ACTA HYDROBIOL.	7	1	59—70	KRAKÓW 1965

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Zooplankton stawu rybnego „Księży“ w Gołyszu — Zooplankton of fish pond „Księży“ in Gołysz

Mémoire présenté le 6 avril 1964 dans la séance de la Commission Biologique de l'Académie Polonaise des Sciences, Cracovie

The problem consisted in the investigation of the qualitative composition, periodicity of development and zooplankton biomass in one of the ponds of the Experimental Farm of the Institute of Water Biology of the Polish Academy of Sciences.

There are many papers concerning the zooplankton of fish ponds in limnological literature. Czapik (1957), Bucka (1960), and Krzeczkowska (1961) have written about the ponds of experimental farms of the Polish Academy of Sciences. Other detailed investigations of the zooplankton in the Gołysz ponds, including the present work, are intended to contribute to a better cognition of the associations of plankton animals developing in the conditions at present existing there.

This work is concerned with plankton collected in 1961 in the pond „Księży" of the Gołysz farm (Cieszyn district) in the „Pod Borem" group of ponds. The farm is supplied with water from the Wisła (Vistula) river by means of a millrace beginning at Kiczyce. The pond is situated on clayey and loamy soil, its bottom covered with a fairly thin stratum of mud with not very abundant carbonates and an acid reaction, containing medium amounts of phosphates and potassium (Pasternak 1959). In 1961 the pond „Księży" was a comparative one (unfertilised).

The filling of the pond was begun at the beginning of April and was completed on April 24. The pond was drained on October 9. The surface of the water amounted to 2.2 ha, its greatest depth being 120 cm and the mean depth 70 cm. On April 19 the pond was stocked with 760 carp fry, the total accrescence of which, after the fishing in September, amounted to 144.4 kg/h.

The pond was mostly overgrown by *Glyceria aquatica* (L.) Vahlb., *Typha latifolia* L., *T. angustifolia* L., *Equisetum limosum* L., *Carex* sp. div., *Heleocharis acicularis* (L.) R. et Sch., *Batrachium aquatile* (L.) Dum., and *Potamogeton gramineus* L.. *Potamogeton natans* L., *P. lucens* L., *Elodea canadensis* Rich., *Polygonum amphibium* L., *Sagittaria sagittifolia* L., *Schoenoplectus lacustris* (L.) Pall., and *Oenanthe aquatica* (L). Poir. were present in smaller quantities. Plants with shoots protruding above the water level occupied about 25 per cent of the surface of the pond.

Plankton samples were collected every two weeks, from April onwards, when the pond was not yet entirely filled. Water was drawn with a 10 litre plankton pail. 50 litres of water were strained through a plankton net made of No. 25 bolting cloth. The sediment from the net was fixed on the spot in Lugol's fluid and after a certain time in 4 per cent formalin.

The dates of the collecting of samples and data concerning temperature, pH, alkalinity, and oxygen content are listed in Table I.

The samples were investigated as to quality and number. Numerical samples, after an appropriate condensation were counted in plankton chambers with a capacity of 0,32 ml. Three chambers were counted from each sample and the obtained mean number of individuals was calculated in turn for one litre of water. For calculation of the zooplankton biomass, the weights of plankton animals drawn from the works of Starmach (1955) and Klimczyk (1957) were used.

Table I

Dates of collection of samples from the "Księży" pond and some hydrometeorological data

Date	Apr. 10	Apr. 24	May 9	May 22	June 6	June 19	July 5	July 17	Aug. 1	Aug. 15	Aug. 28	Oct. 11	Oct. 25	Sept. 9
Air temperature °C	11.6	17.6	11.6	16,1	25,2	18,7	15,0	22,7	21,6	17.6	22,0	15,0	23.6	14,2
Water temperature °C	12,6	17.2	14,3	15.1	22.8	23,7	22,8	21,9	18,0	20,4	20,0	15,7	16,6	14,4
pH	6.75	7.5	7.0	7.0	7.2	7,0	7,0	7,6	7,2	7,2	7,0	7,0	7,2	7,4
Alkalinity mval	0.9	1.0	0.7	1.0	0,9	0,9	0,8	1,1	1,1	0,9	1,0	1,0	1,1	1,3
Oxygen mg/l	2.09	10.94	10.14	9.66	8,05	10,14	8,20	8,37	8,21	7.4	9,01	8,53	9,50	10.4
Rainfall mm	18.5		104,4		139,8		83,7		68,5			0,0		0,0

The material for investigation and hydrometeorological data were collected by the staff of the Experimental Farms of the Polish Academy of Sciences in Ochaby.

