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Plankton nowych stawów przesadkowych gospodarstwa Gołysz

The plankton of new transfer-ponds at the Gołysz Farm

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Abstract — The present work is a continuation of earlier investigations on the plankton of the first and second transfer-ponds in the first year after their construction. It discusses the development of plankton with the application of another type of fertilization. The observed changes in the phyto- and zooplankton indicate a structure more consistent with that occurring in water bodies utilized for a longer time. The analyses of the fertilization did not reveal any influence on the numbers of plankton. Among other factors, some role was probably played by its composition, chiefly among the algae.

The investigations included four first transfer-ponds (Nos 1—4) and four second ones (Nos 5—8) at the Experimental Farm of the Polish Academy of Sciences at Gołysz (district Cieszyn). The composition and the quantitative relations of plankton and its development in the annual cycles from the first three years after the construction of the first transfer-ponds (1958—1960) and from the first two years for the second ones (1959—1960) were published earlier (Krzeczkowska-Wołoszyn 1966). In this work the description of the territory and ponds, data on their fertilization and exploitation and on higher plants occurring in them were given, and also the available literature concerning the problem was discussed.

The present investigations were based on the material collected in 1961, from 10th June to 2nd July from the first transfer-ponds and from 7th July to 6th August from the second ones. The different type of fertilization introduced in that year is presented in Table I.

Tabela I. Typ zastosowanych nawozów
Table I. Type of the applied fertilizers

Stawy Ponds	Nr No	Nawożenie Fertilization
Przesadki Transfer-ponds I	1	Supertomasyna - Thomas phosphate 0.45 q Saletra amonowa - Ammonium nitrate 0.40 q (w 3 dawkach - in 3 doses)
	2	nie nawożony - unfertilized
	3	Supertomasyna - Thomas phosphate 0.45 q Saletra amonowa - Ammonium nitrate 0.30 q (w 3 dawkach - in 3 doses)
	4	nie nawożony - unfertilized
Przesadki Transfer-ponds II	5 6 7	Superfosfat - superphosphate 1q Saletra amonowa - Ammonium nitrate 1q (jednorazowo - in one dose)
	8	nie nawożony - unfertilized

Characteristics of phytoplankton

In the first transfer-ponds the smallest amount of phytoplankton was found in ponds 1 and 4, more than twice as much in pond 2, and the greatest amount (more than seven times as much as in the first two ponds) in pond 4 (fig. 1).

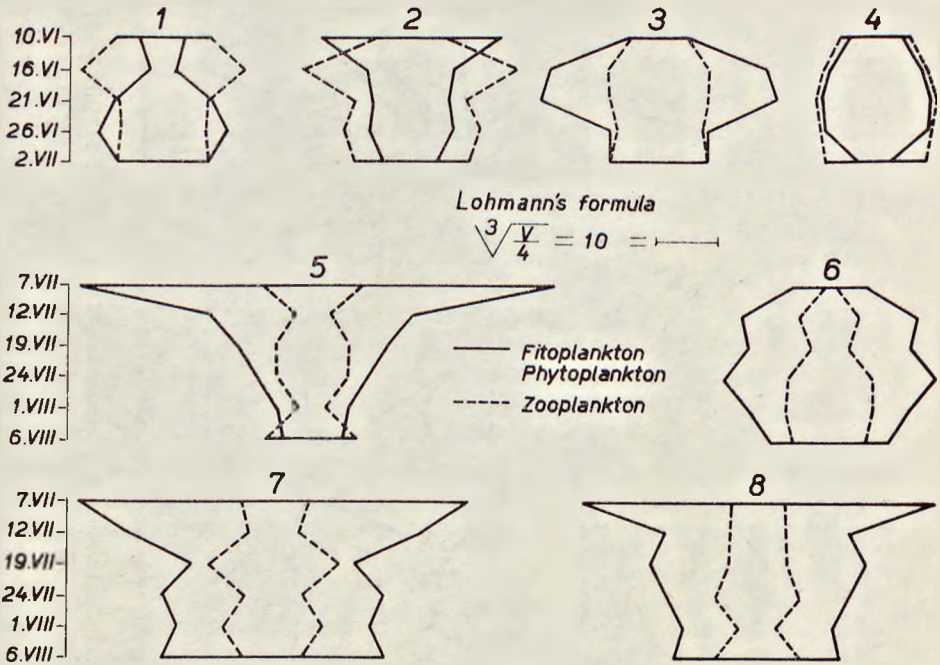
In ponds 1 and 3 *Euglenophyta* and *Chlorophyta* were most numerous, in pond 1 the former and in pond 3 the latter group of algae prevailing (fig. 2). In pond 1 the dominating genus *Trachelomonas* (chiefly *Tr. volvocina*) formed over 50 per cent of specimens of algae, while among various *Chlorophyta* the most common was *Eudorina elegans*. In pond 3 species of the genera *Ankistrodesmus* and *Scenedesmus* were more numerous than the above-mentioned ones (about 60 per cent). In ponds 2 and 4 *Chrysophyta* and *Chlorophyta* dominated, the chrysophytes being especially numerous in pond 2 (fig. 3). Immediately after the filling of pond 2 *Dinobryon divergens* occurred in masses, being almost the only component of phytoplankton at this time. In the period of filling it constituted about 80 per cent of all algae. After some days *Eudorina elegans* already prevailed, and later on some species of *Trachelomonas* and diatoms (Table II). In pond 4 the chrysophytes *Dinobryon divergens* and *Synura uvella*, or the diatoms, chiefly *Synedra acus*, dominated. Among *Chlorophyta* species of the genus *Ankistrodesmus* and *Eudorina elegans* were most often recorded.

