recorded.



Ryc. 3. Pionowe rozmieszczenie dominujących gatunków *Cladocera* w badanym okresie na stanowisku (st.) III i V

Fig. 3. Vertical distribution of predominating *Cladocera* species in the period of the investigation stations (st.) III and V

From June to September a warm stenothermal species *Diaphanosoma brachyurum* appears in the reservoir. It was most numerous in July and August (up to 46 specimens/l in 1975 on the average) and in 1976 (65 specimens on the average) when it predominate among cladocerans. Juvenile forms of *Copepoda* (nauplius and copepodite) were more numerous from April to September, reaching the maximum density in 1975 in June (319 specimens/l) and August (306 specimens/l) and in June 1976 (366 specimens/l). No significant differences in their density at individual stations were observed in 1975 while in 1976 they were more numerous at stations III and V.

Dynamics of zooplankton numbers and biomass in the investigation period

At the beginning of the investigations (February 25th, 1975) abundant zooplankton occurred in the Rybnik impoundment (1612 specimens/l on the average). It was chiefly composed of rotifers (1160 specimens/l) with an average biomass of 3.88 mg/l. In this period *Polyarthra vulgaris* and *Keratella cochlearis* as well as *Kellicotia longispina*, a species characteristic of oligotrophic lakes, appear in great numbers. This species never appeared in such a great density (490 specimens/l) in further stages of the investigation. In March a rapid decrease in zooplankton numbers, chiefly of rotifers, to 532 specimens/l, was noted, but they still composed the dominant group (71% of all plankton animals). In this period the percentage and numbers of plankton crustaceans increased, causing a biomass increase to an average of 4.08 mg/l. From the middle of April abundant zooplankton developed again, reaching its highest annual density by the end of May (1712 specimens/l) with a high biomass value of 6.97 mg/l. In April besides the predominating rotifers, *Protozoa* begin to appear in greater numbers in the impoundment (12% of the total), while in May a considerable role is played by juvenile *Copepoda* forms (18% of the total zooplankton number). In May *Protozoa* completely disappeared in the zooplankton while *Keratella cochlearis* prevailed among rotifers, reaching 1630 specimens/l in the central part of the reservoir. In June the importance of juvenile *Copepoda* forms increased and at this time they constituted 24% of all plankton animals. From July the number of zooplankton in the reservoir decreased while the percentage of crustaceans grew (52% of the total zooplankton numbers). The biomass is still great: 6.57 mg/l due to the numerous occurrences of *Copepoda* juvenile forms and of a summer cladoceran form *Diaphanosoma brachyurum*. A similar character of zooplankton is observed in August. It is the period

of the most numerous occurrence of *Copepoda* juvenile forms, up to 450 specimens/l. In September *Rotatoria* prevail again (76% of the total) and with the settlement being low, the zooplankton biomass decreased by half. In this period larger numbers of zooplankton, and especially of *Rotatoria* were noted in the central part of the impoundment (stations III and IV). In October, chiefly in the surface layers of station IV, a mass development of the prevailing rotifer *Polyarthra vulgaris* was observed (2940 specimens/l). In December the number of plankton animals decrease, their distribution being fairly uniform in the whole water body. In January 1976 at the lowest water temperatures in the reservoir (from 5°C at station V to 19°C at the water discharge from the power plant) the minimum zooplankton development in the period of the investigation was found. It was a *Protozoa* and *Rotatoria* plankton very uniformly distributed in the whole impoundment. In this period the lowest biomass of only 0.54 mg/l was recorded. From March abundant zooplankton occurred in the reservoir. It was chiefly of rotifer character, the prevailing species being *Synchaeta pectinata* and *Polyarthra vulgaris*. *Protozoa* with *Tintinnopsis lacustris* were still numerous. In the part of the reservoir near the dam *Cyclops strenuus* appeared in greater numbers. In April a mass development of a cladoceran *Bosmina longirostris*, up to 420 specimens/l was observed in the reservoir. In May it reached its maximum number (1590 specimens/l) a station III (fig. 3). In this period the highest biomass values of 16.44 mg/l on the average were observed in the impoundment. In June abundant zooplankton was still noted, but it was already of rotifer character and its biomass was decreased by half as compared with May (fig. 6). *Bosmina longirostris* which predominated in the impoundment in May, was only sporadically encountered and among cladocerans *Daphnia cucullata* was noted in great numbers. In June, at the growing water temperatures in the reservoir a gradual quantitative decrease in plankton began. In July zooplankton had a crustacean character owing to the numerous occurrences of *Copepoda* juvenile forms of 660 specimens/l. During this period a warm stenothermal *Diaphanosoma brachyurum* reappeared. A further decrease in the zooplankton was noted in August with a growing share of *Copepoda*. The zooplankton still maintained its crustacean character while *Eudiaptomus gracilis* chiefly contributed to the high biomass value. In September a rapid increase in the number of plankton animals, chiefly of rotifers was noted in the Rybnik impoundment. The prevailing species was a rotifer *Keratella cochlearis*, reaching 3060 specimens/l (fig. 2) at station V at a depth of 1 m. This was the period of the most numerous occurrences of plankton animals so far observed in this reservoir.

