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Fitoplankton w stawach rybnych przy stosowaniu insektycydu fosforoorganicznego (Neguvon)

Phytoplankton in fish ponds treated with an organophosphorus insecticide (Neguvon)

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Abstract — Phytoplankton of first rearing ponds treated with Neguvon, an organophosphorus insecticide, was investigated. Changes occurring in the qualitative composition and in the dynamics of algae numbers are discussed. The dependence on zooplankton whose composition can be adapted to the demands of fish culture by appropriate insecticide treatments, is shown.

Numerous investigations are being carried out on the important problem of biocenoses as affected by insecticides. In the Laboratory of Water Biology of the Polish Academy of Sciences in Kraków special attention has been paid to this problem with reference to fish ponds.

The question can also have a practical impact in fish culture since appropriate insecticide treatments can stimulate the development of the beneficial species and eliminate those impairing fish culture in a given water body.

The influence of pesticides on communities or individual species of aquatic plants and animals were investigated by many authors (Cabejszek et al. 1973, Cooc, Conners 1963, Hurlbert et al. 1972, Lirski et al. 1976, Ranke-Rybicka, Stanisławska 1972).

The present investigation was concerned with the phytoplankton of four first rearing ponds of the Experimental Station of the Polish Academy of Sciences at Gołysz (Province of Bielsko). The experiments were conducted in 1976. Two rearing ponds (No. 1 and No. 3) were treated with Neguvon, which was introduced in two doses of 2.2 kg on the 29th of May, before the ponds were stocked with carp fry, and on the 9th of June. Two other rearing ponds (No. 2 and No. 4) were used as controls. Mineral and organic fertilization was applied in all ponds, 250 kg/ha of ammonium sulphate and 37 kg/ha of superphosphate being given in 5 rates at 1-week intervals. Prior to the filling, all ponds were fertilized with a 5 q/ha dose of farmyard manure.

Net samples (strained through a plankton net of No. 25 bolting cloth) were collected using a Patalas bathometer while unfiltered water samples were used for nannoplankton examination. These two types of samples, collected from all ponds, were examined separately with reference both to their quantitative and qualitative composition. On the basis of the same net samples, zooplankton occurring in them was studied, the numbers of the most numerous representatives being estimated in order to use these data in the interpretation of results. Aside from the present work, zooplankton and chemism were investigated and ichtyological research was carried out in these same ponds (L e w k o w i c z et al. 1979).

Data concerning the investigated ponds, dates and doses of the insecticide, and the ichtyological data are given in Table I. Quantitative lists based on two types of samples, calculated per 1 ml of water, are given in Table II—IV and in fig. 1, while Table IV contains data on the qualitative composition of algae.

Tabela I. Dane dotyczące użytkowania poszczególnych stawów w 1976 r.

Table I. Data on the utilization of separate ponds in 1976

Staw Pond	Powierzchnia Area ha	Okres zalania Period of filling	Dawki stosowanego preparatu Doses of the insecticide	Obsada szt./ha Stocking indiv./ha	Przeżywalność Per cent survival %	Przyrost jednost. Weight increases g	Odłów Catch kg/ha
Neguvon							
nr 1	0.47	31.V. – 16.VII.	à 2.2 kg 29.V.–9.VI.	80 000	21.40	8.82	152.662
nr 3	0.42			80 000	8.10	10.94	73.976
Średnia Mean	0.44			80 000	14.75	9.88	113.319
Kontrola Control							
nr 2	0.47	31.V. – 16.VII.		80 000	0.8	10.20	6.034
nr 4	0.43			80 000	1.0	7.72	5.740
Średnia Mean	0.45			80 000	0.9	8.96	5.887

Tabela II. Liczebność glonów w obrębie poszczególnych grup systematycznych (w ml wody). Stawy 1 i 3 - stawy traktowane Neguvonem; stawy 2 i 4 - stawy kontrolne. + - mniej niż 1 okaz/ml wody

Table II. Number of algae in separate systematic groups (per 1 ml water). Ponds No. 1 and No. 3 - treated with Neguvon; ponds No. 2 and No. 4 - controls. + - less than 1 indiv./ml water

