Does Low Environmental pH Influence Hepatic Growth in Fish?

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WESTFALL (1945) and KUHN & KOECKE (1956) have described harmful effects on the gills of fish which have been exposed to low pH values. There are, however, no reports about negative effects from life in acid water on the internal organs. Fish liver has proved useful in analyses on effects of water pollutants (POELS & STRIK 1975, STRIK et al. 1975). This study was performed to find possible effects of chronically reduced pH on brown trout (Salmo trutta) liver.

MATERIAL AND METHODS

Genetically similar brown trout yearlings (18 mo) averaging 13,6 cm and 25,6 g were obtained from a commercial hatchery. After thermal acclimation to 12°C, six fish were transferred to each of six polyethylene aquaria of 135 litres each. Two aquaria were given untreated tap water, while lower pH values were obtained by addition of dilute sulphuric acid. The pH in each aquarium was measured from four to six times daily on a Radiometer Metrohm pH meter. The mean values are given in TABLE 1. No buffer was added, but in no aquarium no more than ten per cent of the pH measurements differed by more than 0,4 pH units from its mean value. The water temperature was kept at 12,5 ± 1,5°C. Tap water alkalinity samples did not exceed 0,11 ml 0,1 N HCl/l, and electrical conductivity samples averaged 30 µmho/cm. Air was injected gently into the water. The water in each aquarium was renewed daily to remove faeces and remnants of food and reduce the buildup of metabolites. The aquaria were lightened by fluorescent tubes which were turned off between 23^{00} and 07^{00}.

The fish were fed EWOS salmon grower size 4. Total daily ration was 0,75 g food per fish, i.e. 2,9 per cent of the initial body weight, and the food was delivered in three portions daily five days a week and two portions daily two days a week for a total of 48 days. During the experiment four fish were removed from the aquaria because

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of attacks by some unspecified disease which caused erosion of fins or skin, two fish died from digestive problems and two fish died in spite of no visible diseases. When a fish was removed, the food ration delivered to its aquarium was reduced correspondingly.

The fish were measured in a tagging cradle described by NORDENG (1970) and weighed alive in a box of water before and after the feeding period. At the end of the experiment the fish were killed and their livers weighed on a Mettler H 35 balance. Assuming the ratio between liver growth and total fish growth to be constant at normal conditions, a "liver index" W_1/L^3, where W_1 is liver weight in mg and L is fish lenght in cm, was used for comparison between the aquaria.

TABLE 1

Liver index of brown trout exposed to different pH levels for 48 days. S.D. for each level is given.

Aquarium	pH	N	Liver index (x 10^{-1})
1	6,26	64	1,48 ± 0,23
2	6,27		
3	5,44	65	1,14 ± 0,16
4	5,43		
5	4,95	16	1,22 ± 0,11
6	5,00		

RESULTS AND DISCUSSION

The results are given in TABLE 1. A t-test showed that the groups held at pH 5,4 and 5,0 both had a significantly lower liver index than the control group ($P < 0,005$ and $P < 0,025$, respectively), while no significant difference was detected between fish held at pH 5,4 and pH 5,0. Taking the relatively short experimental period into consideration, the results indicate slower hepatic growth in the fish held at lower pH, though no direct proportionality can be declared. Possibly a lowering of the pH below a certain level will not bring about a further growth rate reduction. Since no histological analysis was performed on the livers, it cannot be stated whether only certain cell types had been inhibited, or if a generally retarded growth had taken place.

POELS & STRIK (1975) held accumulation of PCB's and chlorinated hydrocarbons responsible for increased liver

weights in fish exposed to contaminated water. The effect of reduced pH seems to be opposite. LLOYD & JORDAN (1964) found reduced pH in the venous blood of rainbow trout (Salmo gairdneri) which had died from low pH, and LEIVESTAD & MUNIZ (1976) observed lower plasma chloride and sodium content in surviving brown trout from an area with severe fish kills caused by low pH compared with fish from an unstressed locality in the upper parts of the same river. Possibly reduced blood pH or low plasma sodium chloride content may inhibit growth partly in certain organs, but further investigations are needed to find the real responsible factor(s). Similarly, to test whether reduced hepatic growth is a general result from life in acid water, analyses on larger numbers of fish should be carried out, both experimentally and in vivo.

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