In the second transfer-ponds the most abundant development and similar numbers of algae were observed in ponds 5 and 7; in pond 8 their number was almost 40 per cent, and in pond 6 about 5 times lower. In ponds 5, 7, and 8 *Chrysophyceae* prevailed, similar numbers of

Tabela II. Skład jakościowy fitoplanktonu w przesadkach pierwszych (nr 1,2,3,4) i drugich (nr 5,6,7,8)

Table II. Qualitative composition of phytoplankton in the first (Nos 1,2,3,4) and second (Nos 5,6,7,8) transfer-ponds

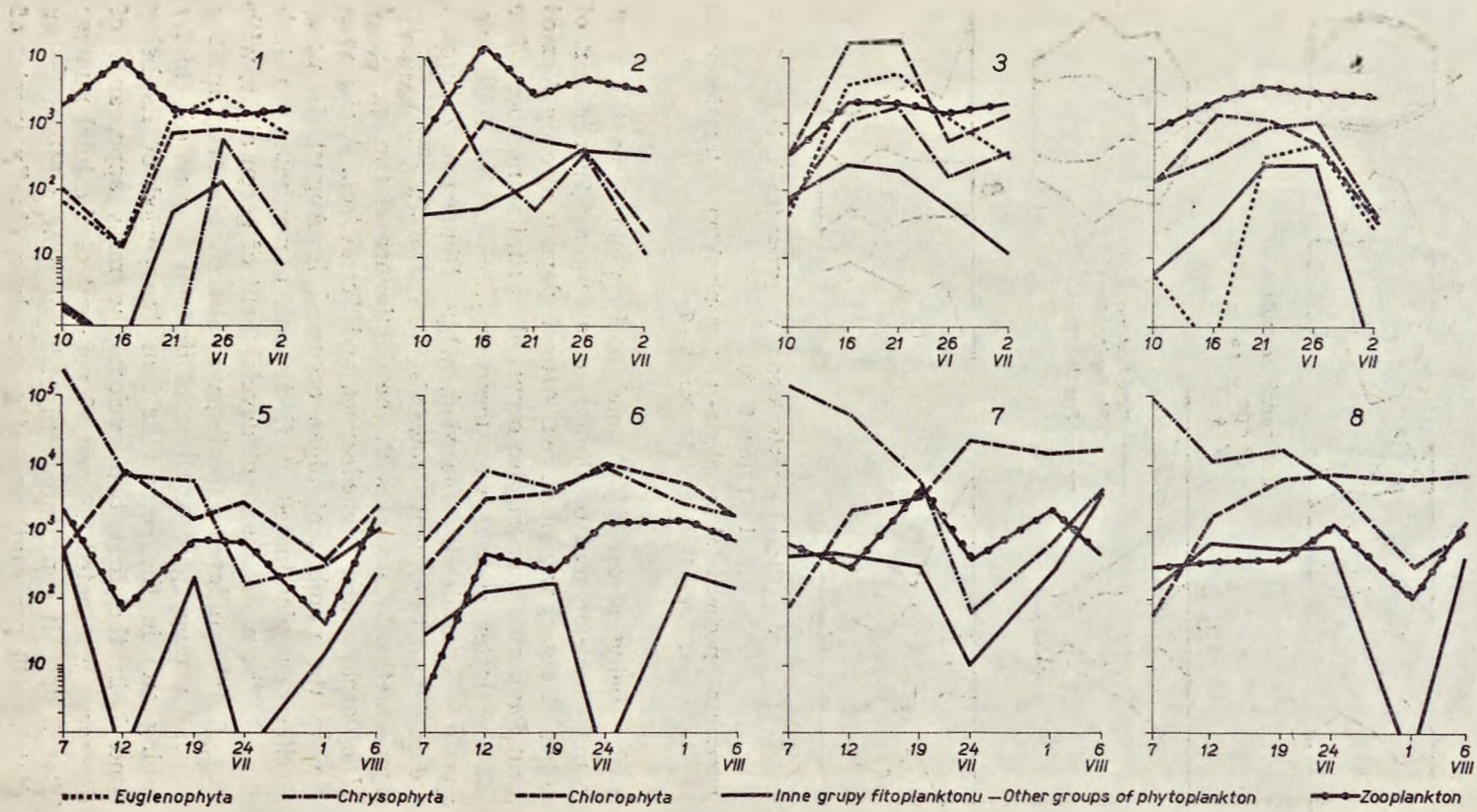
Takson Taxon	Nr przesadki No of tranfer- -pond	Takson Taxon	Nr przesadki No of tranfer- -pond
Coelosphaerium Nägelianum Unger	8	Crucigenia minima Brunnth.	1 2 3 6 7
Gloeocapsa limnetica (Lemm.) Hollerbach	3 4 6 7	- rectangularis (A. Braun) Gay	1 2 3 5 6 7 8
Gloeocapsa sp.	2	- tetrapedia (Kirchn.) West et West	1 2 3 6 7
Gomphosphaeria sp.	8	Dictyosphaerium pulchellum Wood	5 6 7 8
Lyngbya sp.	6	Dimorphococcus lunatus A. Braun	1
Merismopedia sp.	1 5 7	Elakatothrix lacustris Korschik.	3 4 5 8
Oscillatoria sp.	7	Oocystis gigas Archer	6
Euglena sp. div.	1 2 3 4 7 8	Pediastrum Boryanum (Turp.) Menegh.	1 2 3 4 5 6 7 8
Phacus longicauda (Ehr.) Duj.	6	- duplex Meyen	1 2 3 4 5 6 7 8
- pleuronectes (Müll.) Duj.	5	- tetras (Ehr.) Ralfs	1 2 3 4 5 6 7 8
- tortus (Lemm.) Skv.	1 3 7	Scenedesmus acuminatus (Lag.) Chod.	1 2 3 4 6 7
Phacus sp.	1 3 7	- arcuatus Lemm.	1 3 4 6 7
Trachelomonas armata Stein	1 2 3 5	- ecornis (Ralfs) Chod.	2 3 4 5 7 8
- hispida (Perty) Stein en Defl.	2 4 6 7 8	- quadricauda Chod.	1 2 3 4 5 6 7 8
- volvocina Ehr.	1 2 3 4 5 6 7 8	Scenedesmus sp. div.	1 2 3 4 5 6 7 8
Trachelomonas sp.	3 6	Schroederia Judayi G.M. Smith	3
Ceratium hirundinella Duj.	2 3 4 5 6 7 8	- setigera Schroed. Lemm.	2 3
Peridinium sp.	1 2 3 4 5 6 7 8	Selenastrum Bibraianum Reinsch.	3 5 7
