A C T A I C H T H Y O L O G I C A E T P I S C A T O R I A

Vol. VI, Fasc. 2 Szczecin 1976

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Fish culture

RESULTS OF REARING CARP IN „DOLNA ODRA" POWER STATION COOLING WATERS

WYNIKI CHÓWU KARPI W WODZIE POCHŁODNICZEJ ELEKTROWNI „DOLNA ODRA"

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The results obtained in cage rearing of carp (K_2-K_3)* in cooling waters of the „Dolna Odra" power station (near Gryfino) are presented. The cooling water temperature ranged within 18.4 – 31.7°C; oxygen saturation did not fall below 80%; pH ranged from 7.3 to 8.3. The fishes were kept in culture during 130 days (May 20 – October I, 1975), in densities of 75 and 110 individuals/m^3 of water. The fishes were fed on a carp granulate and a piglet dry granulated food.

It has been found that the densities applied exerted no influence upon the fish growth rate, where as the various foods used resulted in different rearing and economic effects.

INTRODUCTION

The constant economic growth of the country is one of major factors altering the water habitats. Most often the changes result in progressive pollution that in turn induces far-reaching changes in the qualitative and quantitative composition of ichthyofauna.

Not always the results of industrialization are definitely detrimental for the fisheries. Considerable quantities of cooling waters leaving various plants and factories, particularly power stations, can be utilized to rearing warm-water fishes.

*K_2 – denotes two-year-old fishes; K_3 – denotes three-year-old fishes

The cooling waters have been for a number of years attempted to be used in fish farming in many countries (USSR, GDR, FRG amont the others) as well as in Poland. Studies by Meske (1969) showed carp to be successfully kept in high densities (fish: water volume ratio of 1:4) in water heated up to 23°C. Steffens (1969 a), when rearing young carp in cages in cooling waters, was able to produce 100 kg/m^3, the feeding coefficient ranging within 1.6–2.2. Stocking the cages with 200, 400, and 600 individuals/m^3, an eight-fold increase in weight was obtained during 116 days (Steffens, 1969 b). Similar results of a culture run in the same way were obtained by Ivacha et al. (1972). Strelcova and Cernikova (1972) as well as Ostraumova and Timošina (1975) studied the qualitative composition and percentages of components in granulated food used for culturing carp in cooling waters.

In order to meet the needs of an increasing interest in cooling waters observed in Poland, the Institute of Marine Biological Resources Exploitation and Protection, Academy of Agriculture in Szczecin commenced studies* on prospects of rearing carp in the „Dolna Odra" power station cooling waters. The goals of the experiments, apart from testing the feasibility of using the River Odra water to keep fish in, were set at following the growth of carp (K_{2-3}) in relation to the density of stocking and quality of food used.

AREA, MATERIAL, METHODS

The experiment was run in the cooling water channel of „Dolna Odra" power station in Nowe Czarnowo. The fishes were kept in net cages placed at a distance of ca 300 m from the water outlet.

The water supply in the channel depended on the number of power blocks working and ranged from 8 to 32 m^3/sec, which resulted in frequent fluctuations in the water level (up to 0.5 m) and flow velocity (from 0.05 to 0.5 m/sec).

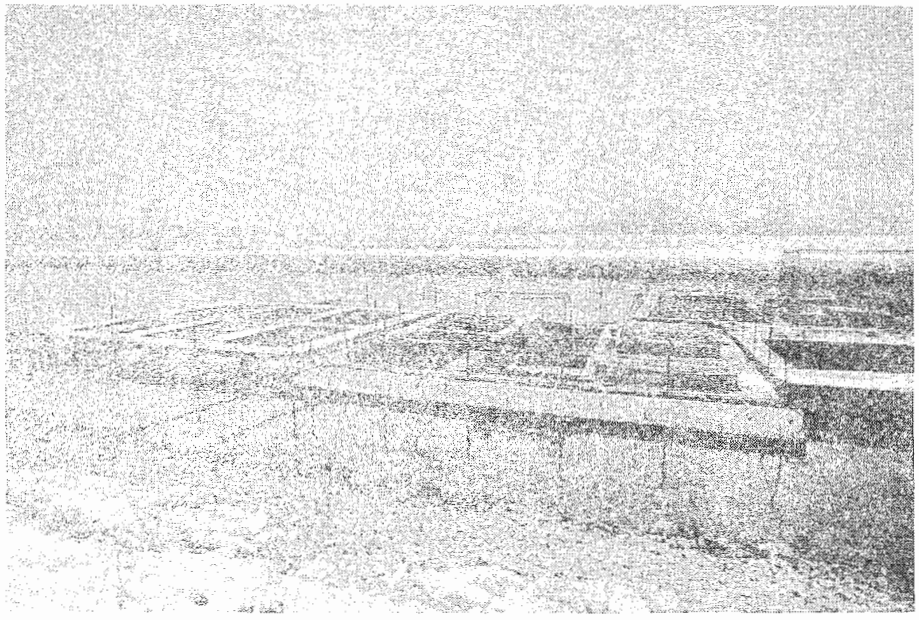
9 culture cages, 2.35×1.25×1.5 m each, were hung on a selfcarrying plarform (Phot. I). They were assembled of ϕ 40 mm plastic tubings making up frames covered with a 10 mm mesh size nylon net (Phot. 2). The effective volume of each cage was 3 m^3 of water. At the last stage of the experiment, a 20 mm net was additionally placed over the original one in order to strengthen the cage walls.