Grupy systematyczne / Systematic groups	Data poboru - Date of sampling												
	1.6.	4.6.	8.6.	11.6.	15.6.	18.6.	22.6.	25.6.	29.6.	2.7.	6.7.	9.7.	14.7.
S t a w nr 1 - P o n d No. 1													
Cyanophyta	20	350	170	960	5	170	-	270	-	5	10	-	-
Euglenophyta	-	120	-	-	-	-	470	5	1	20	-	20	-
Dinophyceae	-	-	-	950	-	90	-	-	-	-	-	-	-
Cryptophyceae	6 350	2 870	790	34 220	1 970	6 340	62 740	77 080	1 220	1 080	250	4 070	-
Chrysophyceae	-	-	-	-	-	-	-	-	30	-	-	-	-
Bacillariophyceae	20	130	60	960	80	90	5	270	-	-	40	370	5 000
Volvocales	2 980	5 860	4 730	51 620	4 510	430	1	1 360	12 720	-	10	-	-
Chlorococcales	14 260	11 350	6 670	95 040	7 220	6 510	6 430	34 570	16 250	3 160	110	25 560	665 000
S t a w nr 2 - P o n d No. 2													
Cyanophyta	-	890	60	-	-	5	-	-	-	60	-	-	
Euglenophyta	-	-	60	-	-	-	-	-	-	+	5	+	
Cryptophyceae	240	1 780	430	-	-	19 700	5	190	400	2 250	-	280	
Chrysophyceae	-	10	-	320	-	-	-	-	-	-	-	-	
Bacillariophyceae	5	690	5	-	-	19 700	-	-	-	230	10	110	
Volvocales	390	1 770	370	-	-	-	1 240	-	-	-	-	20	
Chlorococcales	6 030	32 680	17 350	150 960	89 380	7 663 000	192 850	24 020	930	8 240	440	2 120	
S t a w nr 3 - P o n d No. 3													
Cyanophyta	820	5	160	15	-	1	180	-	-	70	40	2	
Euglenophyta	-	-	-	-	-	-	-	1	25	1	45	5	
Cryptophyceae	6 750	4 830	1 020	510	5 970	5 730	2 450	1 050	280	7 430	4 500	590	
Chrysophyceae	190	5	-	-	-	-	-	-	-	-	-	-	
Bacillariophyceae	700	620	320	30	110	300	1 050	80	1	210	120	200	
Volvocales	940	1 810	710	15	-	5	-	-	-	-	-	70	
Chlorococcales	3 140	11 340	25 430	1 390	4 130	8 770	36 790	2 920	3 260	7 360	1 080	1 080	
Conjugales	-	-	-	-	-	-	-	-	-	-	-	20	
S t a w nr 4 - P o n d No. 4													
Cyanophyta	-	1	10	10	1	180	30	+	-	60	1 240	350	
Euglenophyta	-	-	-	-	-	-	-	-	5	5	830	180	
Cryptophyceae	2 050	150	-	320	5 410	38 830	1 000	1 940	1 940	1 130	3 730	1 400	
Chrysophyceae	80	40	60	70	1	-	-	-	-	-	-	-	
Bacillariophyceae	-	-	-	50	980	910	30	+	20	690	3 320	880	
Volvocales	60	-	110	110	170	2 300	1 790	+	-	140	-	180	
Chlorococcales	590	130	340	2 210	1 570	2 900	1 980	20	320	3 760	29 450	28 560	
Conjugales	-	-	-	-	-	5	-	-	-	-	-	-	

Tabela III. Najliczniejsze taksony fitoplanktonu (w 1 ml wody) w czterech badanych stawach w 1976 r. Stawy 1 i 3 - stawy traktowane Neguvonem; stawy 2 i 4 - kontrolne. + - mniej niż 1 okaz/ml wody

Table III. The most numerous phytoplankton taxons (per 1 ml water) in four investigated ponds in 1976. Ponds No. 1 and No. 3 - treated with Neguvon; ponds No. 2 and No. 4 - controls. + - less than 1 indiv./ml water