In October the numbers of plankton animals rapidly decreased. *Keratella cochlearis* which decisively prevailed in September, receded while *Polyarthra vulgaris* and species of the genus *Synchaeta* appeared. In this

period a more pronounced development of zooplankton was observed in the central part of the impoundment (station III) where its number was more than twice as big as that of the animals found at the remaining stations.

Zooplankton at station II

A separate and detailed discussion of zooplankton occurring at station II seems necessary. Owing to its being situated in the current of heated waters discharged from the power plant, this station was characterized with considerable yields and markedly higher temperatures in the different seasons of the year as compared with the other stations. All these factors have an unfavourable effect on the development of zooplankton.

Waters of the reservoir flowing through the cooling system of the power plant are in a short time (probably several minutes) heated by a few (5—9) centigrades in summer and by several centigrades in winter. Plankton animals have a great ability to adapt (Tarzwell 1970) to certain environmental conditions and changes. However, violent fluctuations in temperature cause a „thermal shock" which usually ends with death of the animals. The thermal shock is more hazardous for aquatic animals than the constant influence of increased temperatures (Praszkiewicz 1974). These animals fall out of the food chain, this directly causing qualitative and quantitative changes in the biocenosis. Constant increase in temperature can also lead to earlier hatch of a given group of animals in relation to the development period of its food. Sometimes the hatch is premature in a physiological sense, i. e. it occurs before the ability of gaining food is developed.

Observations of plankton animals carried out in discharge waters from power plants showed their unfavourable influence on these organisms. Damage to external organs was observed in a large per cent of plankton animals, especially in organism with large body size (*Cladocera* and *Copepoda*). The damages were chiefly found in the locomotive organs such as antennae and caudal furca though the internal organs were also changed. E. g., the decomposition of stomachs and the destruction of eye pigment in the cladocerans *Daphnia cucullata* and *D. longispina* as well as in *Diaphanosoma brachyurum* were observed. The degree of injury was considerably higher in summer, i. e. when water was heated to the highest temperatures of 30—32°C. Rivier (1971) claims that in the Ivankovski impoundment 35% of plankton animals died at 26°C while at 32—33°C 54% and in some species even 86% were killed. Churchill

and Wojtalik (1969) report that in the Grin-River 90% of zooplankton was killed when the water was heated to 27.5—36.3°C. Thus, great losses occur in zooplankton on passing the plant power cooling system. Rivier (1974, 1975) quotes that in the Ivankovski reservoir 12 ton of crustacean plankton is daily lost in 7.000 thousand cubic metres of water on passing the cooling system at 32.5°C. Upon analysing the material collected both from the canal feeding water to the power plant and from the discharge canal, it was found that in the Rybnik reservoir 23.5% of all plankton animals are lost in the water on passing the cooling installation. This percentage is markedly higher (30—35%) for plankton crustaceans and large forms of rotifers, such as *Asplanchna priodonta*. This percentage also grows when the temperature increases are noted (by 13.4° on December 17th, 1975), or when the water is heated to the highest temperatures (30—32°C). Thus in zooplankton biomass, especially in crustaceans, great losses (26.1% on the average) reaching 3.137 to daily are observed.