Young carp individuals to be reared were brought from the State Fish Farms in Międzyrzecz (April 17, 1975, 1950 ind.) and Szczecin (April 22, 1975, 800 ind.).

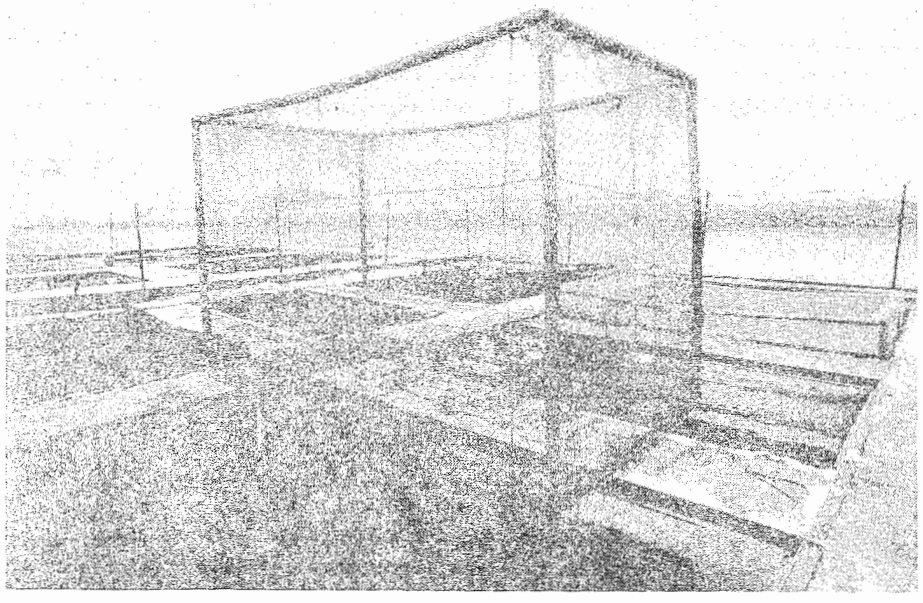
After a week of keeping the fishes in the channel water of a 15–18°C temperature range, all the fishes showed symptoms of septicaemia. The disease was cured by feeding fish on a granulated food saturated with an aquaceous solution of the "Polfamix–C" vitamin mix. A daily dose of this compound, containing also an antibiotic oxyteracin, was set as 2% of food weight. After about 30 days of treatment the symptoms vanished in all fishes. 110 individuals were lost at that time.

The experiment carried out according to a scheme described below was run in 3 variants (I, II, III), each being replicated three times.

* The studies were financially supported by the Inland Fisheries Institute, Olsztyn.



Phot. 1. Platform with cages



Phot. 2. General view of single cage

Schematic pattern of experiment

Kind of food	Cage stocking (ind.)	(experiment variant)
	225	330
Food granulated for carp	+(I)	+(II)
PP "Grower" mix	+(III)	

The cages were not stocked uniformly in terms of fish size. Control weighings were, as a rule, carried out every other week, only the first one was performed after a month.