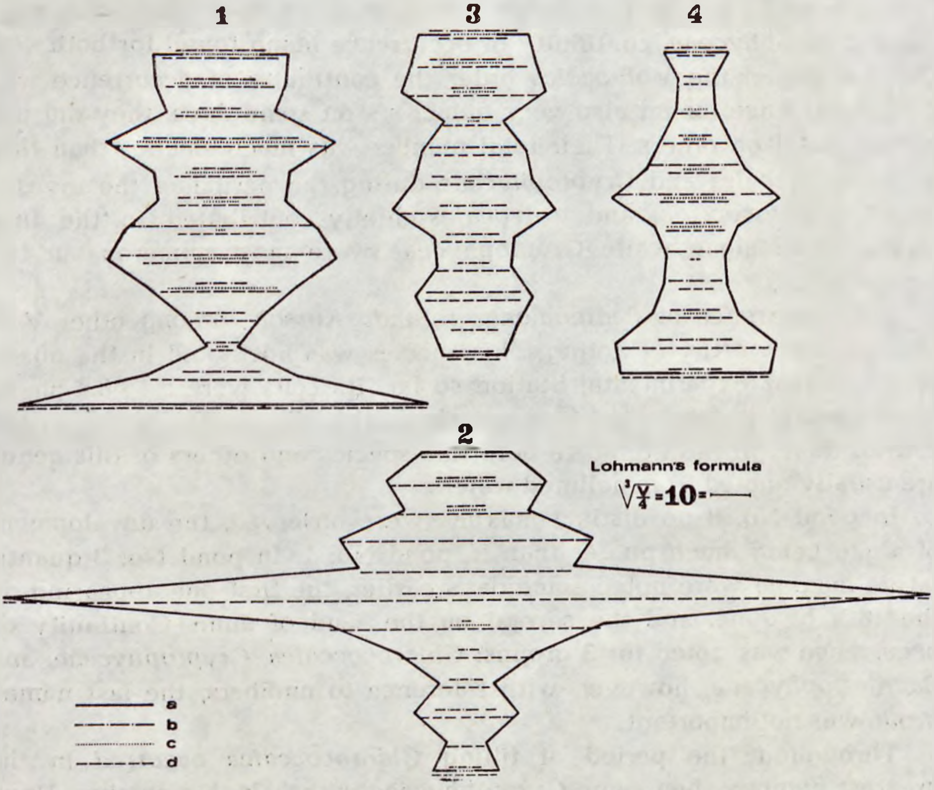
Gatunek - Species	Data poboru - Date of sampling												
	1.6.	4.6.	8.6.	11.6.	15.6.	18.6.	22.6.	25.6	29.6	2.7.	6.7.	9.7.	14.7
Staw nr 1 - Pond No. 1													
Cryptomonas erosa Ehr.	4 280	2 870	790	34 210	1 970	6 340	14 010	57 480	630	690	250	1 850	-
Cryptomonas sp.	2 070	-	-	-	-	5	48 730	19 600	600	400	-	2 220	-
Chlamydomonas sp.	2 980	5 450	4 360	48 170	4 510	430	-	1 360	220	-	10	-	-
Ankistrodesmus falcatus (C.) Ralfs	520	290	-	950	80	90	140	5 170	90	+	30	10 920	475 000
- pseudomirabilis Korschik.	7 000	860	50	-	80	-	270	540	60	-	-	-	-
Ankistrodesmus sp. div.	130	170	-	-	-	-	-	270	-	-	-	-	-
Diacanthos belenophorus Korschik.	-	60	-	2 850	1 150	170	-	270	1	-	-	-	-
Kirchneriella lunaris (Kirch.) Moebius	-	-	50	-	-	90	-	1 900	60	20	10	1 850	57 560
Micractinium pusillum Fr.	520	670	470	-	410	2 740	-	-	-	-	-	-	-
Scenedesmus ecornis (Ralfs) Chod.	-	-	-	-	-	-	-	3 810	1 270	-	-	-	-
- quadricauda Chod.	1 170	1 150	680	950	330	770	1 830	13 880	-	980	-	-	-
- spinosus Chod.	260	-	160	2 850	-	170	-	1 630	-	340	-	-	-
Scenedesmus sp. div.	-	340	160	-	-	-	1 020	2 450	3 060	390	340	12 030	110 000
Tetraëdron caudatum (Corda) Hansg.	390	170	-	-	-	-	-	-	30	-	-	190	2 500
- trigonum (Naeg.) Hansg.	-	60	-	-	250	1 290	3 110	-	90	-	-	370	5 000
Tetraëdron sp. div.	-	230	110	-	-	90	-	540	30	50	-	-	-
Pedinomonas rotunda Korsch.	-	-	-	-	-	-	-	-	12 500	-	-	-	-
Staw nr 2 - Pond No. 2													
Nitzschia sp.	-	300	-	-	-	19 700	-	-	-	230	10	70	-
Actinastrum Hantzschii Lagerh.	-	300	1 670	1 660	-	-	-	-	-	-	-	-	-
Ankistrodesmus arcuatus Korschik.	310	2 070	740	1 660	-	5	-	-	-	-	-	-	-
- falcatus (Corda) Ralfs	240	390	310	-	5	19 700	-	-	-	-	10	280	-
- pseudomirabilis Korschik.	310	2 950	1 730	-	10	-	1 240	290	10	-	-	-	-
Coelastrum microporum Naeg.	-	2 850	500	3 320	880	157 590	-	-	-	-	-	-	-
- proboscideum Bohlin	630	100	930	4 980	10 510	157 590	5	-	-	-	-	-	-
Scenedesmus quadricauda Chod.	2 820	15 650	-	71 330	58 700	-	174 180	22 960	600	4 440	260	-	-
- spinosus Chod.	-	4 240	-	61 380	17 520	-	12 440	680	250	2 420	80	-	-
Scenedesmus sp. div.	160	1 770	9 970	3 320	-	7 170 510	2 490	-	70	1 210	100	1 840	-
Tetraëdron caudatum (Corda) Hansg.	160	790	370	1 660	880	5	1 240	-	-	-	-	-	-
- trigonum (Naeg.) Hansg.	80	300	120	-	-	19 700	-	100	-	-	-	-	-
Tetraëdron sp. div.	1	200	250	5	880	-	1 240	-	-	-	-	-	-
Staw nr 3 - Pond No. 3													
Cryptomonas erosa Ehr.	6 750	4 830	1 020	510	5 970	5 730	2 450	1 050	230	970	1 730	590	-
Cryptomonas sp.	-	-	-	-	-	-	-	-	50	6 460	2 770	-	-
Chlamydomonas sp.	940	1 660	710	10	-	3	-	-	-	-	-	70	-
Actinastrum Hantzschii Lagerh.	60	2 110	4 170	530	1	150	880	-	-	-	-	-	-
Ankistrodesmus pseudomirabilis Korschik.	60	1 360	1 420	10	-	150	1	160	-	-	-	-	-
Ankistrodesmus sp. div.	450	750	240	10	60	300	5 600	510	2 540	830	5	140	-
Coelastrum microporum Naeg.	60	10	710	100	450	600	5	1	1	3	6	20	-
Coelastrum sp. div.	60	1 060	630	270	500	620	7 020	3	-	-	-	-	-
Kirchneriella lunaris (Kirch.) Moebius	-	-	-	10	-	1	180	-	-	-	-	-	-
Kirchneriella sp.	250	1	-	-	-	-	1 750	-	20	-	2	-	-
Lambertia sp.	380	1	80	-	-	-	-	-	90	5 780	40	20	-
Micractinium pusillum Fr.	-	150	1 420	-	-	-	-	-	-	-	-	-	-
Scenedesmus quadricauda Chod.	-	3 320	13 380	170	-	2 110	13 000	1 480	-	-	550	-	-
- spinosum Chod.	-	300	400	-	-	2 870	-	80	-	-	170	-	-
Scenedesmus sp. div.	1 310	1 210	2 050	170	2 900	450	4 330	190	580	760	210	220	-
Staw nr 4 - Pond No. 4													
Cryptomonas erosa Ehr.	1 100	150	-	320	5 410	38 830	1 000	1 940	1 940	1 130	3 730	1 400	-
Nitzschia sp.	-	-	-	20	-	-	30	-	20	440	1 660	350	-
Chlamydomonas sp.	40	-	100	70	2	2 360	370	-	-	-	-	180	-
Ankistrodesmus falcatus (Corda) Ralfs.	-	1	1	-	+	360	50	-	40	380	2 070	1 930	-
Ankistrodesmus sp. div.	-	-	-	3	50	180	160	-	20	3	420	350	-
Dictyosphaerium pulchellum Wood	-	-	-	-	50	2 000	30	-	-	130	830	2 280	-
Kirchneriella lunaris (Kirch.) Moebius	-	-	-	20	-	-	-	-	20	-	1 660	860	-
Kirchneriella sp.	-	-	-	-	-	-	-	-	-	-	-	2 100	-
Lambertia sp.	320	50	330	1 930	-	-	30	-	-	-	-	-	-
Scenedesmus quadricauda Chod.	160	50	1	30	920	4 720	1 100	20	40	2 130	15 760	13 000	-
- spinosus Chod.	-	-	-	-	50	-	80	-	40	690	2 900	2 000	-
Scenedesmus sp. div.	40	-	-	70	220	910	320	-	80	380	2 070	400	-