Dinobryon bavaricum Imhof	6	Sphaerocystis Schroeteri Chod.	2 4 5 7
- divergens Imhof	1 2 3 4 5 6 7 8	Tetraëdron caudatum C. Hansg.	1 2 5
- sertularia Ehr.	5	- trigonum (Näg.) Hansg.	1 3 5
Mallomonas sp.	6 8	- minimum (A. Braun) Hansg.	2 5 7
Synura uvella Ehr.	2 4 5 6 7 8	Tetrastrum staurogeniaeforme (Schroed) Lemm.	5
Uroglena volvox Ehr.	3	Quadrigula Chodatii (Tan.-Ful.) G.M. Smith	5
Asterionella formosa Hass.	6	Spirogyra sp.	4 6 7
Centronella Reicheltii Voigt (C.Rostafinskii Wołosz)	3 4	Zygnema sp.	6
Fragilaria capucina Desmaz.	6 7 8	Arthrodesmus convergens Ehr.	4
- crotonensis Kitton	5 6 7 8	- incus Brèb. Hass.	6
Synedra acus Kütz.	1 2 3 4 6 7 8	Closterium Kützingii Brèb.	1 3 7
- ulna (Nitzsch.) Ehr.	2 3 4 6 7 8	- Leibleinii Kütz.	1 3 5 7
Synedra sp.	1 2 6 7 8	Closterium sp.	3 7
Bacillariophyceae n. det.	1 2 3 4 5 6 7 8	Cosmarium Botrytis Menegh.	2 4 6 8
Ophiocytium capitatum Wolle	1 5	- subtumidum Nordst.	1 2 3 5 7
Tribonema sp.	5 6 7 8	- subprotumidum Nordst.	1 2 3 4 6 8
Eudorina elegans (L.) Ehr.	1 2 3 4 5 6 7 8	- Turpinii Brèb.	3 5 6 7
Genium pectorale Müll.	2 4 7	Cosmarium sp.	1 2 3 4 5 6 7 8
Pandorina morum Bory	2 4 5	Desmidium Swartzii Ag.	5 6 7
Volvox aureus Ehr.	1 3	Euastrum insulare (Wittr.) Roy	7
Microspora sp.	5 7	-'Turneri West	5
Stigeoclonium sp.	2	- verrucosum Ehr. var. alatum Wolle	6
Actinastrum Hantzschii Lagerh.	5 6 7 8	Euastrum sp.	8
Ankistrodesmus falcatus (C.) Ralfs	3 4 5 6 7 8	Hyalotheca dissiliens Brèb.	3
Ankistrodesmus sp. div.	1 2 3 4 5 6 7 8	Pleurotaenium trabecula (Ehr.) Näg.	5
Botryococcus Braunii Kütz.	3 5 6	Staurastrum alternans Brèb.	4 7 8
Characium sp.	4 6 7	- tetracerum (Kütz.) Ralfs	2 5 6 8
Characiopsis sp.	5	Staurastrum sp. div.	2 4 5 6 7 8
Chlorangium sp.	1 7 8	Xanthidium antilopeum (Brèb) Kütz.	2
Coelastrum proboscideum Bohl.	5	Chlorophyta n. det.	2 3 5 8