Two kinds of food were used to feed the fishes: a carp granulate (6–10 mm granule diameter) produced by the State Fish Farm, Słupsk, and a piglet granulated food mix "PP-Grower" (6 mm granule diameter) produced by "Bacutil", Stargard Szczeciński. The two food kinds differed in their protein and carbohydrates contents as well as in their prices (Table 1). The fishes were given food every day at 1.5-hr intervals, i.e., 6 times a day. A daily ration of food equal to 3% of the fish weight at the moment, was given by hand. Once a week "Polfamix-C" was added to the food, the vitamin mix amount being

Table 1

Chemical composition of foods used in feeding carp

Food component	Kind of food	
	Food granulated for carp	„Grower"
Crude protein (%)	31.77	16.93
Fat (%)	8.10	3.27
Water (%)	8.30	11.40
Asch (%)	8.73	4.56
Carbohydrates (supplement to 100%)	43.10	63.84
Dry matter (%)	91.70	88.60
Price of 1 kg food (zł)	10.50	4.90
Production cost of 1 kg carp (zł)	21.00	15.40

1% of the food ration. Every day at noon the oxygen content and pH of water in the cages were determined. Water temperature was measured with a thermograph. Temperature and pH readings as well as water oxygen saturation were plotted on graphs as weekly means and extremal values. In order to obtain a more comprehensive physico-chemical characteristics of water in the channel, suspension, oxidation, BOD_5, total hardness and chlorides content were determined once a week at the Power Station Water-Effluent Laboratory.

RESULTS OF EXPERIMENTS

The carp rearing (K_{2-3}) was carried on in the cooling water channel of the „Dolna Odra" power station during 130 days: from May 20 through October 1, 1975.

Over the period of the experiment the temperature of effluent water ranged within 21.8–29.3°C and was on average by 8°C higher than the water temperature recorded in the supplying channel (Fig. 1). The lowest temperature was 18.4°C, the highest never exceeded 31.7°C. Weekly temperature fluctuations were considerable, the difference reaching 10°C. Instances of rapid temperature falls (down to 8°C) during a few hours were recorded; these resulted from introducing unheated waters into the channel due to turning off some or all power blocks. In spite of these considerable alterations in the water temperature, on no occasion did the fishes show any detectable changes in their behaviour nor any disturbances of their life processes were discernible. Similarly, the temperature exceeding 31°C, maintained over a prolonged period of time (several days) in no way affected the fish feeding intensity.

The oxygen saturation of the effluent water was good and ranged within 75–116% (Fig. 2). Mean weekly values of the saturation ranged from 82 to 108% throughout the entire experimental period, the oxygen saturation in the water-supplying channel being lower by 10–12% than that observed in the cooling water one.

Mean weekly pH range was 7.34–8.25, the extremal values ranging from 6.10 to 8.90 (Fig. 3).

In view of permissible pollution standards for surface waters (according to the Polish regulations) as well as the results of determinations of the more important factors (Table 2), the „Dolna Odra" power station effluent waters can be placed on the borderline between the 2nd and 3rd purity classes (Dz. U. 1970).

Table 3 presents the course of the carp weight growth for every variant of the experiment. In no variant was the growth uniform. Periods of poorer increments were presumably due to a lowered feeding intensity resulting from oil pollution occurring temporarily as well as from increased losses of food. Towards the end of the experiment (September 15 – October 1, variant II), a intensive and energetic feeding of densely-packed large fishes caused some finer food particles being thrown out of the cages, a decrease in growth rate and a feeding coefficient increase ensuing.

The values of feeding coefficients of the diet applied, describing its nourishing power, were as follows for the three variants of the experiment: 1.86, 2.14, 3.14 (Table 4). The