The elaboration of the samples was carried out in the Department of Hydrobiology of the Jagiellonian University under the guidance of Professor K. Starmach to whom the author expresses her very sincere gratitude for his valuable suggestions and help in the writing of the present paper.

Numerical and qualitative development of zooplankton

In a total of 14 one litre samples, collected every 2 weeks, 10 256 specimens of animals were counted. The amount of animals belonging to all the determined species calculated for 1 l of water is contained in Table II.

In the days immediately following the filling of the pond 50 animals were found in the plankton in 1 l of water. *Copepoda* prevailed (only young stages) and eggs of *Rotatoria;* there was a complete lack of *Cladocera.*

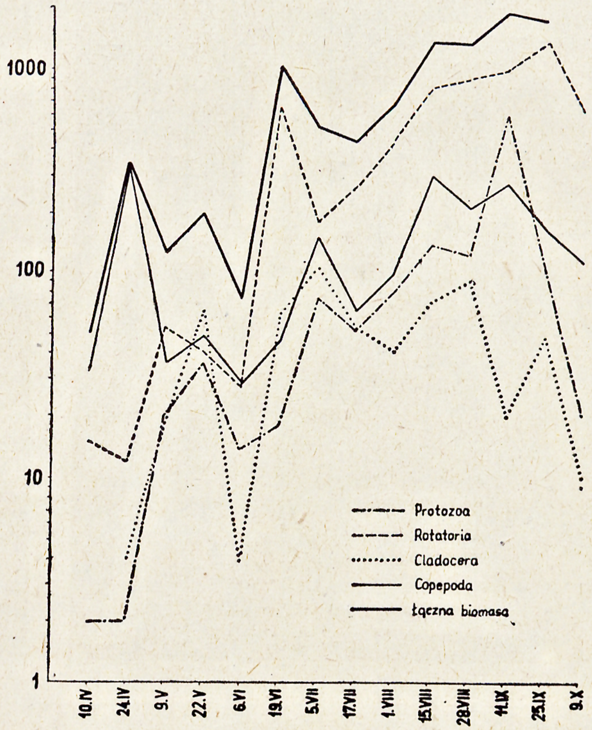

Fig. 1. Number of individuals in 1 litre of water (logarithmic scale).

After two weeks the number of animals increased sevenfold. The number of *Copepoda* amounted to more than 90 per cent, of which more than half were young stages; the first *Cladocera* also appeared. In the next few weeks 75 to 1839 animals were found in a litre of water being most abundant from the middle of August to the end of September.

In the zooplankton of the pond „Księży" the rotifers prevailed numerically (Fig. 1); they were most numerous from the middle of June onwards with a maximum of 1357 specimens in 1 l of water at the end of September. Out of 23 species only *Keratella cochlearis* was constantly