The discharge of heated waters to the impoundment also greatly affects the vertical distribution of zooplankton influencing the movement of animals in the water. In the Rybnik reservoir at the point where the heated discharge water and the water of the reservoir mixed (station IIa) larger numbers of zooplankton, especially of crustaceans, were observed gathering in the bottom water layers which at the given moment were coller than the surface waters. E. g., on June 15th, 1976 surface waters of 28.1°C were settled by 1250 specimens/l with a biomass of 2.36 mg/l, while in the water layers close to the bottom at the temperature of 22.3°C, 2110 specimens/l with a five times higher biomass value of 10.91 mg/l (fig. 6) were found at this station. In these layers the dominance of both groups and individual species is also different. In surface waters *Rotatoria* prevail while in the layers near the bottom the settlement of plankton crustaceans considerably increases and these animals constitute the predominant group. On August 2nd, 1976 the surface layers of this station were settled by 960 specimens/l (in this number 380 specimens of rotifers, i.e., 55%) while in the water layers close to the bottom 720 specimens/l were found (in this number 490 specimens of plankton crustaceans) with 31% of rotifers only. It was distinctly reflected in the biomass of these animals, amounting to 3 mg/l in the surface layers and to 17.25 mg/l in those at the bottom (fig. 6).

Increased numbers of plankton crustaceans in the water layers close to the bottom are chiefly caused by their active movement to cooler water layers, this among other things resulting in reduced numbers of rotifers more intensely consumed by the growing number of crustaceans. A similar reaction of plankton animals to heated waters in impoundments has been reported by Elagina (1975), Gorobij (1974), and Morduchaj-Boltovskoj (1975).

Discussion of results

The investigation on the zooplankton in the Rybnik dam reservoir with heated water, carried out in 1975 and 1976, i.e. in the fourth and fifth year after its construction, resulted in the determination of the qualitative composition, dynamics of settlement and biomas within the water body throughout the whole investigation period. 43 forms and species of plankton animals with 5 *Protozoa*, 26 *Rotatoria*, 10 *Cladocera*, and 2 *Copepoda* species were found to occur there. During the period of the investigation a tendency to reduced qualitative composition was observed (32 species in 1976 against 40 species in 1975). In 1976 8 *Rotatoria* species and 2 *Cladocera* species disappeared while a new rotifer *Brachionus falcatus* and a cladoceran *Polyphemus pediculus appeared*. No other significant differences in the qualitative composition at individual stations were observed. The zooplankton of this reservoir is qualitatively similar to that quoted from dam reservoirs and cooling lakes of Ukraine power plants. E. g., in the Zujev impoundment 35 species, in the Kurachov impoundment 38, and in Lake Liman 34 species of plankton animals occurred (P o l i v a n n a j a, S e r g e e v a 1971).

