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Effects of diversified pond carp culture. 2. Water temperature and transparency in ponds with different carp production

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Abstract – The effect of diversified carp stocking and the course of atmospheric conditions on the temperature and transparency of the water in ponds was determined. Increased intensification of carp farming led to a reduction in water transparency and thus a rise in the vertical temperature gradient; in the ponds with the intensive culture the Secchi disc disappeared from almost the beginning of May at a depth of 30 cm and the temperature of the water layer near the bottom in sunny and windless weather was more than 1 °C lower than in the pond without fish.

Key words: ponds, carp culture intensification, water temperature, water transparency.

Oddziaływanie zróżnicowanej intensyfikacji produkcji karpia. 2. Temperatura i przezroczystość wody w stawach z różną produkcją karpia. Określono wpływ zróżnicowanych obsad karpia i przebiegu warunków atmosferycznych na temperaturę i przezroczystość wody w stawach. Wzrost intensyfikacji chowu karpi powodował ograniczenie przezroczystości wody a tym samym wzrost pionowego gradientu temperatury, w stawach z intensywnym chowem krążek Secchiego zanikał prawie od początku maja na głębokości 30 cm a temperatura w przydennej warstwie wody w czasie słonecznej i bezwietrznej pogody była niższa o ponad 1 °C w porównaniu ze stawem bez ryb.

1. Introduction

The intensification of carp production by introducing large amounts of food into a pond and high fish stock density lead to a decrease in the solar radiation penetrating into the pond and at the same time an increase in the vertical thermal stratification, especially in sunny and windless weather (Szumiec 1971). The variability of weather conditions results in rapid and considerable changes in the pond environment (Szumiec at al. 1995).

The aim of the investigation was to demonstrate the changes in water transparency and temperature occurring as an effect of changes in the atmospheric conditions and diversified level of carp culture.

2. Area and method of investigations.

The investigations were carried out in four ponds each with an area of 1500 m^2 and depth of about 1.2 m, two of which were with intensive culture (I-1 and I-2), one with extensive culture (E) with a tenfold smaller fish stock and intensity of feeding, and one pond without fish stock (C). There was no pond fertilization apart from the spring liming.

The water temperature was measured with a calibrated mercury thermometer placed into a bathometer. Water transparency was determined on the basis of disappearance a Secchi disc with diameter of 20 cm. The characteristics of hydrobiological and meteorological conditions of the farming season (May–September) was carried out on the basis of the monthly mean values of the air temperature, total sunny hours, and precipitation measured by standard meteorological methods. Thermal conditions in the ponds were determined taking into account the monthly and ten-day mean water temperatures in the ponds calculated on the basis of measurements carried out three times a day in one of the ponds.

2. Results

The mean air and water temperatures in the ponds in the farming season were higher than the multiannual one, on average May and August being warmer and July cooler. The total of sunny hours in the season was close to the multiannual one, the highest occurring in May and August (Table I). The ten-day mean water temperature in the greater part of the season showed a positive deviation from the multiannual mean (fig. 1). A deficiency of precipitation in comparison with the multiannual mean was observed; the meteorological balance of water, i.e. the difference between precipitation and evaporation, was negative from May to August, the precipitation prevailing over evaporation in September only.

A considerable diversity in water transparency was found in the ponds, depending on the intensity of fish culture. The bottom was seen throughout the season in the control pond (C), with the exception of a few days in May and June. A fall in water transparency below 20 cm occurred only in mid-July in the pond with extensive culture (E), and was greater than in the intensive culture ponds (I-1, I-2), where transparency decreased up to 30 cm in May and varied between

Table I. Meteorological parameters in the carp farming season 1993.