Tabela IV Skład jakościowy fitoplanktonu w poszczególnych stawach. Stawy nr 1 i 3 - traktowane Neguvonem; stawy nr 2 i 4 - kontrolne

Table IV Qualitative composition of phytoplankton in the investigated ponds Ponds No. 1 and No. 3 - treated with Neguvon; ponds No. 2 and No. 4 - controls

Gatunek - Species	Staw nr - Pond No.			
	1	3	2	4
Anabaena sp.	+	+	+	+
Chroococcus sp.	+	+		
Gomphosphaeria pusilla (Van Goor) Komarek	+			
Gomphosphaeria sp.	+			+
Lyngbya sp.	+			
Merismopedia glauca (Ehr.) Näg.		+		
- punctata Meyen	+			+
- tenuissima Lemm.	+	+		+
Merismopedia sp.	+			
Microcystis aeruginosa Kütz.		+		+
Oscillatoria Agardhii Gomont	+			
- maior Vaucher	+			
- minima Gicklhorn	+			
- planctonica Wołoszyńska		+		
- pseudogeminata G. Schmid		+		
Oscillatoria sp.	+	+	+	+
Phormidium sp.	+			
Pseudoanabaena sp.	+	+	+	+
Romeria sp.			+	
Cyanophyceae n. det.	+	+		+
Astasia Harrisii Pring.			+	
Astasia sp.	+		+	
Colacium sp.		+	+	+
Euglena acus Ehr				+
- viridis Ehr.	+			
Euglena sp.	+		+	+
Phacus tortus (Lemm.) Skv.	+		+	+
- triqueter (Ehr.) Dujardin				+
Trachelomonas planctonica Swir	+	+		
- rotunda Swir. em. Defl.		+		
Trachelomonas volvocina Ehr	+	+		+
Euglenophyta n. det.	+			
Peridinium cinctum (Muell.) Ehr	+			
Peridinium sp.	+			
Cryptomonas erosa Ehr				+
- Marssonii Skuja				+
Cryptomonas sp.	+	+	+	+
Chromulina sp.	+	+		
Chrysococcus minutus (Fritsch) Nyg.		+		
Dinobryon divergens Imh	+	+	+	+
Ochromonas sp				+
Synura uvella E.	+			+
Achnanthes sp.	+			
Ceratoneis arcus (Ehr.) Kütz.			+	
Cocconeis placentula Ehr.		+		
Cyclotella comta (Ehr.) Kütz.	+	+	+	+
Cyclotella sp.	+	+	+	+
Cymatopleura sp.				+
Cymbella sp.		+		
Diatoma vulgare Bory	+			
Diatoma sp.			+	
Eunotia sp.	+			
Fragilaria crotonensis Kitt.		+		+
Gomphonema angustatum (Kütz.) Rabh.	+			
Gomphonema sp.		+		+
Melosira granulata (Ehr.) Ralfs			+	
- varians Ag.				+
Navicula cuspidata Kütz.	+			
- cuspidata var. ambigua (Ehr.) Cl.	+			
- pupula Kütz.	+			
- rhynchocephala Kütz.	+			+
- viridula Kütz	+	+		+
Navicula sp	+	+	+	+
Nitzschia acicularis W. Sm.	+	+	+	
- dissipata (Kütz.) Grun.	+			
Nitzschia sp.	+	+	+	+
Pinnularia mesolepta (Ehr.) W.Sm.	+	+		
Pinnularia sp.	+			
Stauroneis anceps Ehr.	+			
Stauroneis sp.			+	
Stephanodiscus sp.	+	+		+
Surirella angustata Kütz	+			
Surirella sp	+	+	+	
Synedra acus Kütz.	+			+
- ulna (Nitzsch) Ehr		+		+
Bacillariophyceae n. det.	+	+	+	
Ophiocytium capitatum Wolle			+	
Chlamydomonas sp	+	+	+	+
Eudorina elegans Ehr	+	+		+
Gonium pectorale Müll	+	+	+	+
Pandorina morum (Müll.) Bory	+	+	+	+
Pedinomonas rotunda Korsch	+			
Volvox aureus Ehr				+
Ulothrix sp.	+	+		
Actinastrum Hantzschii Lagerh.	+	+	+	+
Ankistrodesmus acicularis (A.Br.) Korschik.	+	+	+	
- arcuatus Korschik.	+	+	+	+
- Braunii Brunnth.		+		
- convolutus Corda		+		
- falcatus (Corda) Ralfs	+	+	+	+
- minutissimus Korschik.	+			
- pseudomirabilis Korschik	+	+	+	+
Ankistrodesmus sp.		+		
Asterococcus superbus (Cienk.) Scherff.		+		+