Ryc. 1. Ogólna ilość okazów fito- i zooplanktonu w przesadkach I (nr 1—4) i II (nr 5—8)

Fig. 1. Total number of specimens of the phyto- and zooplankton in transfer-ponds I (Nos 1—4) and II (Nos 5—8)

Chlorophyta also being recorded in pond 6. In pond 5 in the first sampling the mass development of *Dinobryon divergens* (99 per cent of the total number of algae) was observed. After 5 days it already formed 47 per cent, but *Pandorina morum* also occurred in similar numbers. The occurrence of the latter species was temporary, as in the following period it was only sporadically recorded, while *Dinobryon divergens* continued to dominate (65 per cent). Towards the end of July and August the green algae chiefly developed with the dominance of the species of *Pediastrum*, *Dictyosphaerium*, *Scenedesmus*, and *Tetraedron*. A characteristic decrease in the number of algae occurred in August. In pond 6 *Dinobryon divergens* dominated at first, with a maximum on 12th July (71 per cent). The more abundant development of green algae, with the dominance of *Ankistrodesmus* species, was already observed on 19th July. In this pond a much greater share of diatoms was noted, chiefly at the beginning and in the second half of the period of its being filled. In pond 7 in the first two periods the mass appearance of *Dinobryon divergens* was noted (99 and 95 per cent of the total number of algae). After 5 days it constituted only 1.3 per cent, while a larger number of diatoms (60 per cent) and of green algae, chiefly species of



Ryc. 2. Liczebność (w 1 l wody) poszczególnych grup fito- i zooplanktonu w przesadkach I (nr 1—4) i II (nr 5—8)
Fig. 2. The numbers (in 1 litre of water) of individual groups of the phyto- and zooplankton in transfer-ponds I (Nos 1—4) and II (Nos 5—8)

Scenedesmus and *Ankistrodesmus* (24 per cent), occurred. The chlorococcous *Chlorophyceae*, especially the above-mentioned ones, prevailed up to the end of the exploitation of the pond, with the exception of the sampling on 24th July when *Eudorina elegans* (99 per cent) dominated. In the first period in pond 8 a water bloom of *Dinobryon divergens* (99 per cent) was recorded, after which its number gradually decreased, so that on 24th July it was only noted in small numbers. At this time *Synura uvella* developed abundantly (30 per cent) as well as *Chlorophyta* (*Dictyosphaerium pulchellum, Ankistrodesmus, Scenedesmus, Eudorina elegans*), which prevailed up to the end of the season. A more numerous appearance of diatoms was observed on 12th July (49 per cent) and on 19th July (20 per cent).