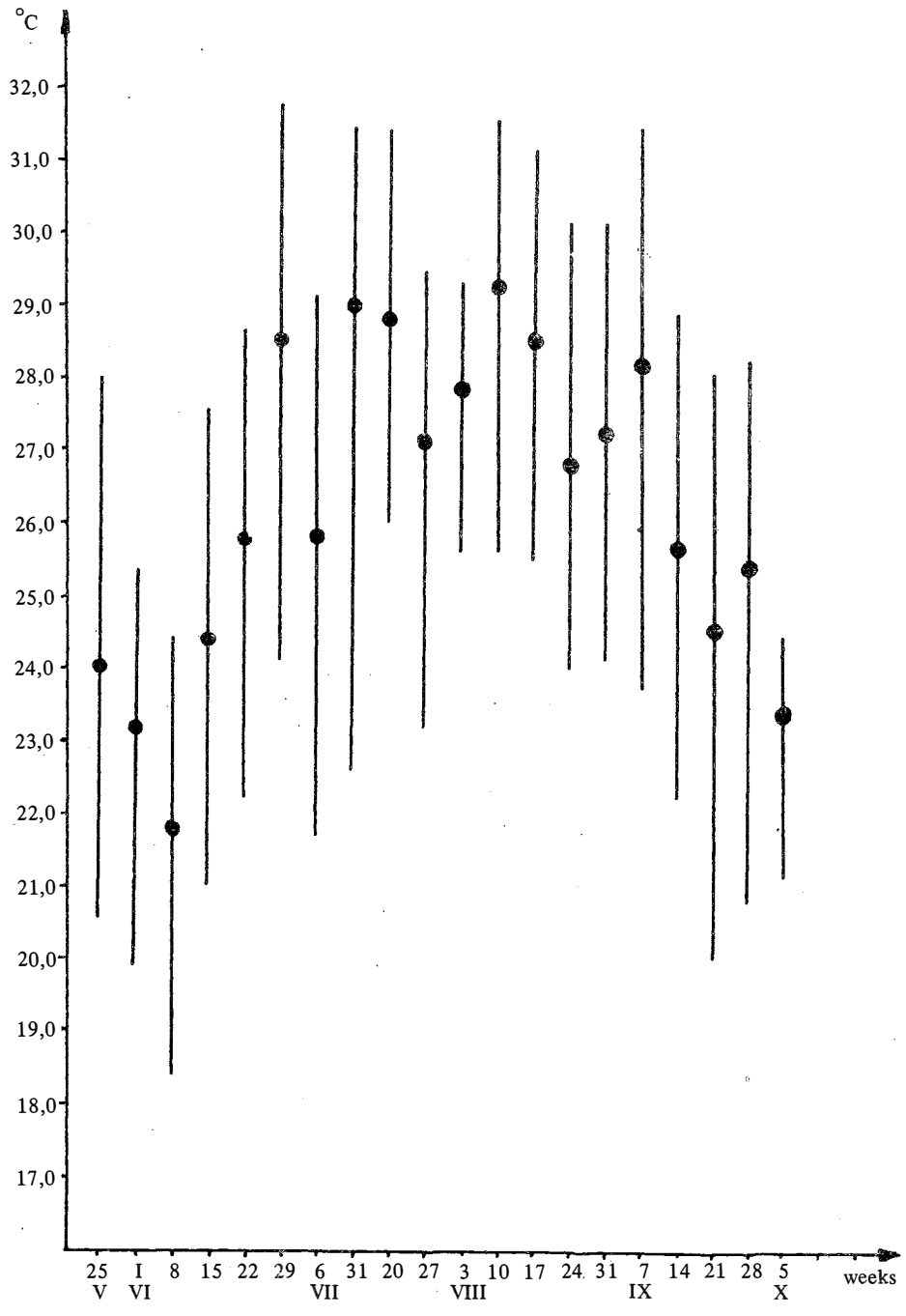


Fig. 1. Ranges and weekly means of cooling water temperature during experiment

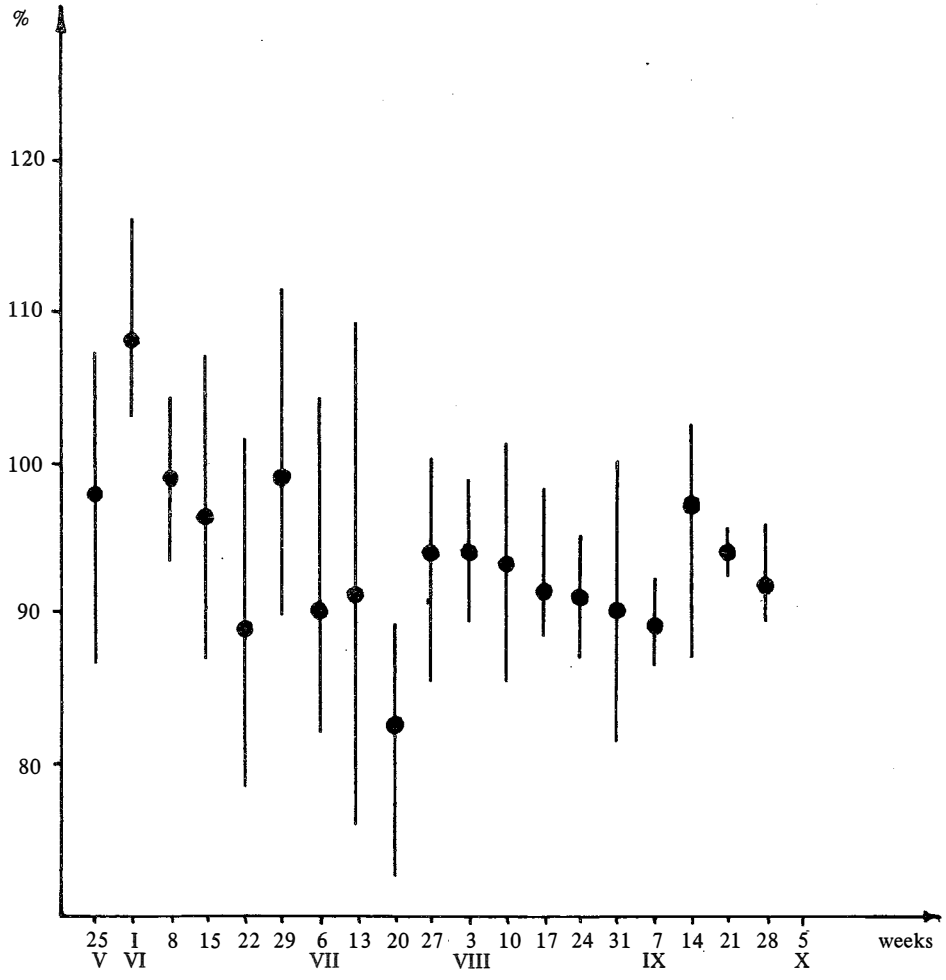


Fig. 2. Ranges and weekly means of oxygen saturation of cooling water during experiment

values indicate a clearly worse nourishment provided by the „Grower" when compared to the carp granulate. The reason was that the first showed much lower total protein content (almost by a half). Thus the „Grower" food coefficient equalling 3.14 seems to be a very good one. It is supposed that the feeding coefficients would be lower, had a food of a granule diameter suitable for each size of fish was possible to have been used throughout the whole experimental period. For example, a 10 mm diameter carp granulate was in use from September 1–15, during which time the feeding coefficients calculated for variants I and II were, respectively: 1.52 and 1.24. Owing to a proper granule size the losses of food were greatly reduced, the food being retained in cages and consumed in almost 100% in spite of an intensive feeding of carp.