Gatunek - Species	Staw nr - Pond No.			
	1	3	2	4
Characium limneticum Lemm.		+		
Characium sp.		+	+	+
Coelastrum microporum Naeg		+	+	+
- proboscideum Bohl.	+	+	+	+
- reticulatum (Dang.) Senn			+	+
Coelastrum sp.			+	
Crucigenia apiculata Schmidle	+	+	+	+
- fenestrata Schmidle				+
- quadrata Morren	+	+	+	
- rectangularis (A.Br.) Gay	+	+		+
- tetrapedia (Kirchn.) W. et W	+	+	+	+
Crucigenia sp.		+		
Diacanthos belenophorus Korschik.	+	+		
Dictyosphaerium pulchellum Wood	+	+	+	+
Elakatothrix gelatinosa Wille	+	+		
Franceia sp.	+			
Golenkinia brevispina Korschik.				+
Golenkinia radiata Chod.	+	+	+	+
Hydrodictyon reticulatum (L.) Lagerh.		+		
Kirchneriella contorta (Schmidle) Bohl.			+	
- elongata G.M. Smith		+	+	
- lunaris Moeb.	+	+		+
- - var. irregularis Smith				+
Kirchneriella sp.	+			
Lagerheimia wratislaviensis Schroeder	+	+	+	
Lambertia Judayi (Smith) Korschik.		+	+	
Lambertia sp.	+	+	+	+
Micractinium quadrisetum (Lemm.) G.M.Smith	+			
- pusillum Fr.	+	+	+	+
Oocystis elliptica West	+	+	+	+
- gigas Archer		+		
- lacustris Chod.		+		
- pusilla Hansg.	+	+		+
- solitaria Wittr		+		
Oocystis sp.	+	+	+	
Pediastrum Boryanum (Turp.) Menegh.	+	+	+	+
- duplex Meyen	+	+	+	+
- tetras (Ehr.) Ralfs	+	+	+	+
- - var. tetraodon (Corda) Rabenh.	+			
Raphidonema sp.			+	
Scenedesmus acuminatus (Lagerh.) Chod.	+	+	+	+
- - var. biseriatus Reinh.		+	+	
- - f. tortuosus Skuja	+			+
- acutus Meyen	+	+	+	+
- - f. alternans Hortob.				+
- arcuatus Lemm.		+	+	
- armatus Chod.	+	+	+	+
- - var. bicaudatus Chod.		+		+
- baculiformis Chod.				+
- Bernardii G.M. Smith				+
- bicaudatus (Hansg.) Chod.	+			
- brasiliensis Bohl.	+	+	+	+
- brevispina (G.M.Smith) Chod.		+		
- circumfusus Hortob.	+			
- denticulatus Kirchner	+	+	+	+
- ecornis (Ralfs) Chod.	+	+	+	+
- ellipsoideus Chod.		+		
- granulatus W. et G.S. West	+			
Scenedesmus intermedius Chod.	+	+	+	
- - var. bicaudatus Hortob.		+		+
- opoliensis P. Richt.		+	+	
- ovalternus Chod.				+
- spinosus Chod.	+	+	+	+
- quadricauda Chod.	+	+	+	+
- - var. longispina (Chod.) G.M.Smith	+	+		+
- - - f. asymetricus (Hortob.) Uherkov.		+		
- - var. Westii (G.M. Smith) Chod.				+
Scenedesmus sp.			+	+
Selenastrum Bibraianum Reinsch	+	+		
- gracile Reinsch			+	
Schroederia setigera (Schroed.) Lemm.	+	+		
Sphaerocystis Schroeteri Chod.				+
Tetradesmus sp.		+		
Tetraëdron caudatum (Corda) Hansg.	+	+	+	+
- incus (Teil.) G.M. Smith	+	+	+	+
- minimum (A.Br.) Hansg.	+	+	+	+
- trigonum (Naeg.) Hansg.	+	+	+	
- regulare Kütz.	+	+	+	+
- - var. incus Teiling	+	+		
Tetrastrum glabrum (Roll) Ahlstr. et Tiff.	+	+	+	
- heteracanthum (Nordst.) Chod.	+			
- staurogeniaeforme (Schroed.) Lemm.	+	+	+	+
Closterium acerosum (Schrank) Ehr.		+		+
- moniliferum (Bory) Ehr.		+		+
Closterium sp.	+			+
Cosmarium Botrytis Menegh.	+	+		
- granatum Bréb.	+	+		+
- subtumidum Nordst.				+
- undulatum Corda	+			
Cosmarium sp.			+	+
Spirogyra sp.		+		
Staurastrum sp.				+
Chlorophyta n. det.	+			
Antophysa vegetans (O. F. M.) Stein	+			