Characteristics of zooplankton

The greatest number of zooplankton animals occurred in pond 2, there were fewer in ponds 1 and 4, and fewest in pond 3. In the ponds 1, 2, and 4 *Bosmina longirostris* or *Keratella cochlearis* dominated, the quantitative relations between them being variable. In pond 1 *Bosmina longirostris* constituted 64 and 79 per cent of animals in the first two periods, while in the later period *Keratella cochlearis* prevailed (32—36 per cent). In pond 2 *Keratella cochlearis* constituted 62 per cent after filling, but already on 16th July only 10 per cent, while *Bosmina longirostris* amounted to 72 per cent. Later on, up to the moment of draining the number of *Keratella cochlearis* again increased and reached 75 per cent of the total zooplankton in the last sampling on 2nd July. In pond 4, as a rule, *Keratella cochlearis* dominated (37—90 per cent). In the middle of June only *Bosmina longirostris* occurred in greater numbers. Copepods prevailed only in pond 3, chiefly their larval stages (nauplii), or *Cyclops* (32—48 per cent). At the end of June *Anureopsis fissa* dominated (37 per cent) and at the beginning of July *Brachionus angularis* (25 per cent). In some first transfer-ponds (especially in 1 and 2) great numbers of eggs of *Bosmina longirostris* and *Keratella cochlearis* were noted.

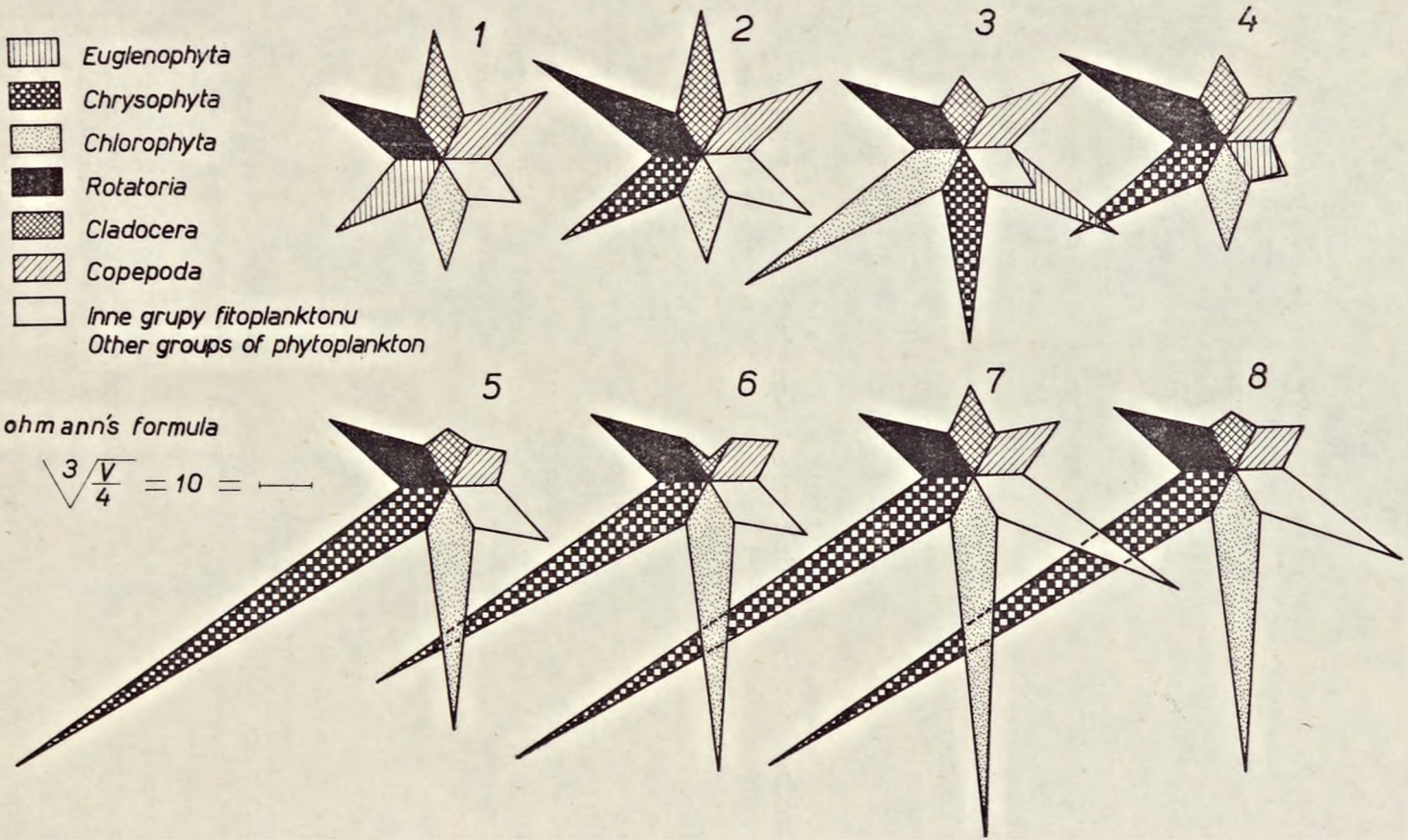
In the second transfer-ponds the greatest numbers of zooplankton were noted in pond 7, in the remaining ponds the numbers being smaller almost by half or similar. In ponds 5, 6, and 8 the zooplankton was of rotiferous character, and in pond 7 of a cladoceran-rotiferous one. Among rotifers the dominants were, as a rule, *Keratella cochlearis, Polyarthra vulgaris, Synchaeta, Conochilus,* and *Anureopsis fissa,* and among cladocerans *Bosmina longirostris* (Table III). As for *Copepoda* their larval stages or *Cyclops* were more common but their numbers were always smaller than those of rotifers and cladocerans. In the individual ponds