Parameters	Month					Total or mean
	M	J	J	A	S	
Mean air temperature (°C)	16 0	16 1	17.4	17.7	13.4	16.1
Deviation from normal value	3 0	0 0	-0.1	0.7	-0 2	0 7
Total hours of sunshine	229 1	182.6	185 1	223 3	97 5	917.6
Percentage of multiannual values	121	97	92	118	69	101
Mean water temperature (°C)	18.3	20.7	20 2	21 9	16 4	19 5
Deviation from normal value	2.1	0 9	-0.8	1 5	0 1	0 8
Total percipitation (mm)	46 5	80.9	79.1	69 6	110 9	387
Percentage of multiannual values	49	68	62	68	172	76

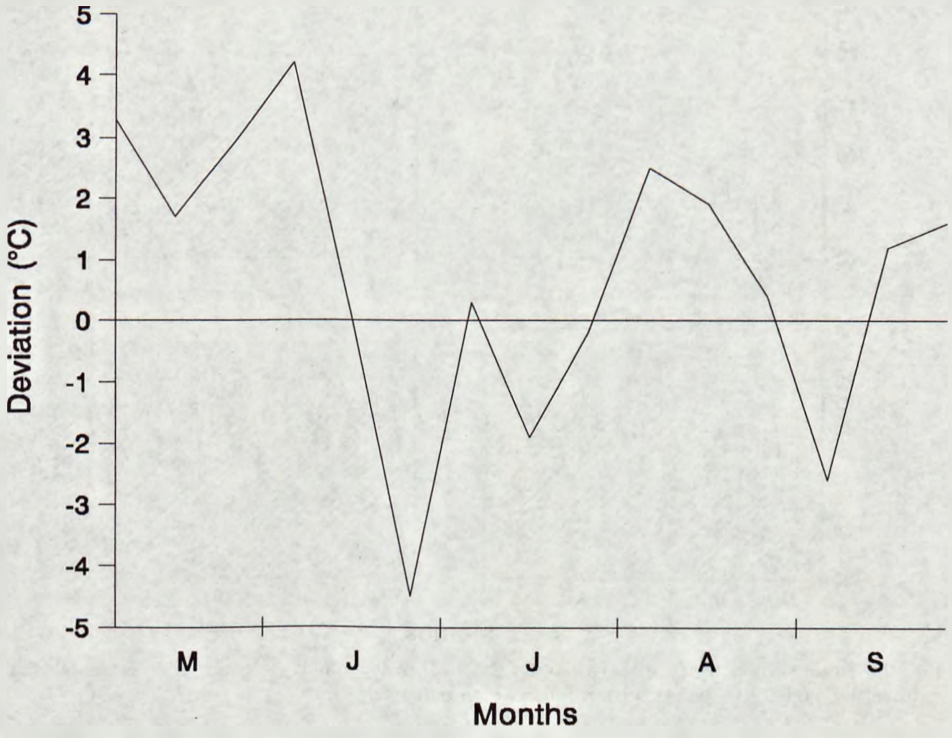

Fig. 1. Deviations of ten-day mean water temperature of carp ponds in the season 1993 from the multiannual mean.

20 and 40 cm by the end of the season (fig. 2). The danger of a potential oxygen deficiency appearing in the pond when the Secchi disc vanishes at a depth of 20 cm increased with the rise in intensification (Augustyn and Szumiec 1985). The circumstances for a potential oxygen deficiency existed in pond E in mid-July, whereas in the ponds I-1, I-2 they appeared at the beginning of the season and were maintained with small intervals throughout the whole season.

Significant differences between the vertical temperature gradient developed in sunny and windless weather, when the temperature above the bottom in pond I-1 was over 1 °C lower than in pond C, while on cloudy days thermal stratification was not observed (fig. 3).

4. Summary

The thermal conditions in the farming season 1993 were favourable for carp growth, particularly in May and August.

The high water temperature affected the phytoplankton growth in the intensive ponds from the beginning of the season (Urbaniec-Brózda 1995), resulting in decreased water transparency in these ponds.