Ryc. 1. Ogólna ilość fitoplanktonu oraz najliczniejsze jego grupy w czterech badanych stawach w 1976 r. Stawy 1 i 3 traktowane Neguvonem; stawy 2 i 4 — kontrolne. a — ogólna ilość glonów; b — *Cryptophyceae*; c — *Volvocales*; d — *Chlorococcales*

Fig. 1. Total number of phytoplankton and its most numerous groups in four investigated ponds in 1976. Ponds 1 and 3 treated with Neguvon; ponds 2 and 4 — controls. a — total number of algae; b — *Cryptophyceae*; c — *Volvocales*; d — *Chlorococcales*

Phytoplankton in ponds treated with Neguvon

In pond No. 1 the most abundant development of algae was noted on the 14th of July. Since on this day pond No. 1 was the only one to be filled with water while the other ones were almost empty and it was not possible to collect samples from them, the data for this period cannot be compared with data from any other pond.

In the period when samples were collected from all ponds (from the 1st of June to the 9th of July), the first maximum of algae appeared on the 14th of June and another, a smaller one, on the 25th of June in this pond. On other sampling days poor development of the phytoplankton was found there.

Chlorophyta of the *Chlorococcales* order were most numerous, next came *Cryptophyceae*, continuity of occurrence being found for both. For *Chlorophyta* of the *Volvocales* order the continuity of occurrence was not found, since, being also very numerous on some days, they did not appear at all on others. Their total number was much smaller than that of *Chlorococcales* and *Cryptophyceae* during the period of the investigation. *Chlorococcales* and *Volvocales* chiefly contributed to the first maximum of algae while Cryptophyceae were most numerous in the second one.

The occurrence of *Pedinomonas rotunda Korsch.*, among other *Volvocales* was worthy of noting. This species was not noted in the ponds of the Gołysz Experimental Station so far. Its cells were 5.4—8.4 μm in diameter and it dominated in a sample collected from this pond on the 29th of June. In the literature both this species and others of this genus are usually quoted from polluted waters.

In pond No. 3 no distinct maxima were observed, the development of algae being much poorer than in pond No. 1. In pond No. 3 quantitative maxima were noted some days earlier, the first one appearing on the 18th of June, and the second on the 22nd of June. Continuity of occurrence was noted for 3 groups: *Chlorococcales*, *Cryptophyceae*, and *Bacillariophyceae*, however, with reference to numbers, the last named group was not important.

Throughout the period of filling *Chlorococcales occurred* in the greatest number, then came *Cryptophyceae* with half this number. Upon examining samples from different dates, *Chlorococcales* prevailed in their prevailing part while in a few samples only *Cryptophyceae* were found to dominate.

Phytoplankton in the control ponds

In the control pond No. 2 the total numbers of algae were similar to those found in pond No. 1 enriched with Neguvon. The only difference was that only one blooming was noted in pond No. 2 on the 18th of June. During the blooming the number of algae was almost 15 times greater than the total of phytoplankton at all other dates of sampling in this pond.

The pond was characterized by the domination of *Chlorococcales* throughout the whole period of filling, the constant dominants, *Scenedesmus quadricauda* and *S. spinosus*, being responsible for this strong blooming.

In pond No. 4 the development of phytoplankton was poor, similar to that in pond No. 3. *Chlorococcales* were most numerous while *Crypto-*

phyceae appeared in lesser numbers. With the former the continuity of occurrence was observed while the latter were only absent in a sample from the 8th of June. No great maxima were noted in this pond. The most numerous species were *Cryptomonas erosa* (18th of June) and *Scenedesmus quadricauda* (6th and 9th of July).

In the discussed pond 9 systematic groups represented by the following 183 taxons were identified: *Dinophyceae* 2 taxons, *Cyanophyta* 19, *Euglenophyta* 11, *Cryptophyceae* 3, *Xanthophyceae* 1, *Chrysophyceae* 5, *Bacillariophyceae* 33, *Volvocales* 7, *Chlorococcales* 92, and *Conjugales* 10 taxons.