Tabela III. Skład jakościowy zooplanktonu w przesadkach pierwszych (nr 1,2,3,4) i drugich (nr 5,6,7,8)

Table III. Qualitative composition of zooplankton in the first (Nos 1,2,3,4) and second (Nos 5,6,7,8) transfer-ponds

Takson Taxon	Nr przesadki No of transfer-pond	Takson Taxon	Nr przesadki No of transfer-pond
Asplanchna brightwelli Gosse	2 3 5 7	Polyarthra euryptera Wierzejski	2 3 4
- priodonta Gosse	2 5 6 7	- major Bruckhardt	7 8
Asplanchna sp.	2 3 5 6 7 8	- vulgaris Carlin	1 5 6 7 8
Anureopsis fissa (Gosse)	1 2 3 4 5 6 7 8	Synchaeta sp.	3 4 5 6 7 8
Brachionus angularis Gosse	1 3 4 5 6	Testudinella patina Hermann	7
- calyciflorus Wierzejski	1 2 3 5 7	Trichocerca cylindrica Imhof	2 6 7 8
- diversicornis Daday	2 3 6 7 8	Trichocerca sp.	2 5 6 7 8
- quadridentatus Hermann	1 2 3 7 8	Trichotria truncata Whitelegge	5 6 7
Brachionus sp.	1 2 3 4 5 6 7 8	Rotatoria n. det.	2 3 4 5 6 7 8
Conochilus unicornis Rousselet	1 5 6 7 8	Rotatoria (ova)	1 2 4
Conochilus sp.	1 5 7 8	Bosmina longirostris O.F. Müll.	1 2 3 4 5 6 7 8
Euchlanis sp. div.	1 4 5 6 7 8	Ceriodaphnia reticulata Sar·	1 2 3 4 5 7 8
Filinia brachiata (Rousselet)	5	- quadrangula O.F. Müll.	1 2 3 4 5 7 8
- longiseta (Ehr.)	1 2 3 4 5 6 7	Ceriodaphnia sp.	1 2 3 4 5 7 8
Keratella cochlearis (Gosse)	1 2 3 4 5 6 7 8	Chydorus sphaericus O.F. Müll.	2 4
- - var. tecta (Gosse)	2 3 4 5 6 7 8	Daphnia longispina Müll.	1 2 3 4 5 7 8
- quadrata (O.F. Müll.)	2 3 4 5 6 7 8	Diaphanosoma brachyurum Lieven	1 2 3 4 7 8
Lecane bulla (Gosse)	1 2 3 4 5	Polyphemus pediculus Linné.	6 7
- luna (O.F. Müll.)	1	Scapholeberis mucronata O.F. Müll.	2 5 6
- lunaris (Ehr.)	1 5 6 8	Cladocera n. det.	3 4 5 7 8
Lecane sp.	1 5	Cladocera (ova)	1 2
Lepadella patella Müll.	2 3 5 6 7 8	Cyclopidae	1 2 3 4 5 6 7 8
Notholca sp.	5 6 7	Diaptomidae	2 3 7 8
Pedalia mira (Hudson)	5 6 7 8	Nauplii	1 2 3 4 5 6 7 8

