Short Communication

BROWN TROUT (SALMO TRUTTA L.) GROWTH AT REDUCED pH

ODD J. JACOBSEN
Zoological Institute, University of Oslo, Blindern, Oslo 3 (Norway)
(Received 9 March 1977)

ABSTRACT


The growth of brown trout (Salmo trutta) yearlings (18 months) was studied at environmental pH levels of about 6.26, 5.44 and 5.00 and a daily ration of 2.9% of the initial body weight. Growth increments for fish at each pH level during a 48-day period were similar.

INTRODUCTION

It is a well known fact that fish usually grow faster in neutral or alkaline waters than in acid ones (European Inland Fisheries Advisory Commission, 1969). Indications exist that this may be due to a direct effect of the pH on the fish (Menendez, 1976), while Pentelow (1944) and others hold that the relation between food supply and fish population density is the factor mainly responsible for slow fish growth even in acid lakes. The present study was undertaken to investigate the effect of experimentally reduced, sublethal pH values on the growth rate of brown trout, Salmo trutta.

MATERIAL AND METHODS

Genetically similar brown trout yearlings (18 months old), averaging 13.6 cm and 25.6 g, were obtained from a commercial hatchery (Drammen and Omegn Fishery Administration). After thermal acclimation to 12°C, six fish were transferred to each of six polyethylene aquaria of 135 l each. Two aquaria were filled with 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 per day on a Metrohm pH meter. The mean pH values are given in Table I. No buffer was added, but in no aquarium did more than 10% of the pH measurements differ by more than 0.4 pH units from their 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
The water was gently aerated. The water in each aquarium was renewed daily to remove faeces and remnants of food and reduce the accumulation of metabolites. The aquaria were lit by fluorescent tubes which were turned off between 23.00 and 07.00 h.

The fish were fed Ewos salmon grower size 4. The total daily ration was 0.75 g/fish, i.e. 2.9% of the initial body weight, and the food was delivered three times per day 5 days a week and two times a day 2 days a week for a total of 48 days. To avoid anaestheticizing, the fish were weighed alive in a box of water and measured in a tagging cradle described by Nordeng (1970) before and after the experiment. To identify the fish, each fish was marked by careful fin clipping at the beginning of the feeding period.

During the experiment four fish were removed from the aquaria because of attacks by some unspecified disease which caused erosion of fins or skin, two fish died from digestive problems and two fish died with no visible signs of illness. The total mortality was highest in the most acid aquaria. When a fish was removed, the food ration delivered to its aquarium was reduced correspondingly.

RESULTS

The fish surviving the experiment increased on average by 1.7 cm in length and 11.7 g in weight during the 48-day period. Only one fish had a length increment less than 1.0 cm. The separate fish groups showed no significant difference in growth rate (Table I), and if the only surviving fish in aquarium 5, which lived on its own for half the experimental period, is excluded the growth rates were almost identical. No behavioural difference was observed between the aquaria when delivering the food.

TABLE I

Growth (mean ± S.D.) of yearling brown trout (*Salmo trutta*) after 48 days’ exposure to various pH levels

<table>
<thead>
<tr>
<th>Aquarium</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean pH</td>
<td>6.26</td>
<td>6.27</td>
<td>5.44</td>
<td>5.43</td>
<td>4.95</td>
<td>5.00</td>
</tr>
<tr>
<td>Surviving fish</td>
<td>6</td>
<td>4</td>
<td>6</td>
<td>5</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Initial length (cm)</td>
<td>13.6 ± 1.1</td>
<td>13.6 ± 0.9</td>
<td>13.9 ± 0.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Length increment (cm)</td>
<td>1.7 ± 0.7</td>
<td>1.6 ± 0.8</td>
<td>1.9 ± 0.7</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial weight (g)</td>
<td>26.0 ± 6.1</td>
<td>26.3 ± 4.9</td>
<td>26.3 ± 3.0</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight increment (g)</td>
<td>12.7 ± 7.4</td>
<td>10.0 ± 10.2</td>
<td>13.0 ± 10.2</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
DISCUSSION

In vitro experiments never fully reflect the natural environments of a fish population. However, the relatively high growth rate of the surviving fish indicates that possible negative factors have affected them only to a small degree during the experiment. The results therefore suggest that a moderate reduction of the pH has negligible or no effect on the growth rate of brown trout, which is in accordance with results for fathead minnow (*Pimephales promelas*) (Mount, 1973). In contrast, Menendez (1976) concluded that brook trout (*Salvelinus fontinalis*) seemed to have slower growth at low pH than in neutral conditions. In Menendez' experiment, the adult fish exposed to pH 4.5 and 5.0 grew significantly slower during the first 3 months compared to the control group held at pH 7.0, whereas no difference was observed during the next 2 months. However, since tagging of the fish was obviously not performed in his study, a comparison between the mean initial weight and the mean terminal weight would possibly not reflect the exact mean growth increments, taking the degree of mortality of the fish during the experiment into consideration. Real discrepancies between brook trout and brown trout explained on phylogenetic grounds may exist, as proposed by Shaw et al. (1975) regarding the different influence of environmental salinities on the growth rate in coho salmon (*Oncorhyncus kisutch*) parr (Otto, 1971) and Atlantic salmon (*Salmo salar*) parr (Shaw et al., 1975). The influence of pH on the growth rate may also change from one stage in a fish's life to another.

Increased salt content in the water is known to reduce fish mortality at a certain pH level (Leivestad et al., 1976), and Leivestad (1965) states that the metabolic work required to maintain an osmotic gradient between the internal and external environment is proportional to this gradient. In waters of low electrolytical conductivity, as in this experiment, one might, therefore, expect that a moderate addition of acid would reduce this gradient and thus contribute to the maintenance of the growth rate. However, Potts (1954) calculated the energy expended on osmoregulation to be only a small proportion of the total energy consumed. Whether reduced pH generally influences the growth of freshwater fish directly, and which mechanisms are involved in growth rate regulation, should probably still be regarded as open questions.

ACKNOWLEDGEMENTS

I am grateful to B. Sleire for performing some of the water analyses.

REFERENCES