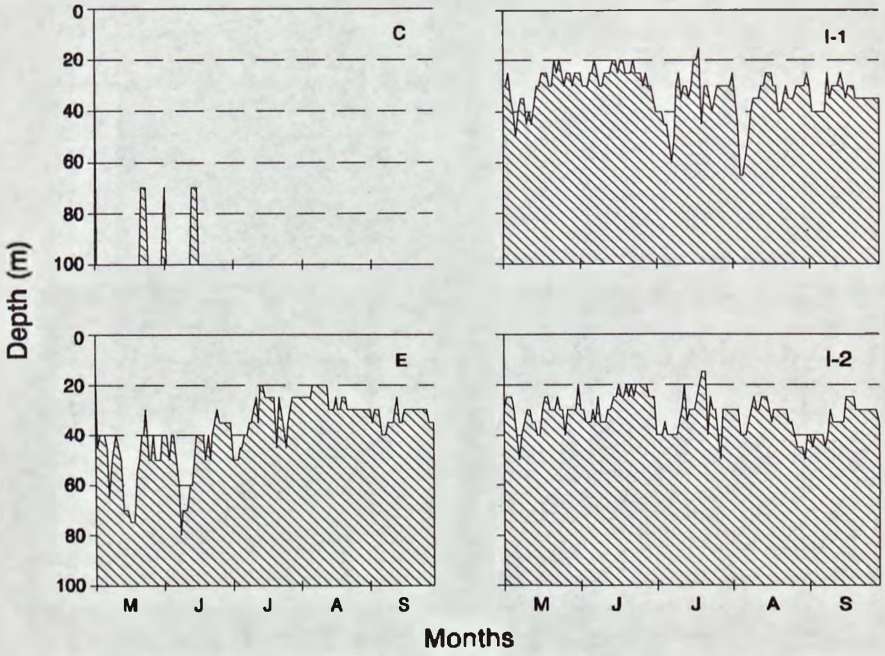

Fig. 2. Water transparency in carp ponds: C — control pond, E — pond with extensive fish culture, I-1 and I-2 — ponds with intensive fish culture).

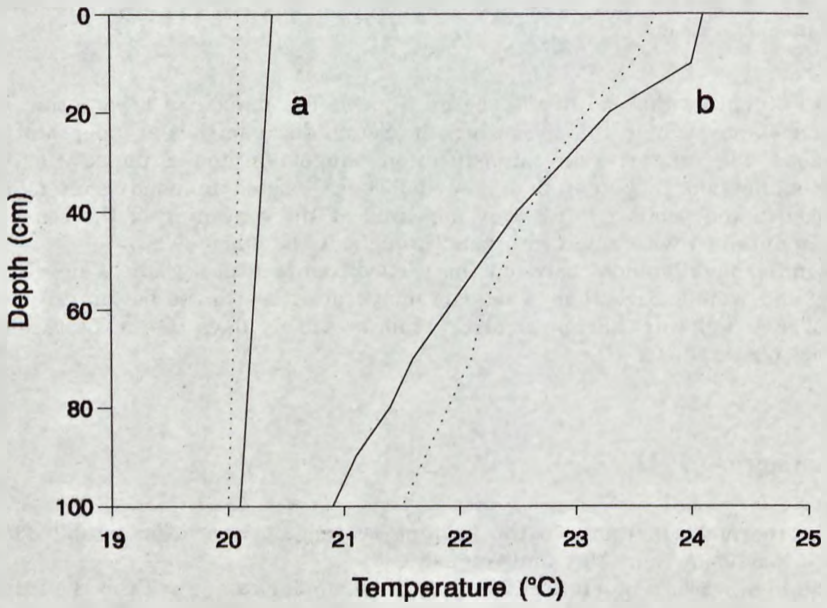

Fig. 3. Thermal stratification in carp pond with intensive fish culture (solid line) and in control pond (broken line): a — cloudy days, b — sunny days.

Together with increased intensification of fish culture, water transparency declined in the ponds but thermal stratification rose, resulting from greater absorption of solar radiation in the surface layers of two water in ponds with intensive culture (Szumiec 1971, 1975).

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