RAPID MORPHOLOGICAL CHANGES FOLLOWING NICHE SHIFT IN THE ZOOPLANKTIVOROUS CYPRINID RASTRINEOBOLA ARGENTEA FROM LAKE VICTORIA

by

JAN H. WANINK and FRANS WITTE

(Institute of Evolutionary and Ecological Sciences, University of Leiden, PO Box 9516, 2300 RA Leiden, The Netherlands. E-mail: wanink@rulsfb.leidenuniv.nl)

ABSTRACT

During the 1980s, the zooplanktivorous cyprinid dagaa (Rastrineobola argentea) expanded its habitat in Lake Victoria. After the eradication of the zooplanktivorous haplochromine cichlids from the sublittoral waters of the Mwanza Gulf (Tanzania) by introduced Nile perch (Lates niloticus), adult dagaa started to explore the bottom zone during daytime. This main daytime habitat for zooplankton and macrobenthic invertebrates was formerly occupied by the haplochromines. Besides extending its range of vertical distribution, dagaa started to include macrobenthic invertebrates in its diet.

In this paper, we present two rapid morphological adaptations of dagaa to its new niche. Samples from 1988, only one year after daytime bottom dwelling became a common habit in dagaa, showed a higher number of gill filaments in comparison with samples from 1983. In contrast, the same samples showed a decrease in the number of gill rakers. The observed increase in the number of gill filaments is postulated to have improved the capacity of dagaa to extract oxygen from the water, which may be crucial to survive the relatively poor oxygen conditions in the new habitat. By decreasing the number of gill rakers dagaa has probably increased its efficiency of feeding on relatively large prey in a benthic habitat.

KEY WORDS: gill filaments, gill rakers, hypoxia, diet change, macrobenthic invertebrates, competitive release, Lates niloticus.

INTRODUCTION

During the 1980s, dramatic changes in the fish fauna of East African Lake Victoria followed the explosive population increase of the Nile perch (Lates niloticus), an introduced large predator (OGUTU-OHWAYO, 1990; WITTE et al., 1992a, b). In contrast to most of the formerly dominating haplochromine cichlids, which were eradicated from the sublittoral waters, the zooplanktivorous cyprinid dagaa (Rastrineobola argentea) strongly increased in numbers, despite its becoming an important prey
for Nile perch (WANINK, 1991, 1999). Competitive release was probably one of the factors behind the success of dagaa. After the disappearance of the haplochromines, dagaa expanded its formerly pelagic distribution and invaded the benthic zone (WANINK, 1998). Adult dagaa now shows the same diel migration patterns as haplochromine zooplanktivores did in the past, concentrating near the bottom by day and surface dwelling at night, thus following the vertical movements of zooplankton (GOLDSCHMIDT et al., 1990; WANINK, 1992; WANINK et al., 1999). Concomitantly with the habitat expansion dagaa started to add chironomid larvae and prawns (Caridina nilotica) to its diet (WANINK, 1998). These macrobenthic invertebrates became much more abundant in the lake after the Nile perch boom (MBAHINZIREKI, 1992; WITTE et al., 1995).

We expected that the observed niche shift in dagaa would lead to at least two morphological adaptations. Firstly, during the rainy season the lower part of the 14 m deep water column at our sampling station sometimes becomes deoxygenated, and these periods of hypoxia have increased in recent years (VAN OIJEN et al., 1981; WANINK et al., in press). It has been shown that of two closely related haplochromines, which used to live in our study area, the species which inhabited water of 8-15 m deep had more gill filaments than the species which lived in water of 3-9 m deep (HOOGERHOUD et al., 1983). The number of filaments is a plastic form-feature of the gills, which partly determines the capability of a fish to extract oxygen from the water (GALIS & SMIT, 1979; GALIS & BAREL, 1980). Hence, an increase in the number of gill filaments may be necessary for dagaa to successfully invade the benthic habitat.

Secondly, benthic feeders usually have a lower number of gill rakers than pelagic feeders, both inter- and intraspecifically (JANSSEN, 1978; BODALY, 1979). This is caused by the fact that a small distance between the gill rakers, which is necessary for zooplankton feeding, makes it difficult for a benthic feeder to separate food from substrate. In Lake Michigan a decrease in gill raker numbers was found in a zooplanktivorous cisco (Coregonus hoyi) after being forced to switch to benthic prey by the invasion of an alien competitor (CROWDER, 1984). Phenotypic plasticity may allow for rapid changes in the number of gill rakers (LINDSEY, 1981).

In this paper we present the results of a preliminary investigation of the gills of dagaa sampled before and after the niche shift.

**MATERIAL AND METHODS**

Fish were collected from the 14 m deep sampling station G in the Mwanza Gulf, at the southernmost tip of Lake Victoria (details in VAN OIJEN et al.,