the quantitative relations of different species varied in time. Thus, in pond 5 the nauplii prevailed at the beginning of July, after a week *Synchaeta* dominated, later being replaced by *Keratella cochlearis* and *Polyarthra vulgaris*. On 6th August the dominance of other rotifers (*Conochilus* and *Anureopsis fissa*) was noted. In pond 6 the specific composition, very similar at first, was characterized by the occurrence of a greater number of *Euchlanis dilatata* on 19th July and of nauplii, *Polyarthra vulgaris*, and *Pedalia mira* on 6th August. The character of zooplankton in pond 7 was chiefly influenced by the development of *Bosmina longirostris*, which constituted as much as 90 per cent of zooplankton on 19th July and reached the greatest number in all the second transfer-ponds. In pond 8 the rotifers *Polyarthra vulgaris*, *Synchaeta*, and *Keratella cochlearis* prevailed up to the end of July. Only in August did *Anureopsis fissa* develop abundantly (22—33 per cent) besides the most numerous *Polyarthra vulgaris*.



Ryc. 3. Sumy okazów poszczególnych grup planktonu w przesadkach I (nr 1—4) i II (nr 5—8)
Fig. 3. The total number of specimens of individual groups of plankton in transfer-ponds I (Nos 1—4) and II (Nos 5—8)

Discussion

With reference to the phyto- and zooplankton communities of the investigated ponds, described in the first years of their filling (Krzeczkowska-Wołoszyn 1966), the later stages of their succession were observed in the present investigations. As far as the phytoplankton is concerned, the most striking change was the prevailing share of another group of algae — *Chrysophyta*. Some authors, chiefly the Russians, interpret in outline the disappearance of *Euglenales* and *Volvocales*, and the increasing quantitative and qualitative share of *Chrysophyceae*, *Dinophyceae*, and *Protococcales*, as the process of establishment of a new pond. In the first years after filling the zooplankton of the investigated ponds was of rotiferous character. According to the opinion of other authors dealing with this problem, this is characteristic for the newly formed zooplankton communities. In the present investigations a much greater share of *Cladocera* and *Copepoda* was found. In the later stage of stabilization the dominance of crustaceans becomes established (Denisova et al. 1971, Morduchaj-Boltovskoj et al. 1971). It is striking that in the first transfer-ponds built and filled a year earlier, only one of them still preserved this rotiferous character (3), while in the second ones, filled a year later, three ponds (5, 6, and 8) still did so. Thus it is justly postulated that the process of establishment of a new water body takes several years (Starmach 1963, Sokolova et al. 1971). In the present investigations a further decrease in the number of organisms was found, this probably indicating a more advanced stage of their stabilization. It was more advanced in the first transfer-ponds, utilized a year longer. The increased productivity of new water bodies as compared with the longer utilized ones was stressed by other authors. Unlike the algae, the amount of zooplankton was maintained on a more equal level in the period of filling. These data are in accordance with the opinions of other authors on the influence of carp fry on zooplankton (Grygierek 1962, 1965, Krzeczkowska-Wołoszyn 1972). The much greater disproportion of the total number of phyto- and zooplankton in the second transfer-ponds and their much more equalized production in the first ones, is characteristic. The smaller numbers of algae in the first transfer-ponds might have resulted from the more intense feeding by crustaceans, which occur in greater numbers (Grygierek 1970, Januszko 1970). Smaller numbers of zooplankton in the second transfer-ponds may be explained by the more active feeding of the carp fry which had already grown older. This is also indicated by greater decreases in the numbers of *Cladocera* and *Copepoda* which, according to the opinion of other authors, might have been a more suitable fodder for older carp fry. The

qualitative composition both among the algae and among the animals was not basically changed as compared with earlier years. In analysing the fertilization no distinct influence on the numbers of plankton was found. It it possible that in the unfertilized ponds some effect of the fertilization applied in the previous years was still felt. As far as the algae are concerned, the composition of the fertilization might also have played some role. In the investigated ponds *Chrysophyta* dominated. As Januszko (1970) reports, the effect of fertilization of the same type on the increase in the number of *Chrysophyta* was small, in contrast to other groups of algae.

