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Fish culture

EXPERIMENTAL REARING OF RAINBOW TROUT (*SALMO GAIRDNERI* RICH.) IN COOLING WATERS OF "DOLNA ODRA" POWER STATION

DOŚWIADCZALNY CHÓW PSTRĄGA TĘCZOWEGO (*SALMO GAIRDNERI* RICH.) W POCHŁODNICZEJ WODZIE ELEKTROWNI „DOLNA ODRA"

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The paper contains results of studies on cage rearing of rainbow trout in cooling waters of the "Dolna Odra" power station. The experiments, concerning the 0+ young rainbow trout, were carried out during 65 days. Fish were fed on a trout granulate, the portion given amounting to 3% of the current fish weight.

From May through October the culture was run in a power station water-supplying channel.

INTRODUCTION

Throughout the recent years an unprecedented interest in culture and breeding of rainbow trout has been observed in many countries. Owing to the feasibility as well as to the relatively short time of culture and vast possibilities of sale, the European production of rainbow trout has been greatly intensified. For example, it has increased from 14.5 to 19.0 thousand tons within the years 1965–1973, various methods of culture and installations being employed. Rainbow trout is bred, among the others, in fresh and marine waters as well as in ponds, lakes, river dam reservoirs, channels, and cages. For a few years the use of cages for rearing rainbow trout has been more and more widely

introduced due to its low cost and simple equipment needed. An example of a quick increase in the rainbow trout production is provided by the German Democratic Republic; the climatic – hydrobiological regime is there similar to that prevailing in our country. The rainbow trout production of the GDR increased over 1967–1973 from 191 to 926 t, which means an almost five-fold rise (Steffens, 1974). It should be noted additionally that the cage cultures themselves yielded an increase from 33 to 764 t, i.e., 82% of the country's overall trout production.

Recently, additional possibilities of increase in the rainbow trout culture and rearing have been sought in the use of cooling waters. The practical advantage is that the fishes can be kept in these waters also in winter, whereby the production cycle is completed in 1 year. This chance of a 6–12 months' shortage in the production cycle will presumably cut the production costs, thus increasing the feasibility of the production.

The first Polish studies on the cooling-waters culture of rainbow trout were carried out by the Inland Fisheries Institute in winters of 1971/1972, '73/'74, and '74/'75 (Bontamps, 1973, 1974, 1975; Littak and Okoniewski, 1975). In a pond fed by the Siekierki Power Station cooling waters, young fish increased their average weight from 100 to 240 g over 130 days (Dec. 10, '73 – April 18, '74) (Bontamps, 1974).

In cage experiments covering a similar length of time (131 days from May through September), carried out in the Legińskie Lake, an increase in fish weight obtained was from 27.9 to 82 g (Wojno, 1974). In Gliszczyński's opinion (1972) rainbow trout can be intensively reared at the water temperature range of +10–22°C. Under our climatic conditions, natural waters of rivers, ponds, and lakes show this range of temperatures throughout five months in a year only (May – September). When using cooling waters for the purpose, the period of intensive rearing of rainbow trout can be practically extended on the remaining 7 months of the year.

The present paper contains results of studies on the rainbow trout rearing in cages placed in a channel filled with the "Dolna Odra" power station cooling waters*. The experiments were aimed at finding an answer to the question if the River Odra water, after cooling the power station power blocks, is suitable to be used in the rainbow trout rearing and, should the answer be affirmative, what productive effects are likely to be obtained using this water.

AREA, MATERIAL AND METHOD OF STUDY

The experiment concerning the rainbow trout culture in winter and spring was run in a cooling waters channel (warm) of the "Dolna Odra" power station, while in the spring – summer months the experiment was carried out in a water – supply channel (cool) of the power station.

In the "warm" channel the cages were placed 300 m below the outlet of cooling water, while in the "cool" one they were submerged at a distance of ca 100 m of the water

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uptake point. The water flow in the "warm" channel depended upon the number of power blocks in operation and ranged from 8 to 32 m^3/sec. The number of working blocks bore also an effect on a water level in the "warm" channel, inducing changes of tha range of 0.5 m. In the "warm" channel, rainbow trout were kept in 1.35 m×2.3 m×1.5 m net cages of 3 m^3 culture water capacity. The cages were constructed of plastic tubing-made frames covered with nylon net 10×10 mm mesh size and hung on a special self-carrying platform (Fig. 1). Since the "warm" channel water surface was considerably oil-polluted, the platform was screened with vertically set plastic plates submerged down to 30 cm in water.