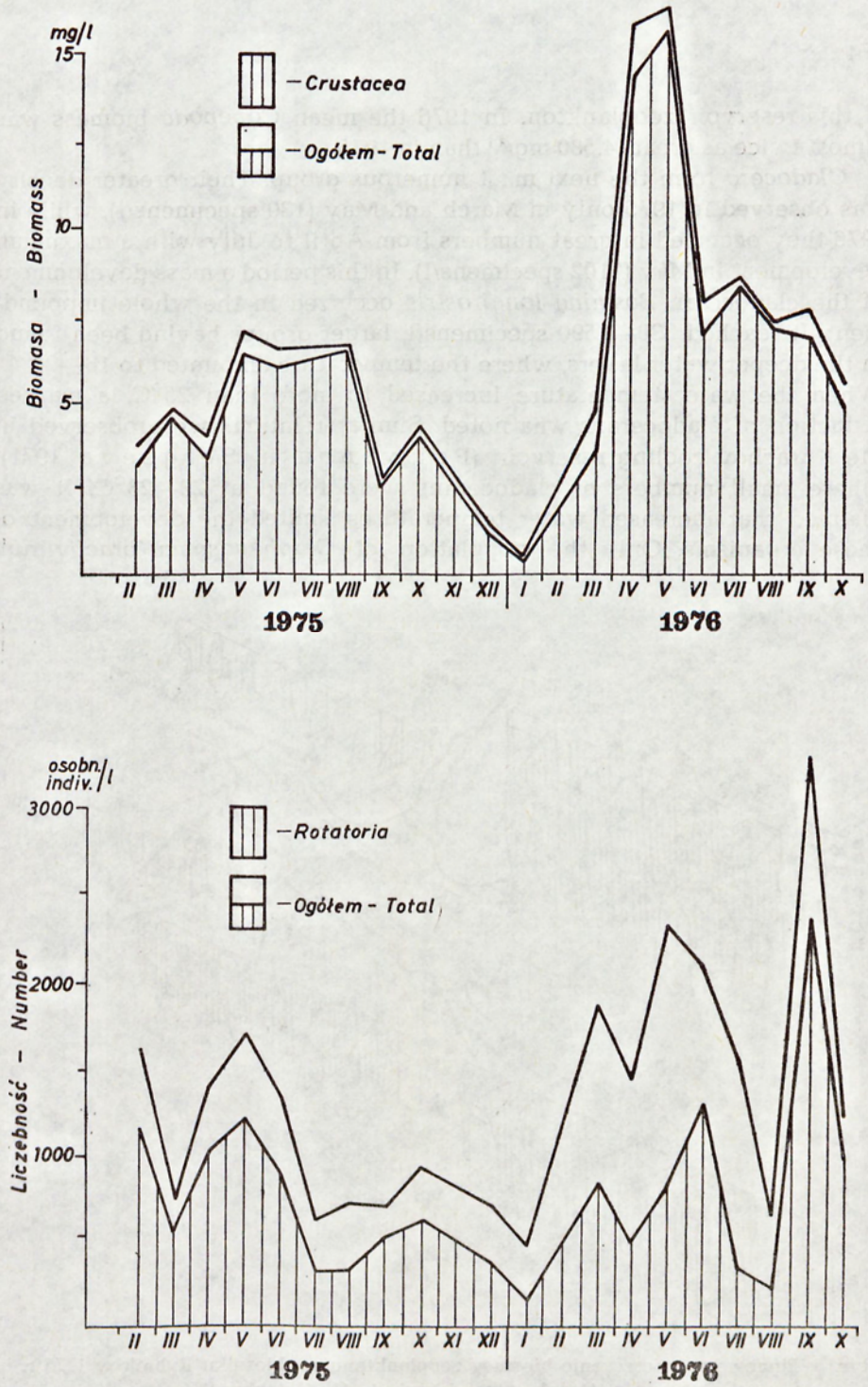
In 1975 the waters of the Rybnik dam reservoir were settled by 1047 specimens/l, this number ranging from 611 in July to 1712 specimens/l in May (fig. 4). In the next year the mean number of plankton animals increased to 1596 specimens/l, with greater numbers being noted in the central (station III) and dam part (station V) of the impoundment.

During the greater part of the investigation period *Rotatoria* constituted a predominant group with two development maxima in 1975 (in February and on the turn of April) and with three maxima in 1976 (in March, June, and September) (fig. 4). The mean numbers of rotifer populations found in this water body were similar to those reported for unfertilized ponds (L e w k o w i c z 1974a) or dam reservoirs on the River Soła at Tresna (K r z a n o w s k i 1971) and in Porąbka (S m a g o w i c z 1963) as well as on the River Dunajec at Rożnów and Czchów (K r z a n o w s k i 1965).