Table II

Amount of individuals in 1 litre of water

Species \ Date	Apr. 10	Apr. 24	May 9	May 22	June 6	June 19	July 5	July 17	Aug. 1	Aug. 15	Aug. 28	Sept.11	Sept.25	Oct. 9
PROTOZOA														
Difflugia limnetica Lewander	2	2	14	5	14	18	76	44	77	100	96	530	98	8
Tintinnopsis lacustris Entz			6	31				8	3	36	24	52	2	12
ROTATORIA														
Trichocerca cylindrica Imhof						2	+		1	190	584	2	2	1
Ascomorpha sp.									29	36	30			
Asplanhna brightwelli Gosse				1				1	2	4				8
- priodonta Gosse		2						14	2	3	1	2	6	8
Ploesoma hudsoni Imhof											3	5		
Polyarthra euryptera Wierzejski						2		16		13				
- major Bruckhardt				+	+	2	22	32	26	65	70	420	605	44
- vulgaris Carlin				1				4			5	24	250	98
Brachionus angularis Gosse	+		+	1			2	30	22	44	34	34	12	2
- calyciflorus Wierzejski											3	2	2	
- rubens Ehrenberg									+					
Platyias patulus Mueller							+							
Keratella cochlearis Gosse	3	7	15	8	5	2	5	57	269	274	169	280	137	324
- - f. tecta Gosse								20	34		42	64	24	18
- quadrata Mueller		+	1	1		+		3	42	23	+	1	3	15
Trichotria pocillum Mueller				1				1	1					
Lepadella patella Mueller		+			1		+							
Colurella adriatica Ehrenberg			1	+										
Lecane luna Mueller			4						1	+				
Monostyla lunaris Ehrenberg			1					+		+				
- quadrientata Ehrenberg										+				
Filinia limnetica Zacharias	+													
- longiseta Ehrenberg							+					1		
Conochillus unicornis Rousselet	4		8	11	17	892	132	71	3	112	8			
Ova Rotatorium	8	3	23	17	5	2	13	14	7	41	122	134	316	84
CLADOCERA														
Diaphanosoma brachyurum Lieven						3	14	1	3	39	19	9	1	1
Daphnia longispina Mueller		3	19	64	4	57	86	41	12	5	17	5	37	2
Ceriodaphnia reticulata Sars					+					1				
- quadrangula Mueller				1		1		10		11			2	
- - var. pulchella Sars							1		18	5	24	5		+
Moina rectirostris Leydig								1			1	1	7	1
Bosmina longirostris Mueller		1	+	+					8	10	28		1	5
Acroperus harpae Baird							+	+						
Alona quadrangularis Mueller										1				
Chydorus sphaericus Mueller								+		+				
Polyphemus pediculus Linné							1	+		+	2			
COPEPODA														
Eudiaptomus vulgaris Schmeil		18	6	21	1	15	42	3	2					
- gracilis Sars										1	10	2	2	10
Mesocyclops leuckarti Claus	+	140	2	3		2	22	2	3	48	48	1		22
Metanauplius	1					1	8		9	38	10	42	36	
Nauplii	32	170	28	25	28	28	77	60	85	212	135	223	125	78
Total	50	346	128	191	75	1027	501	433	659	1312	1285	1839	1668	742

Note: Specimens marked "+" were discovered in the qualitative investigation of zooplankton samples, but not found when counting specimens in the chamber.

found; these were especially numerous in the second half of June (a maximum of 324 specimens in 1 l of water). *Conochilus unicornis* with a distinct maximum in the second half of June (822 in 1 l of water) and *Polyarthra major*, with up to 605 specimens towards the end of summer and in autumn, were fairly frequently seen. The species *Trichocerca cylindrica* in the second half of August (up to 384 specimens) and *P. vulgaris* towards the end of September (250 specimens) appeared in greater numbers.

Copepoda dominated, as already mentioned, immediately after the filling of the pond. They appeared in greater quantities (up to 299 specimens in 1 l of water) towards the end of summer and in autumn, but constituted less than 25 per cent of the total amount of animals. In all samples the young stages were much more numerous (up to 223 specimens in 1 l of water) than adult specimens which might have escaped during the collection of samples. Once only, soon after the filling of the pond, one of the three species which had been found *Mesocyclops leuckarti* was the only one present in greater numbers in nearly all samples (140 specimens in 1 l of water).

Cladocera were found in the greatest numbers at the beginning of July (a maximum of 102 in 1 l of water) and at the end of August. In the second half of May they constituted 34 per cent and at the end of July 20 per cent of the animals counted in a sample; however, they formed considerably less than 15 per cent altogether. In most of the samples *Daphnia longispina*, appearing almost constantly, was represented in the greatest numbers (a maximum of 86 specimens in 1 l of water at the beginning of July). *Diaphanosoma brachyurum* (a maximum of 39 specimens in the middle of August), *Ceriodaphnia quadrangula* with the *pulchella* variety, and *Bosmina longirostris* were found fairly often, especially during the summer.

Protozoa were more numerous at the beginning of September (1582 specimens in 1 l of water, i. e. 31.7 per cent of the whole amount of animals). Altogether, they formed slightly more than 15 per cent. Of the two determined species, *Difflugia limnetica* was found in all samples. Its numbers increased with a certain regularity in individual samples up to a sudden maximum at the beginning of September and then diminished rapidly.

In fig. 2 the species are listed according to dominance, the species appearing in an amount exceeding 10 per cent of the total number of individuals found in 14 samples being considered as dominants. Subdominants had a percentage of 1—10 per cent and adominants less than 1 per cent.

