ABSTRACT

Three models of the sieving mechanism of the branchial sieve were used to predict the ability to retain zooplankton of three sympatric cyprinids: common bream, white bream and roach. The model predictions were tested with filter-feeding experiments, using three size classes of each species. Results of experiments in darkness corroborated closely with the reducible-channel model for common bream (retention in the medial channels on the gill arches; the diameter of these channels can be reduced with the lateral rakers), rather well with the unreducible-channel model for white bream (the channel diameter cannot be reduced) and possibly with the saw-tooth model for roach (retention on the gill slits). Common bream can adjust the mesh size of its branchial sieve, thus achieving a higher flexibility in food uptake than the other two species. In light experiments, roach and the small common and white bream switched to particulate intake, characterized by a lower retention ability and a higher filtering rate than during gulping.

The retention ability was used to calculate the percentage of the available zooplankton energy that the three cyprinids can retain as a function of the fish's length. This retained energy percentage decreases sigmoidly with increasing fish length. At any length between 10-50 cm, common bream has the highest retained energy percentage, white bream the lowest and roach is intermediate. The population of common bream will therefore be at an advantage in the competition for food when zooplankton is a major food source, like in eutrophic lakes.

KEY WORDS: cyprinids, zooplankton, retention ability, filtering rate, branchial sieve, eutrophication, competition, reducible-channel model.

INTRODUCTION

Common bream (*Abramis brama*), white bream (*Blicca bjoerkna*) and roach (*Rutilus rutilus*) are opportunistic feeders and their diets show a considerable degree of overlap (LAMMENS & HOOGENBOEZEM, 1991). The most frequently found food categories of common bream are dipteran larvae and zooplankton and of white bream dipteran larvae, molluscs, macrocrustaceans and to a lesser extent zooplankton. The
food categories of roach include all of the above, but dominant food types are molluscs, detritus/algae and macrophytes (LAMMENS & HOOGENBOEZEM, 1991). Common bream, white bream and roach can coexist in a diversified habitat with both vegetation and open water, where each species occupies its own niche. However, due to eutrophication such conditions have become rare in the Netherlands. In Tjeukemeer (a eutrophic lake in the north of the Netherlands) large numbers of algae and suspended particles strongly reduce the light level and macrophytes have almost disappeared (LAMMENS, 1986, 1989; DE NIE, 1987). Chironomid larvae, buried in the soft substrate, and zooplankton are the major food sources for the fishes (LAMMENS, 1986, 1989).

Due to the reduced diversity of the eutrophic lake ecosystem, common bream, white bream and roach are forced to live in the same niche, which most resembles the original niche of common bream (open water). In these (eutrophic) circumstances common bream has become the dominant fish species, while the other cyprinid species have decreased sharply in number and average size. This corroborates the common notion that a certain amount of niche segregation is required for species to coexist in an ecosystem. A major aim of this study is to find out why the opportunistic cyprinids discussed here cannot coexist in the same niche and why common bream is dominant in eutrophic lakes. Competition for food may well be an important factor. In eutrophic lakes white bream and roach are forced to compete with common bream for zooplankton and chironomid larvae. if these food sources are limited, differences in feeding efficiency will lead to dominance of the most efficient species.

Filter-feeding fishes exert a positive size selection on the zooplankton and will therefore change the size-frequency distribution of the zooplankton population. The average size of each zooplankton species in Tjeukemeer is smaller than in non-eutrophic lakes (DE NIE et al., 1980; LAMMENS, 1985), indicating a strong predation pressure. In summer, the average length of *Daphnia hyalina* is reduced from about 1.5 to 0.7 mm, which is caused by plankton feeding of the new 0+ fish generation (Vijverberg & Richter, 1982a) and by the poor food conditions for the zooplankton (Boersma et al., 1991). These data strongly suggest that the supply of zooplankton (in particular the larger specimens) is limited in eutrophic lakes. Hence, competition for zooplankton is likely to occur. Interspecific differences in retention ability (the ability to retain the smaller zooplankters, as well as the larger ones) may therefore be a crucial factor explaining the relatively sudden dominance of common bream in eutrophic lakes (Hoogenboezem et al., 1991, 1993).