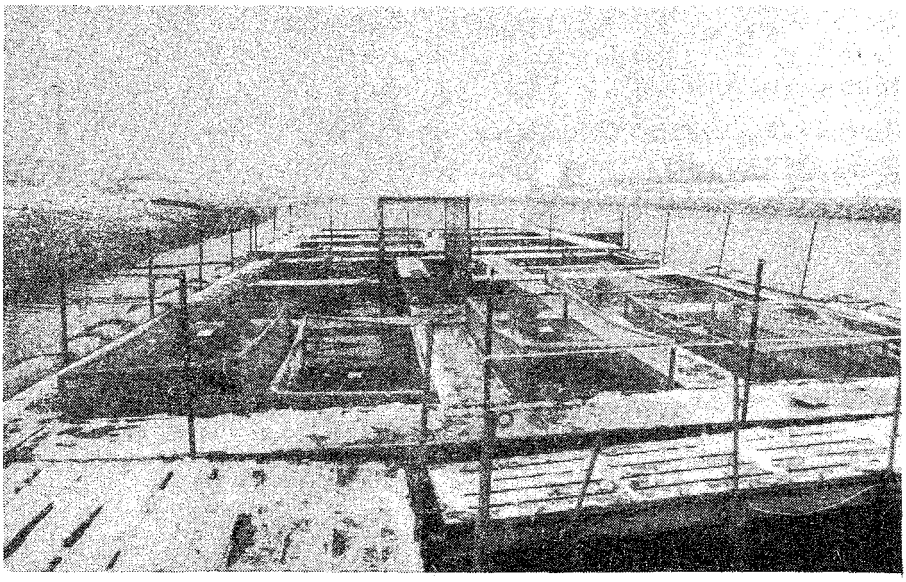

Fig. 1. Platform with cages.

In the "cool" channel the fishes were kept in one similarly built cage of larger size (2.0 m×2.0 m×1.5 m).

In the "warm" channel the experiment was run in 3 cages stocked with 330 young fish individuals per m^3, of a 21 g average weight. In summer, the fishes were transferred to the "cool" channel and placed in one cage of a 4 m^3 culture water capacity.

6000 young rainbow trout individuals were brought from the Trout Centre in Bukowo Morskie (the State Fish Farm, Słupsk) on March 6, 1975. The cages were stocked with 3000 individuals, 1000 each.

The fishes were fed on a trout granulate produced by the State Fish Farm, Słupsk; the granulate contained 35.2% protein, 8.8% fat, and 37.6% carbohydrates. During the first 4 days of feeding, a daily food portion amounted to 2% of fish weight, afterward being increased tu 3%. The food was thrown by hand. In order to supply the diet with certain

vitamins and to improve the immunity of fish, once a week the usual food was saturated with aquaceous solution of the "Polfamix – C" vitamin mix. The fishes were fed 6 days a week.

The "warm" channel fishes were fed 4 times a day at 2-hr intervals, while those in the "cool" channel twice a day at 6-hr intervals.

Throughout the entire experiment the basic physico-chemical parameters of the water (temperature, pH, and oxygen content) were assessed both in the "warm" and "cool" channels. The results of these assessments are presented on graphs as weekly means and extremal values.

DISCUSSION OF RESULTS

a) Environmental conditions

The graph (Fig. 2) shows the water temperatures in the two channels never to exceed 27°C and fall below 10°C. After 4 weeks following the transfer of fishes from the "warm" into "cool" channel, the water temperature in the latter reached the level similar to that observed in the "warm" channel before May 19. Water pH throughout the experimental period was relatively stable in both the cages (Fig. 3) ranging within 7.2–8.4 except for the first two weeks of April when, owing to an over-dosing of effluent-alkalizing agents after acid treatment of boilers, pH exceeded 9.2

The oxygen content in the water of the two channels was never lower than 7 mg O_2/l, which along with relatively high temperatures allowed the oxygen saturation to maintain its level above 100% (Fig. 4).

b) Results of rearing

Rainbow trout were reared in colling waters from March 16 till May 19, 1975, i.e., over 65 days. The first control weighing was carried out after a month following the cage stocking. Next weighings were performed every other week, the number of fishes being checked at the same time.