The dominating species were: *Keratella cochlearis, Nauplii, Polyarthra major, Conochillus unicornis,* and *Difflugia limnetica. Trichocerca cylindrica* and *Polyarthra vulgaris* were the most numerous of the subdominant species. The remaining 28 species should be considered as adominants.

It can be seen, from the above disposition, that in the zooplankton of the pond „Księży", in 1961, the *Rotatoria* and *Protozoa* prevailed numerically, while *Daphnia longispina* and *Mesocyclops leuckarti* were only subdominants.

In the plankton of the pond „Księży" littoral species were found, considered as characteristic for the euplankton of lakes, typical species

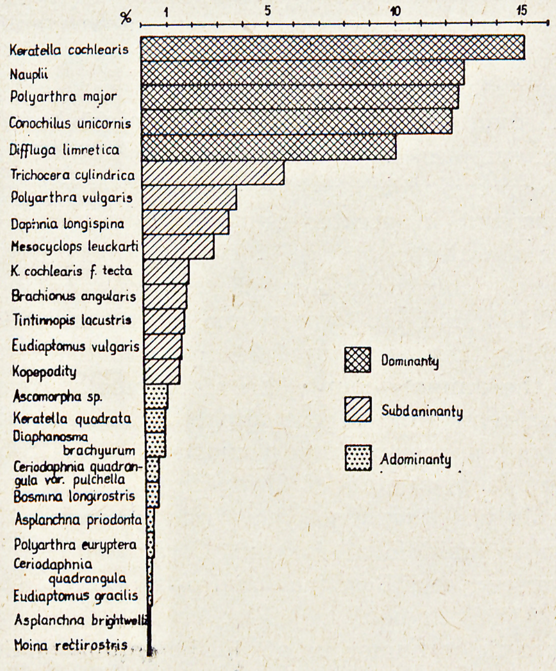

Fig. 2. Percentage of individuals of more important species in the total amount of individuals, E = 10 256.

for the zooplankton of ponds, and ubiquitous species. *Lecane luna, Monostyla lunaris, Monostyla quadridentata, Platyias patulus* are considered as littoral species (B a r t o š 1959); R y b a k (1960) calculated indices showing three times that the species *Diaphanosoma brachyurum* is a littoral form, and twice that it is a pelagial one. *Bosmina longirostris* is, in this author's opinion a littoral form in midsummer, and appears in the pelagial at the beginning of summer and in autumn. In the pond „Księży" this species was found in August in greater quantities and in autumn in smaller ones. The species considered as characteristic for the plankton of lakes and seldom seen in smaller reservoirs are: *Ploesoma hudsoni, Filinia limnetica,* and *Eudiaptomus gracilis* (R y l o v 1935).

Asplanchna brightwelli, Brachionus angularis, B. calyciflorus, Trichocerca cylindrica, Ceriodaphnia quadrangula var. *pulchella,* and *Eudiaptomus vulgaris* (Rylov 1935) are characteristic for plankton of lakes. Ubiquitous species were found in the greatest number (24 species).

Several specimens of *Asplanchna priodonta* were observed, their stomachs containing *Keratella cochlearis.* These observations are in accordance with those of Pawłowski (1958) and are opposed to the inferences of Beauchamp (1938) who maintains that *A. priodonta* does not feed on other rotifers.

The *Ploesoma hudsoni* species has not hitherto been observed in the ponds of the Gołysz Farm.

Zooplankton biomass

The numerical data discussed in the previous chapter served for the determination of the so-called biomass, i. e. the weight of animals present in the plankton. The amount of biomass obtained was calculated from each fishing for 1 m^3 of water from the pond (Table III).

Soon after the filling of the pond (April 10), there were only 149 mg of animals in the plankton of 1 m^3, 92 per cent of which consisted of young stages of the *Copepoda* (fig. 3). After two weeks the biomass was nearly 52 times as great; 93 per cent was composed of *Copepoda,* of which only 9 per cent belonged to young stages. At the beginning of May a decrease in the biomass, to 3682 mg/m^3, was observed, 72 per cent of which consisted of *Daphnia longispina* and 26 per cent of *Copepoda.* Towards the end of May the biomass increased up to 12 037 mg, of which 74 per cent was composed of *Daphnia longispina* and 23 per cent of *Eudiaptomus vulgaris.*

The smallest zooplankton biomass was observed at the beginning of June — 355 mg — and the greatest in the first half of July (19 398 mg). In this period *Daphnia longispina* formed 62 per cent and the *Copepoda* 34 per cent, of which 6 per cent were young stages. In turn, a decrease in the mass of animals was observed until the first days of August, after which a slight accrescence, maintained till September 25 occurred. The greater part of the biomass was again composed of the *Cladocera* (*Daphnia longispina*) and *Copepoda* (*Mesocyclops leuckarti* and *Eudiaptomus gracilis*) together with young stages.