One of the main factors causing reduced density of plankton populations, especially of rotifers, in summer is temperature. It was observed that the growth of these populations was limited at a temperature of 27°C.

Most rotifers occurred in the central and lower part of the impoundment. In the period of the investigation the mean rotifer biomass was higher in 1976 (0.554 mg/l) than in 1975 (0.335 mg/l).

Copepoda followed on the list of the most numerous groups, though their great numbers are chiefly due to the occurrence of the development forms: nauplius and copepodites. They had a large part in the biomass

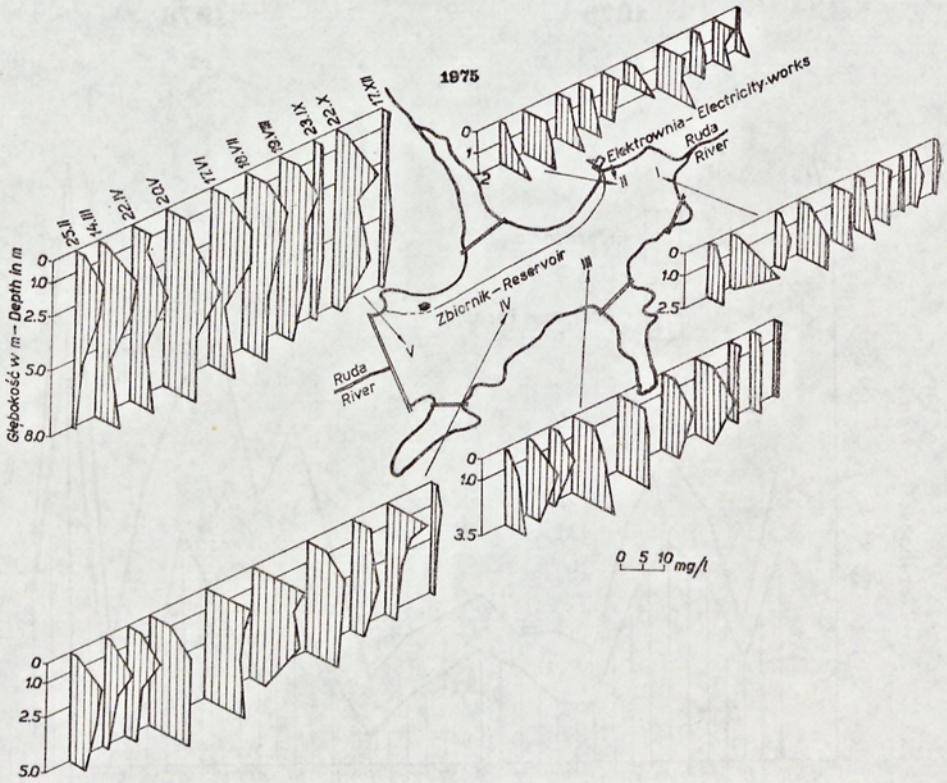


Ryc. 4. Dynamika biomasy i liczebności zooplanktonu w zbiorniku Rybnik w latach 1975—1976

Fig. 4. Dynamics of zooplankton biomass and numbers in the Rybnik reservoir in 1975—1976