Throughout the entire culture period (April 2 – October 10, '75) the health of fishes cultured was systematically monitored. Samples for parasitologic and anatomico-pathological tests were collected every third week.

The tests showed the rainbow trout individuals kept in the "warm" channel to display considerable vitality and good health, which was proved indirectly by small natural losses in the stock recorded during the experiment. Only a small number of parasites (*Diplostomum, Dactylogyrus,* and *Chilodonella*) was found in a few individuals, while all the fishes were affected by dorsal fin necrosis determined by bacteriological tests as "fin rot". The disease, however, hardly influenced the feeding intensity, vitality, and growth, neither did it cause any increase in mortality.

Throughout the experimental period, the fishes kept in the "warm" channel increased their weight by 130% on average, i.e., from 21.0 to 48.4 g (Table). Losses in the stock,

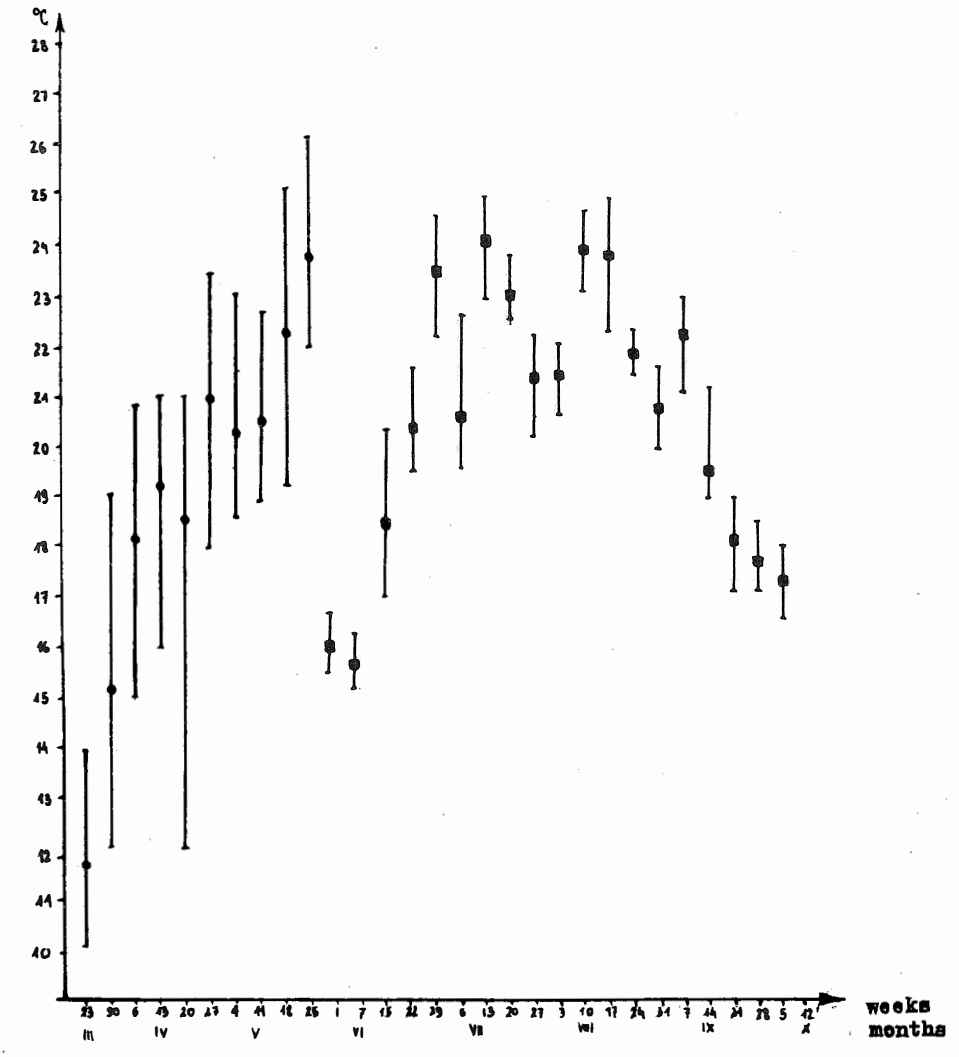

Fig. 2. Temperature ranges and mean temperatures of water in "warm" (●) and "cool" (■) channels

covering both deaths and escapes (19 and 39 individuals, respectively) did not exceed 2%. The feeding coefficient of the food given to fish remained at a more or less stable level (1.9 on average).

The increase observed in the channel water temperature up to 25°C called for transferring the fishes to the "cool" channel. The transfer was executed on May 10, when the difference in water temperatures recorded was 7°C (23°C and 16°C). The health and vitality of fishes transferred were negatively affected by the lack of any slow acclimatization equipment necessary to adapt the fish organism to a lower water

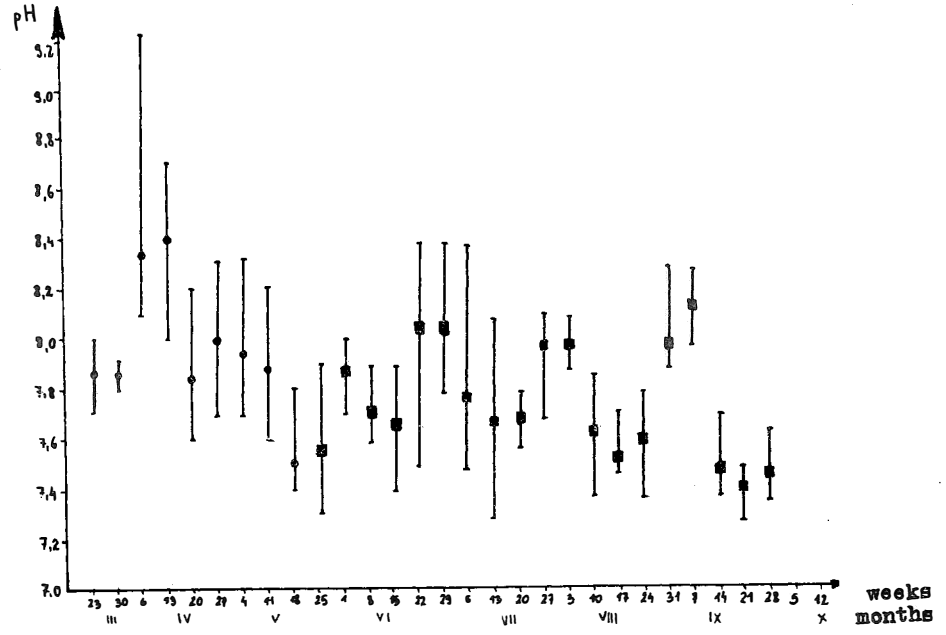

Fig. 3. pH range and mean weekly pH values of water in "warm" (●) and "cool" (■) channels