A basic role in the whole biomass was played by Crustaceans. *Rotatoria* formed only 9 per cent of the zooplankton mass even when their number was greatest (at the end of September). The decisive role was played by *Daphnia longispina* of which 53 per cent of the whole biomass consisted. Then came, in turn, individuals of *Eudiaptomus vulgaris* (15 per cent), *Mesocyclops leuckarti* (9 per cent), *Conochilus unicornis* (2 per cent), *Nauplii* (5 per cent), *Metanauplius* (1 per cent). Individuals of *Daphnia longispina*

Table III

Biomass of individual species in mg calculated for 1 m^3 of water in the pond

Species \ Date	Apr. 10	Apr. 24	May 9	May 22	Jun. 6	Jun. 19	July 5	July 17	Aug. 1	Aug. 15	Aug. 28	Sept. 11	Sept. 23	Oct. 9
Difflugia limnetica	1,8	1,8	12,6	4,5	12,6	16,2	68.4	39.6	69,3	90,	86,4	477	88.2	7.2
Tintinnopsis lacustris			2,4	12,4				3.2	1,2	14.4	9,6	20.8	0.8	4.8
Trichocerca cylindrica						0,8	+		0.4	76	153,6	0,8	0.8	0.4
Ascomorpha sp.									11.6	14,4	12.0			
Asplanchna brightwelli				20				20	40	80				160
- priodonta		40						280	40	60	20	40	120	160
Ploesoma hudsoni											+	+		
Polyarthra euryptera						0,8		6.4		5.2				
- major				+	+	0,8	8.8	12,8	10.4	26.0	28,0	168,0	242	17,6
- vulgaris				0,4				1,6			2,0	9.6	100	39.2
Brachionus angularis	+		+	0,4			0,8	12.0	8.8	17,6	13.6	13.6	4,8	0,8
- calyciflorus spinosus											19.5	13,0	13,0	
- rubens									+					
Platyias patulus							+							
Keratella cochlearis	0,6	1,4	3,0	1,6	1,0	0.4	1,0	11.4	53.8	54.8	33.8	56,0	27.4	64,8
- quadrata		+	0.4	0.4		+		1.2	16,8	9.2	+	0.4	1,2	6,0
Trichotria pocillum				+				+	+					
Lepadella patella		+			+		+							
Colurella adriatica			+	+										
Lecane luna			3,6						0,9	+				
Monostyla lunaris			0,5					+						
- quadridentata										+				
Filinia limnetica	+													
- longiseta							+					0.3		
Conochilus unicornis	8		16	22	34	1784	264	142	6	224	16			
Ova Rotatorium	0,8	0,3	2,3	1,7	0,5	0,2	1,3	1.4	0.7	4.1	12.2	13,4	31.6	8.4
Diaphanosoma brachyurum						45	210	15	45	585	285	135	15	15
Dapnia longispina		420	2660	8960	560	7980	12040	5740	1680	700	2380	700	5180	280
Ceriodaphnia reticulata										25				
- quadrangula				25		25	0	250		275			50	
- - var. pulchella							25		450	125	600	125		+
Moina rectirostris								10			10	10	70	10
Bosmina longirostris		7,8	+	+					62.4	78	218.4		7,8	39,0
Acroperus harpae							+	+						
Alona quadrangularis										2				
Chydorus sphaericus								+		+				
Polyphemus pediculus							61	+		+	122			
Eudiaptomus vulgaris		2430	810	2835	135	2025	5670	405	270					
- gracilis										135	1350	270	270	1350
Mesocyclops leuckarti	+	4200	60	90		60	660	60	90	1440	1440	30		660
Metanauplius	10					10	80		90	380	100	420	360	
Nauplii	128	680	112	100	112	112	308	240	340	848	540	892	500	312
Total	149.2	7781,3	3682.8	12073.4	855,1	12060.2	19398.3	7251.6	3287.3	5268.7	7452.1	3394.9	7082.6	3137.2

Note: Owing to a lack of data concerning the wight of Ploesema hudsoni species, the biomass of this species was marked in the table by the symbol had the greatest biomass during the whole period of investigation (fig. 4). Only in the middle of August had individuals of the *Mesocyclops leuckarti* a greater biomass.