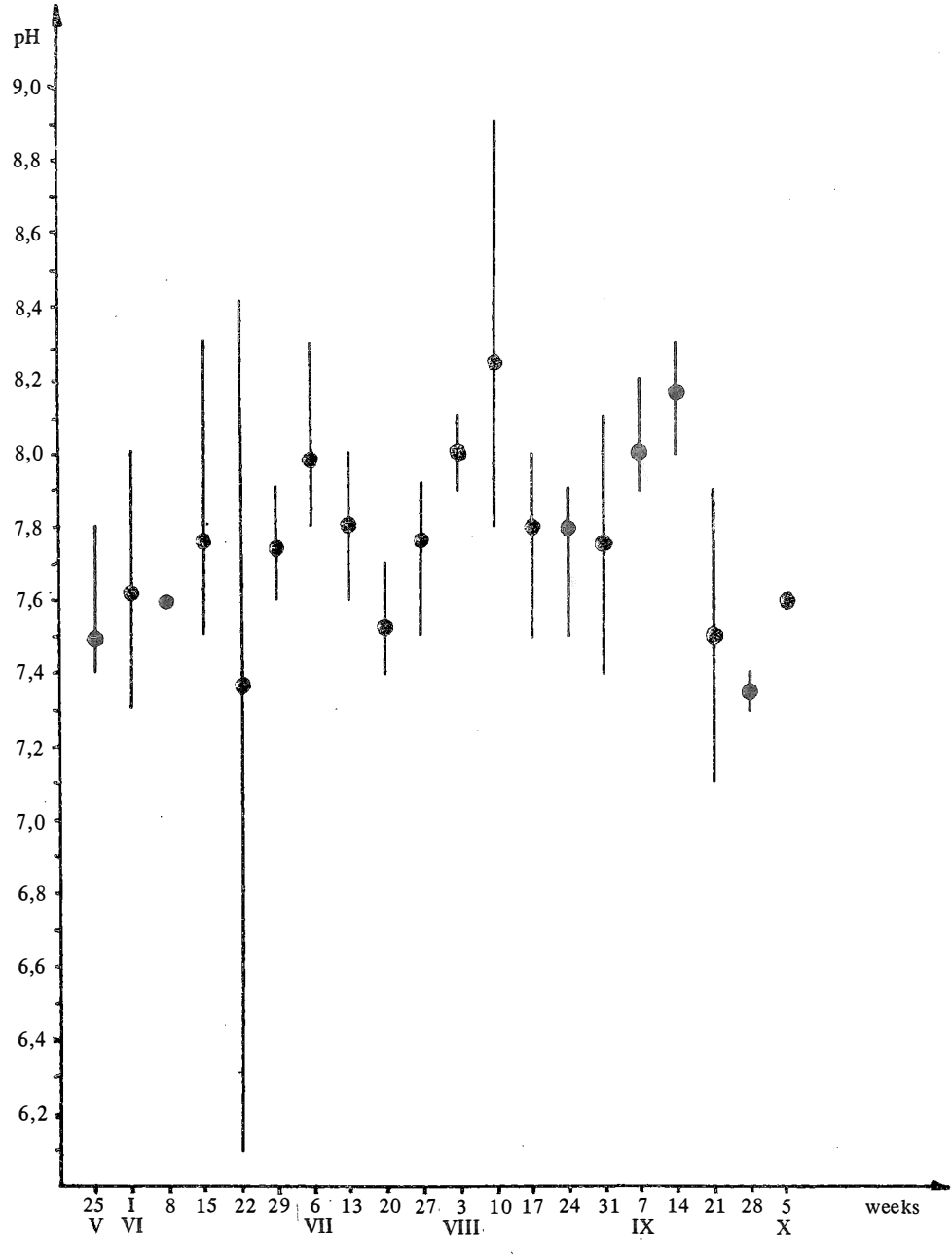


Fig. 3. Ranges and weekly means of cooling water pH during experiment

Table 2

Values of some parameters of effluent channel water
(data supplied by the „Dolna Odra" Power Station water – Effluent Laboratory)

Date of determination	Suspension	Oxidation	BOD_5	Total hardness	Chlorides
	mg/dcm³	mgO_2/dcm³	mgO_2/dcm³	mg/dcm³	mg/dcm³
21.04.75 r.	12.5	8.4	8.0	4.05	67.35
28.04.75 r.	12.0	9.6	3.0	4.40	62.03
05.05.75 r.	18.0	9.8	4.8	4.10	63.85
12.05.75 r.	17.2	7.3	4.5	3.6	69.90
19.05.75 r.	25.0	10.0	6.5	5.0	78.00
26.05.75 r.	20.6	10.6	2.6	5.0	70.00
02.06.75 r.	23.2	–	8.9	4.2	97.50
09.06.75 r.	30.8	12.5	–	4.3	–
23.06.75 r.	21.6	11.6	7.9	4.3	92.17
30.06.75 r.	15.9	10.09	4.3	4.2	96.50
07.07.75 r.	13.7	10.3	10.5	3.7	77.90
14.07.75 r.	18.6	9.12	6.5	4.5	77.90
25.07.75 r.	25.0	11.4	6.1	4.0	78.00
29.07.75 r.	20.0	14.4	9.9	4.1	–
04.08.75 r.	12.3	8.8	5.0	4.05	79.70
08.08.75 r.	24.7	11.7	4.9	3.8	67.40
12.08.75 r.	18.0	10.4	3.5	3.7	70.90
18.08.75 r.	21.0	11.4	5.9	3.9	72.70
25.08.75 r.	14.0	9.6	6.2	4.1	79.80
01.09.75 r.	30.3	10.7	8.7	4.0	82.10
08.09.75 r.	19.2	10.0	4.0	4.1	99.30
15.09.75 r.	30.4	12.8	8.2	4.1	116.90
22.09.75 r.	34.9	9.9	5.6	4.3	92.20
20.09.75 r.	16.6	–	–	4.4	108.00

In spite of a larger amount of the „Grower" needed to obtain 1 kg of fish weight increment, its cost was lower than that of the carp granulate, 15.40 and 21.0 zł, respectively.

The carp weight growth, as measured by a daily increment of body weight (expressed in per cent.) averaged for each experiment variant 1.05, 1.08, 0.85 (Table 3). When weighing the fishes for the last time in cages (3 cages of the variant I and 2 of the variant II) no losses except for the non-natural ones were found and the fishes were divided into 5 weight classes set at 500 g intervals (Table 5). The first class contained fishes weighing less than 1000 g, the last one – those above 2500 g. It was found out that both in the variant I and II most fishes comprised the third weight class, 40.7 and 54.9% of all the fishes, respectively. In the variant I, the fifth class (above 2500 g) housed 4.7% of fishes; the largest fish weighed 2890 g. The lack of fish in this class in the variant II should be