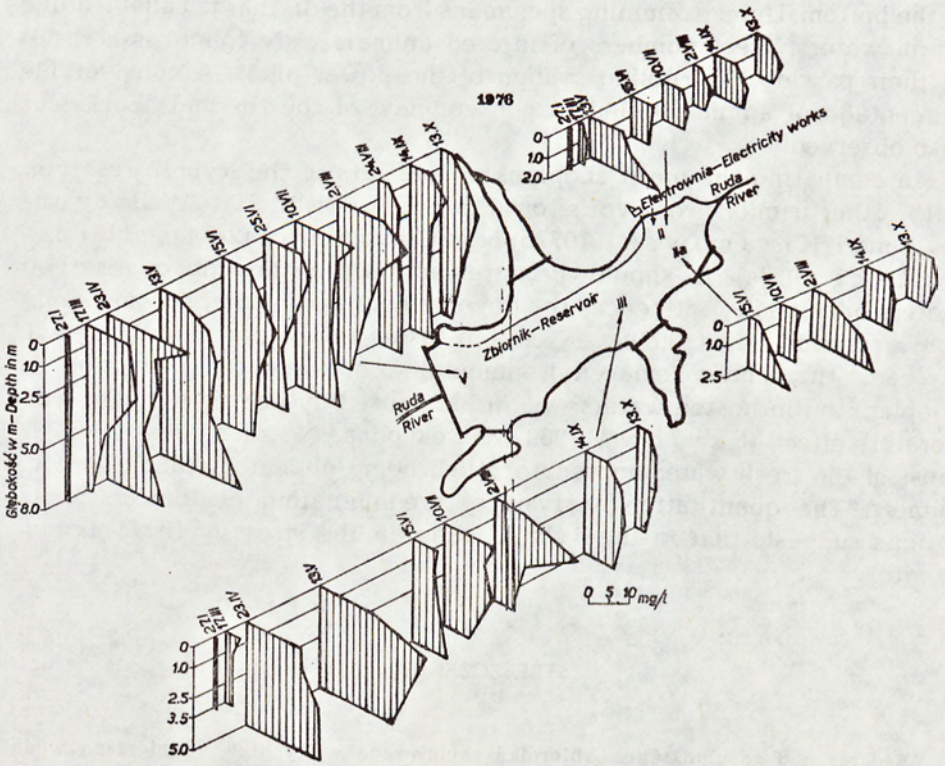
of this reservoir zooplankton. In 1976 the mean *Copepoda* biomass was almost twice as great (4.580 mg/l) than in 1975.

Cladocera form the next most numerous group. Their greater density was observed in 1975 only in March and May (130 specimens/l), while in 1976 they occurred in great numbers from April to July with a maximum development in May (1102 specimens/l). In this period a mass development of the cladoceran *Bosmina longirostris* occurred in the whole impoundment. It reached 330—1590 specimens/l, larger groups having been found in the deeper water layers, where the temperature amounted to 18—20°C. When the water temperature increased to more than 25°C, a marked reduction of cladocerans was noted. Similar relations were observed in the Kurachov cooling reservoir (P o l i v a n n a j a, S e r g e e v a 1971), where small numbers of cladocerans were found at 23—28°C. It was claimed that increased water temperatures limited the development of these organisms. Only the population of *Diaphanosoma brachyurum*



Ryc. 5. Pionowe rozmieszczenie biomasy zooplanktonu w zbiorniku Rybnik w 1975 r. na poszczególnych stanowiskach. I—V — stanowiska

Fig. 5. Vertical distribution of zooplankton biomass in the Rybnik reservoir in 1975 at different stations. Stations I—V



Ryc. 6. Pionowe rozmieszczenie biomasy zooplanktonu w zbiorniku Rybnik w 1976 r. na poszczególnych stanowiskach. ↓ — miejsce zrzutu podgrzanych wód z elektrowni

Fig. 6. Vertical distribution of zooplankton biomass in the Rybnik reservoir in 1976 at different stations. ↓ — the point of heated waters discharge from the power plant

increased under the influence of higher water temperatures. This species appeared in the Rybnik impoundment in June and predominated among cladocerans during the summer period. In the period of the investigation *Ceriodaphnia quadrangula*, a cladoceran not previously reported for this reservoir, appeared. This species occurs in masses in cooling reservoirs of the Ukraine power plants.

The mean biomass of cladocerans was similar during the two years of the investigation and amounted to 2.18 and 2.45 mg/l respectively.