The greatest biomass of *Daphnia longispina* was noted at the beginning of July. It then amounted to 12 040 mg/m^3, the smallest, at the beginning

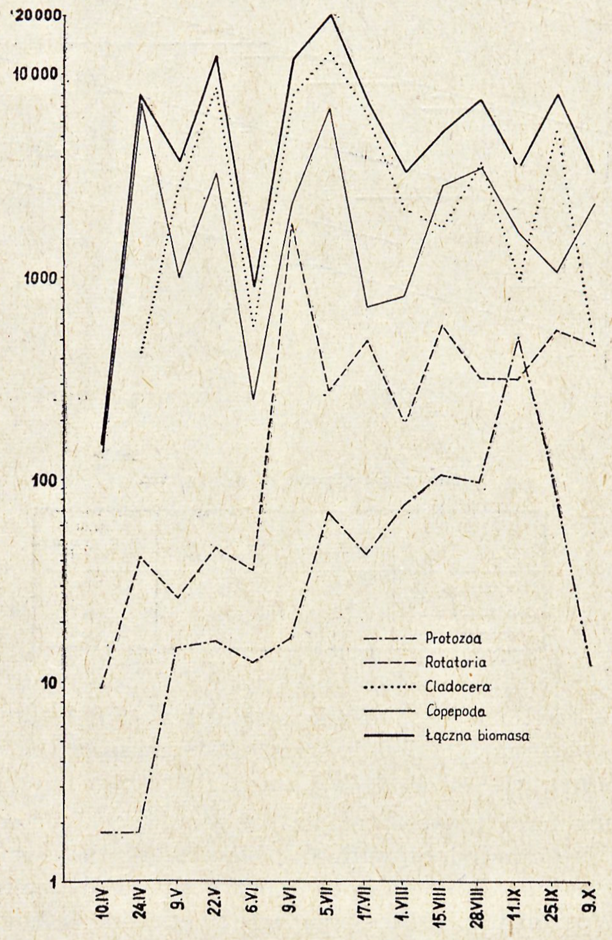

Fig. 3. Zooplankton biomass in 1 m^3 of water (logarithmic scale).

of June, being 560 mg/m^3. *Eudiaptomus vulgaris* appeared from April to August; the greatest biomass of individuals of this species was found at the beginning of July — 5670 mg — and the smallest, 270 mg/m^3, at the beginning of August.

The greatest biomass of *Mesocyclops leuckarti*, 4200 mg/m^3, was noted at the end of April and the smallest in the first fortnight of September. The greatest biomass of the *Nauplii* was found at the beginning of

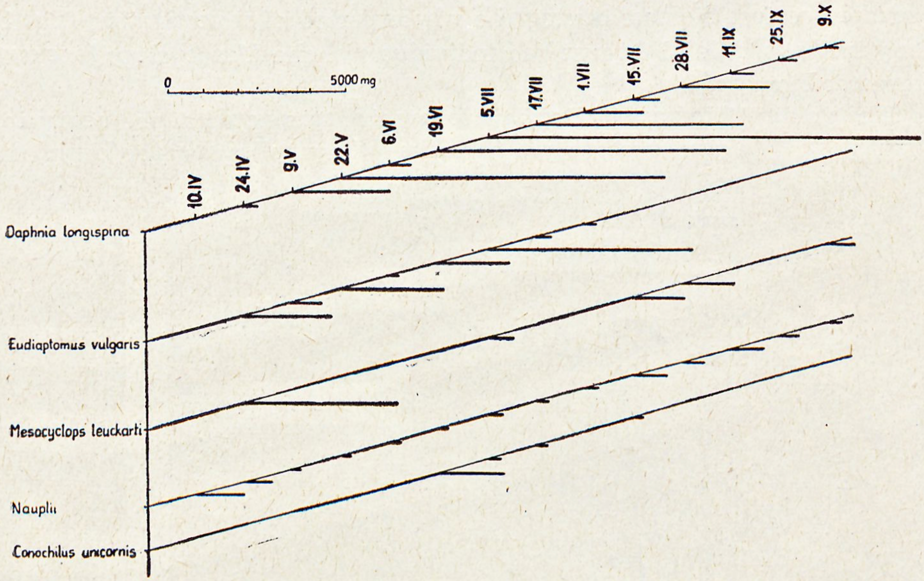

Fig. 4. Biomass of the important animals in 1 m^3 of water.