In the individual ponds the following numbers of taxons were noted:

pond No. 1 — (treated with Neguvon)	116
pond No. 2 — (control)	74
pond No. 3 — (treated with Neguvon)	110
pond No. 4 — (control)	93

Discussion

In recapitulating the obtained results it may be claimed that the insecticide used in the experiment had no direct and evident influence on the dynamics of phytoplankton development. The abundant development of phytoplankton appeared both in the treated pond No. 1 and in the control pond No. 2 while in the treated pond No. 3 and in the control pond No. 4 the observed growth was considerably poorer. However, it seems that Neguvon treatments even stimulated the development of some groups, in spite of the fact that in the control ponds the numbers of algae were sometimes larger. The course of the investigation seems to suggest that not the negative action of the insecticide but some other factors, which among other phenomena caused a markedly strong blooming of species of the genus *Scenedesmus* in the control pond No. 2, played the decisive role here.

Decreases in the number of plant and animal organisms under the influence of pesticides were observed by other authors, however, in general they considered protozoans, crustaceans, and rotifers to be the most sensitive organisms and algae — the least sensitive ones (Cabejszek et al. 1973, Ranke-Rybicka, Stanisławska 1972, Stanisławska-Świątkowska, Ranke, Rybicka 1976). The stimulation of growth and blooming of some algae (among other species, *Anabena*) by great doses of pesticides was also observed (Cooc et al. 1963, Hurlbert et al. 1972).

In all the discussed ponds the most numerous algae were *Chlorophyta*, mainly *Chlorococcales; Volvocales* and *Cryptophyceae* being less numerous. Small algae which are most useful in fish culture as a suitable food for zooplankton and benthos, and, therefore, indirectly for the carp fry, usually prevailed.

According to data from literature, green algae, especially of the order *Chlorococcales*, are most resistant to the action of toxins; contrary to other algae (e.g. blue-green algae) they are tolerant to highest concentrations of algicides.

In the ponds treated with Neguvon, an increased tendency to the appearance of species usually found in fairly polluted waters, was observed. Among other organisms species of the genera *Cryptomonas* and *Chlamydomonas*, or *Pedinomonas rotunda*, found in this area for the first time, should be mentioned here. The qualitative composition might have been influenced by water pollution, which was increased by the decomposing insecticide.

As stated by a great many authors, the same groups of algae, i.e. *Chlorophyta* and *Cryptophyceae* are strongly stimulated by the nitrogen--phosphorous fertilization (Braginskij 1961, Januszko 1971, Januszko et al. 1977). It also seems justified to revert to earlier investigations of phytoplankton, carried out from the beginning of exploitation of these ponds after they were rebuilt in 1958. In those years *Chlorophyta* also frequently prevailed, yet the role of such numerous groups as *Chrysophyceae* and *Bacillariophyceae* was much greater. The occurrence of algae in the first rearing ponds No. 1 and No. 2 was also more abundant than in No. 3 and No. 4 (during the present author's investigations ponds 2 and 4 were also used as controls) (Krzeczkowska-Wołoszyn 1966, 1973).

In the rearing ponds treated with Neguvon the dominance of *Rotatoria*, chiefly of the genera *Asplanchna, Brachionus, Filinia, Polyarthra*, and *Keratella*, was found in zooplankton on the basis of the same samples. With great numbers of *Rotatoria* the numbers of phytoplankton were always small. These relations were particularly striking on the 22nd of June in the pond No. 1, when simultaneously insignificant numbers of *Chlorococcales*, especially of species of small body size, were noted. Also in pond No. 3, on the 11th and 25th of June, a rapid decrease in algae number occurred simultaneously with an increase in the number of *Rotatoria*, and, a distinct prevalence of zooplankton over phytoplankton was observed as a result. Since the last sampling in June, in pond No. 3 where algae were scare, great numbers of *Cladocera* and *Copepoda* were being noted. The more distinct was their domination, the poorer was the growth of algae. It seems that they were filtered through by the abundantly developed zooplankton.

In the control ponds No. 2 and No. 4 the share of *Cladocera*, frequently of considerable body size (e.g. *Daphnia* and *Bosmina*), and of *Copepoda* was much greater than in the ponds treated with Neguvon. In samples from the last sampling, just as it had been in the period after filling, with insignificant numbers of phytoplankton, zooplankton occurred more frequently, while at an abundant growth of algae, the numbers of animals were insignificant. E.g. in pond No. 2 in a sample from the 22nd of June, when almost only *Chlorococcales* appeared, and in that from the 18th of June, when they bloomed, very small numbers of zooplankton were noted, while in pond No. 4, a distinct dominance of animals over algae was found on the 25th and 29th of June, the developed zooplankton being of distinct Rotifer-type.

As reported by Hurlbert et al. (1972), treatment with an organophosphorus insecticide resulted in the reduction of herbivorous crustaceans and herbivorous rotifers, and, as a result, in a rapid growth of phytoplankton populations. After three insecticide treatments the blooming of *Anabaena* and, simultaneously, decreasing numbers of *Crustacea* were observed by Cooc and Conners (1963).