Table 3

Mean values of weight and individual increments of carp during experiment

Variant	I – 225 ind./cage			II – 330 ind./cage			III – 225 ind./cage „Grower"		
Date of weigning	Mean weight of individual	Increment in. individual		Mean weight of individual	Increment in. individual		Mean weight of individual	Increment in. individual	
	g	g	%	g	g	%	g	g	%
May 20	314.1	x	x	284.8	x	x	350.9	x	x
June 20	401.7	87.6	27.8	377.1	92.3	32.4	409.3	58.4	16.6
July 4	519.3	117.6	29.2	484.8	107.7	28.5	507.6	98.3	24.0
July 18	617.2	97.9	18.8	598.3	113.5	23.4	597.9	90.3	17.7
August 4	794.2	117.0	28.6	786.3	188.0	31.4	752.8	154.9	25.9
August 18	998.2	104.0	25.6	943.1	156.8	19.9	823.4	70.6	9.3
September 1	1142.4	144.2	14.4	1120.6	177.5	18.8	897.5	74.1	9.0
September 15	1482.5	340.1	29.7	1495.1	374.5	33.4	1093.9	196.4	21.8
October 1	1701.1	218.6	14.7	1646.7	151.6	10.1	1230.1	136.2	12.4
Mean increment	–	1387.0	441.6	–	1361.9	478.2	–	879.2	250.1
Mean daily weight increment (%)			1.05			1.08			0.85

Table 4

Food dosage and feeding coefficients of food stuff used in cach experiment variant

Experiment variant / Date of weighing	I – 225 ind./cage		II – 330 ind./cage		III – 225 ind./cage „Grower"	
	Food dose per 1 cage	feeding coefficient	Food dose per 1 cage	feeding coefficient	Food dose per 1 cage	feeding coefficient
	kg		kg		kg	
20.05–20.06	43.190	2.24	56.277	2.37	44.256	3.37
20.06–4.07	34.883	1.36	44.166	1.33	31.983	1.44
4.07.–18.07	45.716	2.10	58.993	1.69	34.700	2.32
18.07–4.08.	69.66	1.73	90.216	1.55	53.625	2.49
4.08.–18.08	65.283	1.60	88.900	1.83	48.150	4.14
18.08–1.09	81.950	2.21	113.450	3.41	48.300	5.58
1.09.–15.09.	97.966	1.52	136.500	1.24	47.500	2.96
15.09.–1.10.	102.866	2.19	135.965	3.77	46.300	2.87
Mean value	–	1.86	–	2.14	–	3.14

Table 5

Carp weight distribution

Variant	Number of cage	Weight classes (g)										Number of fish per cage (ind.)	Mean original weight (g)
		less than 1000		1000–1500		1500–2000		2000–2500		above 2500			
		ind.	%	ind.	%	ind.	%	ind.	%	ind.	%		
I	4	2	0.9	40	17.8	96	42.9	64	28.6	22	9.8	224	344.4
	9	1	0.4	42	19.1	108	49.1	60	27.3	9	4.1	220	357.0
	12	24	11.5	123	58.9	62	29.6	–	–	–	–	209	240.8
Total:		27	4.1	205	31.4	266	40.7	124	19.0	31	4.7	653	
III	7	9	3.0	113	37.5	165	54.8	14	4.7	–	–	301	288.1
	8	3	1.0	53	18.0	162	54.9	77	26.1	–	–	295	330.9
Total:		12	2.0	166	27.8	327	54.9	91	15.3	–	–	596	

explained by a lower mean weights of fishes at the beginning of the experiment (Table 5). In the two variants fishes of weight less than 1000 g were found as well (4.1 and 2% in the variants I and II, respectively).

The losses in cage stocks occurring over the period of the experiment were divided into 2 groups:

– natural ones resulting from death of fish,
– non-natural ones caused by theft or damages of cages.

The natural losses over the whole experiment amounted in the variants I, II, and III to 3 individuals (0.62%), 41 ind. (4.10%), and II ind. (1.40%), respectively. The deaths recorded occurred only during the first month of the experiment; the individuals that had died were the ones weakened due to the disease or those incompletely cured.

The non-natural losses were substantial, except for the variant I with 22 ind. missing at the end of the experiment. In one cage of the variant II 268 (81%) were found missing, while all the three cages of the variant III lost jointly 455 individuals (67.4%).

The cages containing intact stocks (no non-natural losses) yielded on average 123.9 and 163.4 kg of fish/m^3 in the variants I and II, respectively. The highest yield amounting to 175 kg of fish per m^3 was found in one of the variant II cages.

CONCLUSIONS

The results of a 130-days long experiment on carp rearing (K_{2-3}) in the „Dolna Odra" power station cooling waters can be summarized in the following conclusions:

1. The „Dolna Odra" power station cooling waters, assessed by fish cultures run in them and by physico-chemical determinations performed, proved suitable for carp rearing.
2. There exists a possibility of an intensified rearing of carp in summer in the cooling waters of quality observed presently.
3. Given valuable food and an appropriate method of feeding, the feeding coefficient should not exceed 2.5.
4. The results show the protein content of the Polish-made food stuffs possible to be lowered down to ca 20–25%.
5. The health state of carp in culture was good. Should any septicaemia infliction occur, the successful treatment of the disease is offered by applying the "Polfamix-C" vitamin mix used normally in feeding calves.