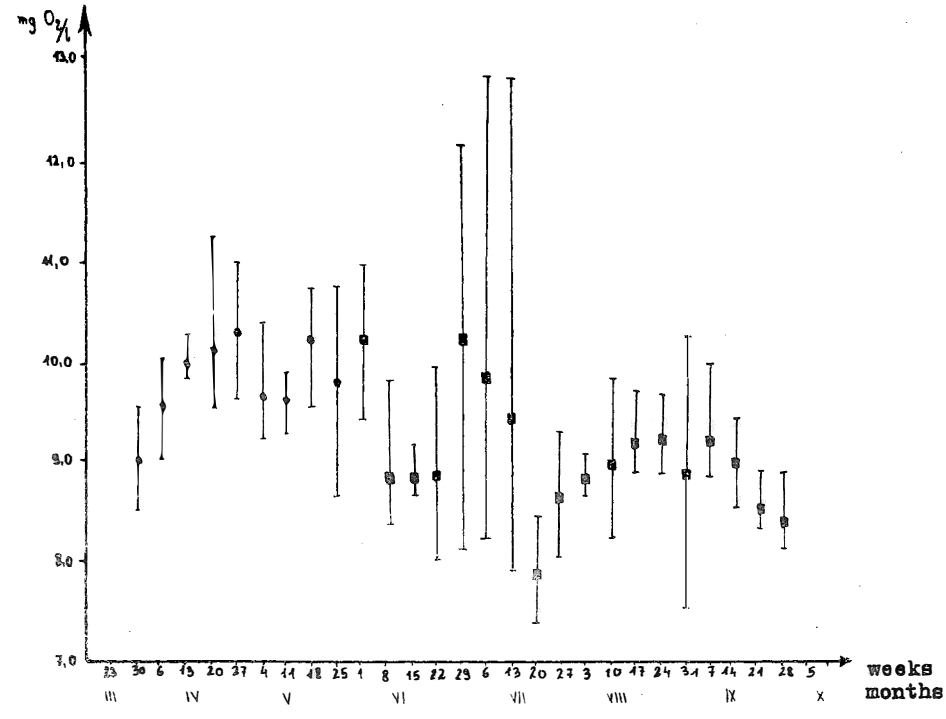

Fig. 4. Oxygen saturation ranges and mean saturation values of water in "warm" (●) and "cool" (■) channels

Table 1

Results of rainbow trout rearing in warm and cool channels

Warm channel

Date of weighing	Number of fish	Total weight of fish	Mean weight	Mean weight increment		Losses (individuals)		Amount of food consumed	Feading coefficient
		(kg)	(g)	(g)	(%)	death	other	(kg)	
16.03.75	3000	63.00	21.00	–	–	–	–	–	–
8.04.75	2983	81.50	27.30	6.3	30.0	–	17	38.87	2.1
22.04.75	2976	103.35	34.70	7.4	27.1	4	3	30.78	1.6
5.05.75	2957	122.70	41.50	6.8	19.6	7	10	34.65	1.7
19.05.75	2942	142.80	48.50	7.0	16.9	8	9	46.17	2.2
				27.4	130.5	19	39	190.57	1.9

Cool channel

18.06.75	1319	98.1	74.4	25.9	53.4	–	47.40	Owing to losses changing the total weight, due to other causes, feeding coefficient was inpossible to be properly calculated at this stage of investigations
2.07.75	1291	114.6	88.8	14.4	19.4	28	33.45	
30.07.75	1219	130.5	107.1	18.3	20.6	72	79.50	
13.08.75	1158	130.9	113.0	5.9	5.5	61	35.00	
27.08.75	1113	134.7	121.0	8.0	7.1	45	40.00	
10.09.75	1075	134.5	125.1	4.1	3.4	38	38.50	
23.09.75	1004	133.2	132.7	7.6	1 6.1	71	33.86	
11.10.75	943	130.6	138.5	6.8	4.4	61	42.50	
				117.5	559.5	376	350.21	

temperature. While no immediate death of any of the rainbow trout individuals was observed, yet the food uptake was stopped completely for a week, the feeding being significantly hampered thereafter. Moreover, almost every day following the transfer 2–10 individuals were found dead in the "cool" channel.

Ichthyopathologic examnations revealed the thermal shock to cause fissures in gill lobes blood vessels in many fishes, the epithelium necrosis and breathing difficulties ensuing. Until the completion of the experiment the fishes were unable to reach the vitality level they were at prior to their removal from the "warm" channel.

The experiment was completed on October 10, 1975, when 943 individuals of an average weight of 138 g and the total weight of 131 kg were caught. Apart from natural losses, about 50 kg of fish were lost due to 3 cases of theft.

CONCLUSIONS

1. The River Odra water used to cool some industrial installations can be utilized to an intensive rearing of fish.
2. It has been found possible to rear rainbow trout in this water from November through April at water temperatures lower than 20°C.
3. The health of fish kept in this water was satisfactory, showing no deviations from the normal state.
4. Using the most valuable food and an appropriate techniques of feeding, the feeding coefficient should not exceed 2.5.