Table IV

Amount and biomass of zooplankton

	Number of species	Number of individuals in per cent	Biomass in g per m^3 of water
Dominants	5	63.3	9.5
Subdominants	9	31.3	74.7
Adominants	28	5.4	8.4

September — 892 mg -- and the smallest at the beginning of April. *Conochilus unicornis* attained its greatest biomass in the second half of June — 1784 mg/m^3 — the smallest being at the beginning of August.

A comparison of the composition of zooplankton determined on the basis of species dominance with the biomass of these species provides interesting results (Table IV). It appears that the dominating species forming 63,3 per cent of all the zooplankton specimens, have a biomass of only 9.5 mg/m^3. Subdominants, however, constituting 31.3 per cent of all specimens, have a biomass of 74.7 mg/m^3.

It results, therefore, that in order to characterise a zooplankton, and especially in order to stress its importance as a food reserve for fish, determination of the biomass is the most expedient. The total biomass of the zooplankton for the whole pond (assuming that 17 500 m^3 is the volume of water in the pond) amounted to approximately 1625.3 kg.

STRESZCZENIE

Badano zooplankton porównawczego stawu rybnego „Księży" w 1961 roku, w Gospodarstwie Doświadczalnym PAN w Gołyszu (pow. Cieszyn). Staw zalano w kwietniu 1961 r., a wodę spuszczono w październiku tegoż roku. Najwyższa temperatura wody za cały okres produkcji stawu wynosiła 23,7 °C, a najniższa 12,6 °C; pH wody wahało się w granicach od 6,7 do 7,6, alkaliczność od 0,8 do 1,3, ilość tlenu od 2,09 do 10,94 mg na 1 litr wody (Tabela I).

W planktonie znaleziono 2 gatunki *Protozoa*, 23 *Rotatoria*, 10 *Cladocera* i 3 *Copepoda*. Stwierdzono gatunki litoralowe, gatunki podawane jako charakterystyczne dla zooplanktonu jezior, typowe gatunki dla zooplanktonu stawów i gatunki ubikwistyczne.

Największą ilość zooplanktonu stwierdzono w pierwszej połowie września (1839 okazów/l wody), a najmniejszą z początkiem kwietnia (50 okazów/l). (Rys. 1). Ilościowo przeważały *Rotatoria*, z kolei *Copepoda*, *Protozoa* i *Cladocera* (Tabela II). Gatunkami dominującymi były: *Keratella cochlearis*, *Nauplii*, *Polyarthra major*, *Conochilus unicornis* i *Difflugia limnetica* (Rys. 2).

Orientacyjna biomasa zooplanktonu dla całego stawu (17 500 m^3 wody) za cały okres wynosiła 1625,5 kg. Największą biomasę stwierdzono w pierwszej połowie lipca (19 398 mg/m^3), a najmniejszą z początkiem kwietnia (149,2 mg/m^3) (Tabela III). Podstawową rolę w biomasie grały *Cladocera* i *Copepoda* (Rys. 3). Decydującą rolę odgrywa *Daphnia longispina*, która stanowiła 53% całej biomasy, z kolei *Eudiaptomus vulgaris*, *Mesocyclops leuckarti*, *Nauplii*, *Conochilus unicornis* (Rys. 4.). Dominanty stanowiące 63,3% wszystkich okazów zooplanktonu miały biomasę zaledwie 9,5 mg/m^3, natomiast subdominanty 31,7% wszystkich okazów miały biomasę 74,7 mg/m^3 (Tabela IV).

Ogólna ilość planktonu zwiększała się aż do końca września i spadła dopiero w październiku, jednak większe okazy zwierząt, korzystne jako pokarm dla ryb, znikły z planktonu praktycznie już z końcem sierpnia.

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