STRESZCZENIE

Badania niniejsze omawiają rozwój planktonu przesadek pierwszych i drugich, w 1961 roku, przy zastosowaniu innego typu nawożenia. Są one kontynuacją wcześniejszych badań, prowadzonych w pierwszych latach po ich wybudowaniu (Krzeczkowska-Wołoszyn 1966). W porównaniu z nimi skład jakościowy fito- i zooplanktonu nie wykazywał istotnych zmian, stwierdzono natomiast dominację odmiennych grup. Wśród glonów dominowały *Chrysophyta*. W obrębie zooplanktonu stwierdzono przewagę, lub znacznie większy udział *Cladocera* i *Copepoda*. Notowano też dalszy spadek liczebności organizmów. Charakter planktonu oraz tego typu zmiany wskazywałyby, zgodnie z danymi innych badaczy, na późniejsze etapy sukcesji oraz układy bardziej zbliżone do występujących w zbiornikach z dłuższym użytkowaniem. Obserwowano większą dysproporcję produkcji glonów i zwierząt w przesadkach drugich, przy bardziej wyrównanej ich produkcji w pierwszych. Mniejsza ilość fitoplanktonu przesadek pierwszych mogła wynikać z intensywniejszego wyjadania obficiej występujących skorupiaków. Natomiast mniej liczny zooplankton przesadek drugich można tłumaczyć aktywniejszym żerowaniem starszego narybku karpia. Rozpatrując nawożenie nie stwierdzono jego wpływu na ilość planktonu. W stawach nie nawożonych mógł jeszcze wchodzić w grę następczy wpływ nawożenia stosowanego w latach poprzednich. Odnośnie glonów pewną rolę mógł też odgrywać jego skład. W badanych stawach dominowały *Chrysophyta*. Zgodnie z danymi z literatury wpływ tego typu nawożenia na wzrost liczebności *Chrysophyta* w przeciwieństwie do innych grup glonów jest niewielki.

REFERENCES

Denisova A. I., E. P. Nakhshina, 1971. Hydrochemical regime of the Dnieper river under conditions of regulated flow. Leningrad, Limnol, Conv. 18.

Grygierek E., 1962. Wpływ zagęszczenia narybku karpi na faunę skorupiaków planktonowych. Roczn. Nauk Roln., 81, B, 189—210.

Grygierek E., 1965. Zmiany rozmieszczenia skorupiaków jako wyraz oddziaływania narybku karpi na plankton. Roczn. Nauk Roln., 65, B, 183—194.

Grygierek E., 1970. Wstępne wyniki badań wpływu nawożenia stawów na zooplankton. (Porównanie działania węglanu i siarczanu amonu). Roczn. Nauk Roln., 91, H, 467—483.

Januszko M., 1970. Rozwój planktonu roślinnego pod wpływem nawożenia azotowo-fosforowego w stawach z wylęgiem karpia. Roczn. Nauk Roln., 91, H, 485—497.

Krzeczkowska-Wołoszyn Ł., 1966. Plankton nowych stawów przesadkowych gospodarstwa Gołysz — Das Plankton der neuen Streckteiche der Teichwirtschaft Gołysz. Acta Hydrobiol., 8, Suppl. 1, 47—109.

Krzeczkowska-Wołoszyn Ł., 1972. Zooplankton stawu karpiowego pozostającego pod kilkuletnim zalewem — The zooplankton of a carp pond under conditions of continuous filling. Acta Hydrobiol., 14, 307—315.

Morduchaj-Boltovskoj F. D., N. A. Dziuban, V. A. Eksevtzev, 1971. Die Ausbildung der Pflanzen und Tierwelt in den Stauseen der Volga. Leningrad, Limnol. Conv. 18.

Sokolova N. Yu., A. A. L'vova, E. I. Izvekova, 1971. The formation of benthos in near-Moscow water — supply reservoirs and the role of bottom organisms in the turnover of matter. Leningrad, Limnol. Conv. 18.

Starmach K., 1963. Staw jako środowisko hodowlane (Hodowla ryb w stawach, red. A. Rudnicki). Warszawa, PWRiL.

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