A gradual increase in the zooplankton biomass was observed in the successive years, from 1973—1976 amounting to 1 mg/l (W r ó b e l 1973), 3 mg/l (L e w k o w i c z 1974b), 5.774 mg/l, and 8.299 mg/l, respectively.

In their vertical distribution most of the plankton animals occurred in surface water layers down to a depth of 2.5 m (figs 5, 6), except for station IIa, where the mixing of warm discharge waters and reservoir waters resulted in greater numbers of zooplankton gathering in the layers close

to the bottom. Upon examining specimens from the discharge canal leading warm waters, great numbers of injured animals were found as a result of their passing the cooling system of the power plant. A considerable percentage of animals killed in consequence of the thermal shock was also observed.

In comparing the mean zooplankton biomass of the Rybnik reservoir with other similar reservoirs on the River Vistula at Wisła-Czarne (1—3 mg/l Krzanowski 1977b) or at Goczałkowice (2—4 mg/l Krzanowski 1977a) it should be stressed that the heating of reservoir waters beneficially influences the development and biomass of zooplankton; as a side effect, however, certain losses in the zooplankton result. It seems that under some environmental conditions the reduction of zooplankton in heated waters was rather caused by fish than by the temperature effect (Krylowa 1969, Zitenova, Nikanorova 1972), most of the fresh water unpredatory fish being obligatory plankton consumers. The quantitative analysis of predominating cladoceran populations suggests that in the Rybnik reservoir the stress of fish was moderate.

STRESZCZENIE

Badania nad zooplanktonem zbiornika zaporowego w Rybniku z podgrzaną wodą w latach 1975—1976 określiły jego skład gatunkowy, dynamikę zasiedlenia i biomasy w obrębie zbiornika jak i na przestrzeni badanego okresu. W latach 1975—1976 zanotowano występowanie 43 gatunków zwierząt planktonowych, w tym 5 gatunków *Protozoa*, 26 gatunków *Rotatoria*, 10 gatunków *Cladocera* i 2 gatunki *Copepoda*. Nie stwierdzono większych różnic w składzie gatunkowym na poszczególnych stanowiskach, a większość gatunków tu występujących to formy eurytermiczne i ciepłolubne pojawiające się z reguły w letnim planktonie jezior, stawów czy zbiorników zaporowych. W 1975 r. występowało średnio w zbiorniku 1047 osobników/l zwierząt planktonowych o biomasie 5,774 mg/l, natomiast w 1976 r. 1596 osobników/l o biomasie 8,299 mg/l. Grupą dominującą przez większość badanego okresu były *Rotatoria* z gatunkami *Polyarthra vulgaris, Keratella cochlearis*, a wśród wioślarek najliczniej występowały *Daphnia cucullata* i *Bosmina longirostris*. Większość zwierząt planktonowych występuje w tym zbiorniku w warstwach powierzchniowych do 2,5 m głębokości, a w swym rozmieszczeniu w zbiorniku w części środkowej i przyzaporowej zbiornika. Stwierdzono znaczny wpływ ciepłych wód zrzutowych na rozwój i rozmieszczenie zooplanktonu w tym zbiorniku. W materiale zebranym na kanale zrzutowym stwierdzono liczne uszkodzenie zwierząt (organów ruchu i wewnętrznych), jak też duży 23,5 procent martwych organizmów, których śmierć nastąpiła wskutek szoku termicznego. Z tej przyczyny ginie w zbiorniku ok. 3,137 tony zwierząt planktonowych na dobę. W miejscu mieszania się ciepłych wód zrzutowych z wodami zbiornika stwierdzono liczniejsze gromadzenie się skorupiaków planktonowych w warstwach przydennych w danej chwili chłodniejszych. Porównując średnie biomasy zooplanktonu zbiornika rybnickiego z podobnymi z innych zbiorników należy stwierdzić, że podgrzewanie wód zbiornika mimo dużych strat z wyżej wymienionych przyczyn oraz zwiększonej presji ryb wpływa dodatnio na rozwój zooplanktonu i jego biomasy.

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