

Kleine Mitteilung

**Temperature preference of the redbelly tilapia,
Oreochromis zilli (GERVAIS)**

By J. R. STAUFFER, Jr., J. M. BOLTZ and S. E. BOLTZ

With 1 figure in the text

Abstract

The acute preferred temperature of the redbelly tilapia, *Oreochromis zilli* (GERVAIS) was determined in a horizontal thermal gradient. Fish were acclimated to 20, 25, 30, and 35 °C at a rate which did not exceed 1 °C per day. The model which best described the relationship between preferred temperature (P) and acclimation temperature (A) was $P = 2.52A - 0.032A^2 - 14.4$ ($R^2 = 0.73$). The final preferred temperature was 38.4 °C and was determined by calculating the point where acclimation temperature equalled preferred temperature. It was hypothesized that the final preferred temperature approached the upper lethal temperature, because attempts to acclimate *O. zilli* to 40 °C resulted in 100% mortality.

Introduction

Oreochromis zilli (GERVAIS), the redbelly tilapia, is native to Africa and the Jordan River in the Near East (THYS VAN DEN AUDENAERDE 1968). This species has been introduced into the United States, with populations occurring in Arizona, California, Florida, Texas, Alabama, North Carolina, and South Carolina (COURTENAY et al. 1986). Known reproducing populations occur only in the first four states listed above (COURTENAY 1986).

Temperature may act as a directive factor (FRY 1947, STAUFFER 1980) which "allow(s) or require(s) a metabolic response on the part of the organism directed in some relation to a gradient of the factor" (FRY 1947:22). Previous studies indicate that preferred temperature of various species may be influenced by their geographical location (SHINGLETON et al. 1981, STAUFFER et al. 1984, STAUFFER 1980, CHERRY et al. 1975, STAUFFER et al. 1976). This may have implications concerning the ability of exotic fishes to successfully expand their range. In two previous studies of exotic fishes, *Oreochromis mossambicus* (PETERS) and *Sarotherodon melanotheron* (RUPPELL), results indicated that based on their respective lethal and preferred temperatures, these species have the potential to expand their ranges within North America (STAUFFER et al. 1984, STAUFFER 1986 a, 1986 b).

Preferred temperature is influenced by many factors including: starvation (BOLTZ et al. 1987); salinity (STAUFFER et al. 1984, STAUFFER 1986 a); age (STAUFFER et al. 1985, STAUFFER 1986 b); and sex (STAUFFER et al. 1985).

The purpose of this study was to determine the preferred temperature of *O. zilli* as a means at predicting its range in the U. S.

Materials and methods

All specimens of *O. zilli* used in this experiment were raised at The Pennsylvania State University from brood stock obtained from the Leestown National Fisheries Center, Kearneysville, West Virginia. Fish were held on a 12:12 L:D photoperiod maintained by Vitalites, which emit light similar in quality to that of natural sunlight. The fish were fed a commercial diet *ad libitum*, except on days when they were tested. Fish were acclimated to 20, 25, 30, and 35 °C at a rate that did not exceed 1 °C per day. Fish were held at the acclimation temperature for a minimum of five days prior to testing.

Tests were conducted in an aluminum trough (3.6 m × .203 m × 0.245 m) modeled after the one described by MELDRIM & GIFT (1971). The interior of the trough was painted with a non-toxic white epoxy paint and the exterior bottom was painted with a temperature resistant flat black paint to facilitate heating. Cool water was introduced at one end and was heated by a series of twelve 250-watt heat lamps located beneath the trough, creating a 15–20 °C temperature gradient. Temperature was monitored using twenty-two evenly spaced thermistors. The water depth was maintained at approximately 4 cm. The trough was enclosed with plywood panels to minimize external disturbance. Overhead mirrors placed at an angle provided a complete view of the trough.