Opuszyński and Onoszkiewicz (1976) found that in a fish pond dense stocking caused certain phenomena similar to these brought about by Foschlor treatments, eliminating crustaceans and leaving an ecological niche for the development of rotifers.

In the discussed ponds, the situation of plankton was obviously affected by small numbers of carp fry in the control rearing ponds, as it was finally noted on catch. On the other hand, in the rearing ponds treated with Neguvon very good results of fry catches were found. Lirski et al. (1976) reported that in ponds treated with Foschlor fish attained body weight almost 10 times greater than without this compound, while Opuszyński and Onoszkiewicz (1976) claimed that the production of fingerlings and of carps from the second rearing ponds markedly increased under the influence of Foschlor treatments.

The above discussed phenomena suggest that at the given doses the Neguvon treatment did not directly and evidently influence phytocenoses in the investigated ponds. Nevertheless, the character of the phytoplankton can be affected by the use of insecticides, chiefly through its distinct dependence on the zooplankton. The composition of the zooplankton can be modified according to the needs of other trophic links and of the given fish culture ponds.

STRESZCZENIE

Praca dotyczy fitoplanktonu stawów przesadkowych, przy stosowaniu insektycydu fosforoorganicznego — Neguvonu.

Stwierdzono, że stosowany w podanych dawkach preparat nie wywarł wyraźnego,

bezpośredniego wpływu na liczebność glonów. Wśród najliczniejszych zielenic przeważały drobne chlorokokkowe.

W stawach z Neguvonem zauważono tendencję do pojawiania się gatunków glonów związanych z wodami o silniejszym stopniu zanieczyszczenia.

W zooplanktonie stawów kontrolnych większy udział miały *Cladocera*, a także *Copepoda*, niż w stawach z Neguvonem.

W występowaniu glonów obserwowano największą zależność od zooplanktonu.

Poprzez odpowiednie stosowanie preparatów tego typu można wpływać na charakter planktonu, ukierunkowując go w sposób najkorzystniejszy dla danego typu zbiornika hodowlanego.

REFERENCES

Braginskij L., 1961. O sootnošenii meždu sostavom prudovogo fitoplanktona i projavlenijach ego potrebnosti v biogennych elementach. (w — in: G. G. Winberg (red.): Pervičnaja produkcija morej i vnutrennych vod. Minsk, Min. Vysš. Sred. Specj. i Prof. Obrazov. BSSR), 139—147.

Cabejszek I., J. Łuczak, J. Maleszewska, J. Stanisławska, 1973. Limnological character of experimental reservoirs treated with Tritox 30% (DDT, DMDT, gamma HCH). Ekol. Pol. 21, 121—140.

Cooc S. F., Jr., J. D. Conners, 1963. The short-term side effects of the insecticidal treatment of Clear Lake, Lake County, California, in 1962. J. Econ. Entomol., 56, 819—824.

Hurlbert S. H., S. Mulla, H. R. Willson, 1972. Effects of an organophosphorus insecticid on the phytoplankton, zooplankton and insect populations of fresh-water ponds. Ecol. Monographs, 42, 269—299.

Januszko M., 1971. The effect of fertilizers on phytoplankton development in fry ponds. Pol. Arch. Hydrobiol., 18, 129—145.

Januszko M., T. Bednarz, M. Broda, E. Grzelewska, 1977. Nawożenie azotowo-fosforowe odgrodzonych części stawów. 4. Fitoplankton. Roczn. Nauk Roln., H, 98, 75—104.

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

Krzeczkowska-Wołoszyn Ł., 1973. Plankton nowych stawów przesadkowych gospodarstwa Gołysz — The plankton of new transfer-ponds at the Gołysz Farm. Acta Hydrobiol., 15, 427—436.

Lewkowicz S., M. Lewkowicz, L. Szarowski, 1979. Biotyczne i abiotyczne warunki formowania się zbiorowisk zooplanktonu w stawach po zastosowaniu fosforoorganicznego insektycydu Neguvon — Biotic and abiotic conditions of the formation of zooplankton communities in ponds treated with the organophosphorus insecticide Neguvon. Acta Hydrobiol., 21, 2, 117—138.

Lirski A., B. Onoszkiewicz, K. Opuszyński, M. Woźniewski, 1976. Podchów wylęgu tołpygi białej w sadzach. Gosp. Ryb., 38, 9, 7—10.

Opuszyński K., B. Onoszkiewicz, 1976. Użycie preparatu foschlor dla zapewnienia bazy pokarmowej przy podchowie wylęgu. Gosp. Ryb., 28, 10, 10—12.

Ranke-Rybicka B., J. Stanisławska, 1972. Zmiany w zespołach perifitonowych wywołane działaniem pestycydów fosforoorganicznych (Malation, Foschlor). Roczn. Państw. Zakł. Hig., 23, 137—146.

Stanisławska-Świątkowska J., B. Ranke-Rybicka, 1976. Changes in periphyton communities under the effect of Dichlorfos. Pol. Arch. Hydrobiol., 23, 261—269.

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