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Translated: mgr Teresa Radziejewska

WYNIKI CHOWU KARPI W WODZIE POCHŁODNICZEJ ELEKTROWNI „DOLNA ODRA"

Streszczenie

W oparciu o wody pochłodnicze Elektrowni „Dolna Odra" w Nowym Czarnowie, w 1975 r. przeprowadzono doświadczenie nad chowem karpii (K_2 –K_3). Celem doświadczenia było testowe sprawdzenie przydatności podgrzanej wody z rzeki Odry do chowu ryb oraz zbadanie szybkości ich tempa wzrostu w zależności od gęstości obsad i jakości stosowanej paszy.

Temperatura wody pochłodniczej była średnio o 8°C wyższa niż w rzece Odrze i wahała się w granicach 18,4–31,7°C, zaś nasycenie jej rozpuszczonym tlenem nie spadało poniżej 80%. Średnie tygodniowe wartości pH wody wahały się w granicach 7,3–8,3. Chów karpi prowadzono przez okres 130 dni (20.05.–1.10.75 r.) w obsadach 75 i 110 szt./m³ wody. Ryby żywiono granulatem karpiowym (32% białka ogólnego) i granulowaną paszą dla prosiąt „PP Grower" (17% białka ogól.).

Badania wykazały, że stosowane gęstości obsad nie miały istotnego wpływu na wzrost ciężaru ryb (przy 75 szt/m³ – wzrost 5,4-krotny, zaś przy 110 szt/m³ – 5,8-krotny, natomiast wzrost na granulacie karpiowym był większy (5,4-krotny) niż na mieszance PP „Grower" (3,5-krotny). Dobowy przyrost ryb żywionych granulatem karpiowym wyniósł średnio 1,06%, współczynnik pokarmowy zaś 2,0, natomiast dla PP „Grower" odpowiednio 0,86% i 3,14%.

Ubytki karpi w czasie doświadczenia nie przekroczyły 4%. Największa produkcja karpi z 1 m³ wody wyniosła 175 kg.

Wyniki przeprowadzonych doświadczeń wskazują na istniejące możliwości intensywnego chowu karpi w oparciu o podgrzane wody rzeki Odry, uprzednio wykorzystywane do chłodzenia bloków energetycznych.

РЕЗУЛЬТАТЫ ВЫРАЩИВАНИЯ КАРПА В ОХЛАЖДАЮЩЕЙ ВОДЕ ЭЛЕКТРОСТАНЦИИ „ДОЛЬНА ОДРА" В НОВОМ ЧАРНОВЕ

Р е з ю м е

В 1975 г. был проведен опыт по разведению карпа (K_2-K_3) в охлаждающей воде гидроэлектростанции „Дольна Одра" в Новом Чарнове. Целью данного опыта были проверка на основе теста пригодности подогретой при охлаждении энергоблоков воды из р. Одра для разведения рыбы и исследование их темпа роста в зависимости от плотности зарыбления и качества применяемого корма.

Температура охлаждающей воды была в среднем на 8°C выше, чем в Одре, и колебелась в границах от 18,4°C до 31,7°C. Насыщение же её кислородом не падало ниже 80%. Средние недельные величины pH воды колебались в границах 7,3–8,3. Разведение карпа продолжалось в течение 130 дней (с 20 мая 1975 г.

по 1 октября 1975 г.) при плотности посадки 75 и 110 экз./м^3 воды. Рыб кормили карповым гранулированным кормом (32% общего белка) и гранулированным кормом для поросят „ПП Гровер" (17% общего белка).

Исследования показали, что применяемые плотности посадки не имели существенного влияния на увеличение веса рыб (при 75 экз./м^3 вес увеличивался в 5,4 раза, а при 110 экз./м^3 – в 5,8 раза). Увеличение же веса при применении карпового гранулированного корма было большим (в 5,4 раза), чем при применении кормовой смеси „ПП Гровер" (в 3,5 раза). Суточный привес рыб, которых кормили карповым гранулированным кормом составлял в среднем 1,06%, кормовой коэффициент – 2,0; при применении же „ПП Гровер" соответственно – 0,86% и 3,14%.

Отход карпов во время опыта не превышал 4%. Наибольший выход карпа с 1 м^3 воды составлял 175 кг.

Результаты проведенных опытов указывают на возможность интенсивного разведения карпа в подогретой воде Одры, используемой для охлаждения энергетических блоков.

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Received: 18 II 1976 r.

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