Eight fish were tested individually at each acclimation temperature. Fish were placed in the trough at a point equal to the acclimation temperature and given forty minutes to accommodate to the test conditions. Water temperature at each fish's location was recorded every 15 seconds for the next twenty minutes. A statistical model that best described the effect of acclimation temperature (independent variable) on preferred temperature (dependent variable) was derived using a stepwise linear regression procedure. The final preferred temperature was then calculated by solving the equation for the point where preferred temperature equalled acclimation temperature.

Results and discussion

The model which best described the relationship between acclimation temperature and preferred temperature was $P = 2.52A - 0.032A^2 - 14.4$ ($R^2 = 0.73$) where P is preferred temperature and A is the acclimation temperature (see STAUFFER 1980). The point where $P = A$, the final temperature preferendum (FRY 1947) was calculated to be 38.4 °C. Fig. 1 shows the relationship between acclimation temperature and preference temperature. Throughout the range of acclimation temperatures tested, preferred temperature increased with an increase in acclimation temperatures for *O. zilli*.

This experiment supports the hypothesis that final preferred temperature approaches the upper lethal temperature. The preferred temperature of *O. zilli* as indicated above is 38.4 °C, and our attempts to acclimate *O. zilli* to 40 °C resulted in 100% mortality. Thus, it is hypothesized that the upper lethal tem-

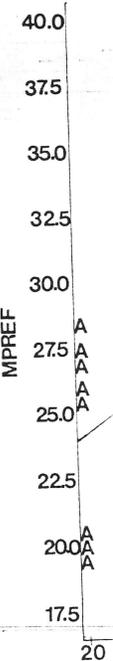


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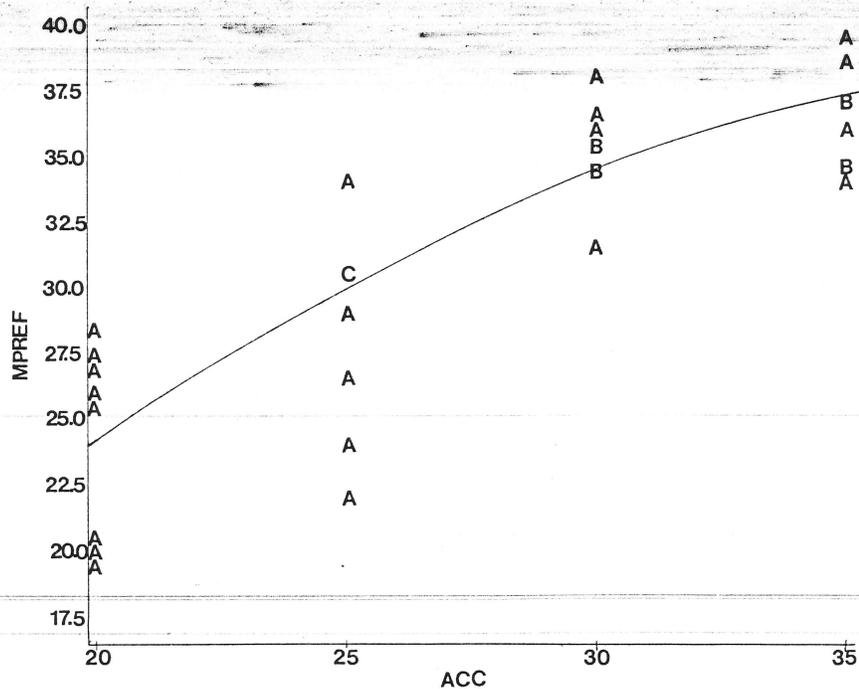


Fig. 1. Mean preference temperature (MPREF) plotted against acclimation temperature (ACC), where A = 1 observation, B = 2 observations, etc.

perature for *O. zilli* is between 38.4 °C and 40.0 °C. Although no test was conducted to determine the upper lethal temperature, it was noted during the acclimation period that the fish died at approximately 39.0 °C after 1 day.

Further studies need to be conducted in order to determine the lower lethal temperature of *O. zilli*, so that the northern limit of this species in North America may be predicted.

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