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Streszczenie

Chów doświadczalny pstrąga tęczowego w wodzie odrzańskiej prowadzony był w okresie zimowo-wiosennym w kanale wody pochłodniczej (ciepłym), w miesiącach zaś wiosenno-letnich w kanale doprowadzającym (zimnym) Elektrowni „Dolna Odra". W kanale „ciepłym" ryby przetrzymywano w 3 sadzach sieciowych o wymiarach 1,35× 2,3× 1,5 m i objętości hodowlanej 3 m^3 każdy, w kanale „zimnym" zaś w jednym sadzu, o wymiarach 2,0× 2,0× 1,5 m. W obydwu kanałach sadze hodowlane zawieszone były na samonośnych pomostach.

Temperatura wody w obydwóch kanałach wahała się w granicach 10–27° C, zawartość tlenu nie spadła poniżej 7 mg O_2/l, natomiast odczyn wody (pH) mieścił się w zakresie 7,2–8,4.

Sadze hodowlane obsadzono narybkiem pstrąga tęczowego w dniu 16 03 1975 r. w liczbie 1000 szt/sadz.

Ryby żywiono granulatem pstrągowym, zawierającym 35,2% białka ogólnego, 8,8% tłuszczu i 37,6% substancji węglowodanowych. Dzienna dawka paszy wynosiła 3% ciężaru ciała ryb.

W okresie 65 dni hodowli (16 03–19 05 1975 r.) w wodzie kanału „ciepłego" średni ciężar pstrąga zwiększył się z 21,0 do 48,4 g przy współczynniku pokarmowym paszy 1,9. Ubytki ryb w omawianym okresie, wynikłe na skutek śnięcia i ucieczek były niewielkie i wyniosły 58 szt (1,9%).

Ze względu na wzrost temperatury wody w kanale „ciepłym" do 25° C w dniu 19.05.1975 r. ryby przeniesiono do kanału „zimnego" (o temperaturze wody niższej o 8–10° C), w których do 11.10.1975 r. kontynuowano jego chów. W tym okresie pstrągi zwiększyły swój średni ciężar do 138 g.

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ОПЫТНОЕ ВЫРАЩИВАНИЕ РАДУЖНОЙ ФОРЕЛИ (SALMO GAIRDNERI RICH.) В ВОДЕ ИЗ ХОЛОДИЛЬНИКОВ ЭЛЕКТРОСТАНЦИИ „ДОЛЬНА ОДРА"

Р е з ю м е

Опытное выращивание радужной форели в речной воде р. Одры проводилось в зиме-весенний период в канале воды из холодильников (тёплый) и в весенне-летний период в подводящем канале (холодный) электростанции „Дольна Одра". В „тёплом" канале рыбу удерживали в 3 сетевых садках следующей величины: 1,35 х 2,3 х 1,5 м, объём для выращивания равнялся 3 $м^3$ каждого садка. В „холодном" канале находился один садок (2,0 х 2,0 х 1,5 м). По обоим каналам садки являлись подвешенными на самонесущих платформах.

Температура воды по обоим каналам составляла предел 10-27°С, pH 7,2--8,4, содержание кислорода не уменьшивалось ниже 7 мг O_2/л. Радужную форель в количестве 1000 штук/садок впусками 16.03.75 г.

Рыбу кормили гранулированным кормом для форели, состоящим из: 35,2% общего белка, 8,8% жира и 37,6% углеводных веществ. Дневная доза корма равнялась 3% веса рыбы.

В „тёплом" канале на протяжении 65 дней выращивания (16.03.-19.05.75 г.) средний вес форели увеличивался с 21,0 до 48,4 г при кормовом коэффициенте 1,9. В это время потери рыбы из-за засыпания и бегства являлись небольшими и равнялись 58 штук (1,9%).

Принимая во внимание повышение температуры воды в „тёплом" канале до 25°C, 19.05.75 г. рыбу перенесли в „холодный" канал (температура воды ниже на 8-10°C), в котором её выращивали до 11.10.75 г. За это время средний вес форели увеличивался до 138 г.

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